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Western Journal of Emergency Medicine:

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Western Journal *of* Emergency Medicine:

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Scribe Impacts on Provider Experience, Operations, and Teaching in an Academic Emergency Medicine Practice

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Introduction: Physicians dedicate substantial time to documentation. Scribes are sometimes used to improve efficiency by performing documentation tasks, although their impacts have not been prospectively evaluated. Our objective was to assess a scribe program's impact on emergency department (ED) throughput, physician time utilization, and job satisfaction in a large academic emergency medicine practice.

Methods: We evaluated the intervention using pre- and post-intervention surveys and administrative data. All site physicians were included. Pre- and post-intervention data were collected in four-month periods one year apart. Primary outcomes included changes in monthly average ED length of stay (LOS), provider-specific average relative value units (RVUs) per hour (raw and normalized to volume), self-reported estimates of time spent teaching, self-reported estimates of time spent documenting, and job satisfaction. We analyzed data using descriptive statistics and appropriate tests for paired pre-post differences in continuous, categorical, and ranked variables.

Results: Pre- and post-survey response rates were 76.1% and 69.0%, respectively. Most responded positively to the intervention, although 9.5% reported negative impressions. There was a 36% reduction (25%-50%; p<0.01) in time spent documenting and a 30% increase (11%-46%, p<0.01) in time spent in direct patient contact. No statistically significant changes were seen in job satisfaction or perception of time spent teaching. ED volume increased by 88 patients per day (32-146, p=0.04) pre- to post- and LOS was unchanged; rates of patients leaving against medical advice dropped, and rates of patients leaving without being seen increased. RVUs per hour increased 5.5% and per patient 5.3%; both were statistically significant. No statistically significant changes were seen in patients seen per hour. There was moderate correlation between changes in ED volume and changes in productivity metrics.

Conclusion: Scribes were well received in our practice. Documentation time was substantially reduced and redirected primarily to patient care. Despite an ED volume increase, LOS was maintained, with fewer patients leaving against medical advice but more leaving without being seen. RVUs per hour and per patient both increased. [West J Emerg Med. 2015;16(5):602-610.]

INTRODUCTION

Patient care includes a range of indirect activities, such as reviewing patient charts, documenting findings and impressions, ordering and reviewing tests, and interacting with other healthcare personnel. Indirect care constitutes a significant proportion of emergency medicine (EM) physician tasks,[1] and was found to occupy more than half of EM physicians' time in academic settings in one study.[2]

Scribes–paraprofessional staff that perform charting and sometimes other tasks for licensed medical providers–have been used to reduce indirect patient care demands. Scribes have long been a fixture in American healthcare[3,4] but have become more common in the last decade. Their roles are generally agreed upon but not fixed. Their primary role is to document in the medical record at the direction of a physician. Scribes can also help navigate the medical record, gather results of laboratory and radiographic testing, and assist with managing and coordinating communication with consulting and referring physicians.

Scribes have become common in EM, and scribe services are typically acquired through contracts with national corporations. Scribe corporations tout the benefits of scribes for emergency departments (EDs),[5-7] citing known associations between waits and delays in care and patient satisfaction and quality of care,[8,9] as well as associations between physician job satisfaction and time for teaching in academic settings[10-12] and links between job satisfaction and burnout risk, which is particularly high in EM.[13] Corporations also highlight the potential impacts on the bottom line by increasing the number of patients seen per hour and improving documentation, reducing downcoding and thereby increasing reimbursement.

Scribes have recently become a significant part of the healthcare landscape in recent years and have been seen, in part, as a workaround for cumbersome electronic medical records.[14] Research on scribes and their impacts on EM is growing. Preliminary work in the form of recently published abstracts has substantiated some of scribe service providers' claims, suggesting, for instance, that scribes have the potential to protect against burnout,[15] that scribe services may increase ED throughput,[16] productivity among certain providers,[17] and revenues,[18] decrease turnaround time for billing,[17] and decrease downcoding.[18] Other work suggests that scribes can increase the amount of teaching in a clinical shift.[19]

Several published studies suggest scribe programs have the potential to improve EM productivity and operations but that improvements vary by context. Arya et al. found that at one-year post-implementation of a scribe program there was an increase in patients seen per hour and in relative value units (RVUs) generated per hour but no effect on time to discharge.[20] Marshall et al. found no change in patients seen per hour, a decrease in patient length of stay (LOS), and no change in physician charges.[21] Bastani et al. found post-scribe improvements in the time to see a provider and the time from provider to admission as well as in ED LOS and patient satisfaction.[22] Walker et al. found a decrease in time to provider and increase in productivity and revenue in their Melbourne ED.[23] Using retrospective methods, Allen et al. found an increase in ED throughput and provider satisfaction after scribes were implemented.[24]

While scribe impacts on productivity have been studied prospectively, research on other outcomes such as provider satisfaction and teaching have been retrospective. The goal of this prospective study was to assess a scribe program's impact on ED throughput, physician time utilization, and physician job satisfaction in a large, urban, academic EM practice. Our hypothesis was that the incorporation of a scribe program would increase the amount of time spent in direct contact with patients, increase the amount of time spent teaching students and residents, improve overall work efficiency, and improve provider job satisfaction.

METHODS

Study Setting and Design

This was a prospective quasi-experimental pre-post design conducted in an academic EM practice supporting multiple EDs. The scribe program was implemented in two of these EDs, both in primary teaching hospitals within our university medical center with a combined volume of 100,000 annual patient visits. Our EM academic practice has approximately 70 providers working at these two sites and an annual turnover rate of approximately 3%. Providers typically work in one of the two sites as well as an independently-owned county hospital that did not implement a scribe program. Both scribe sites host residents and medical students.

Selection of Participants

Study subjects were EM physicians with clinical and teaching responsibilities in our academic practice. Physicians were eligible if at least half of their clinical time was spent at one of the two scribe sites (hereafter termed primary site). There was no minimum clinical time threshold required to participate. The study was approved by our institutional review board and participants gave written consent to participate.

Interventions

The intervention was the implementation of a scribe program at the two clinical sites. Emergency Medical Scribe Systems (EMSS) implemented the program and provided ongoing program management. There were no financial arrangements between EMSS and any of the authors. In the EMSS model, scribes are college students or recent college graduates interested in health science careers. Scribes receive on the job training and are considered by EMSS to be proficient after 15 shifts and skilled after 45 shifts. The program was initiated in January 2012 and fully staffed (defined as greater than 95% of shifts with a scribe) beginning April 2012. Scribes and providers are matched for a shift and

the scribe works closely with the physician and transcribes the history of present illness, physical exam findings, differential diagnosis, and medical decision-making. The scribe also documents orders, procedures, test results, and consultant input, as well as patient re-evaluations and final disposition. Scribe charts are forwarded to providers for review, amendment, and signature. By the time post-intervention data were collected all scribes had enough experience to be considered skilled (i.e. each had worked more than 45 shifts).

Methods and Measurements

This study used multiple data collection methods. The primary sources of data were administrative data and two self-administered online surveys of EM physicians, one administered prior to the scribe intervention and one approximately six months afterward.

The administrative data were collected for similar time periods and included data on ED throughput, including ED LOS, defined as the time between patient arrival and departure from the ED; the rate of patients leaving without being seen (WBS) and leaving against medical advice (AMA). These metrics are standardized across the specialty[25] and known to correlate with other outcomes such as ED crowding and wait times.[26] Data on provider productivity including patients seen per hour, RVUs per hour, and RVUs per patient were collected through administrative records. Pre- and post-intervention data were collected for four months each. We analyzed both raw and normalized productivity data; normalized data were generated by dividing monthly provider-specific data by monthly site-specific ED volume.

No validated survey instrument was available so surveys were drafted using a logic model of provider satisfaction and charting activities, tested on a convenience sample of faculty, and revised according to their input. Surveys were self-administered anonymously online. Provider-descriptive data was obtained, including hospital site, cumulative time in the academic practice, and clinical time commitment at the primary site. Self-reported information included uncompensated time spent charting after a shift, job satisfaction, and estimates of time spent in various clinical teaching activities. The pre-intervention survey collected information regarding expectations of scribe program impacts on charting and other activities, and the post-intervention surveys collected information regarding scribe activities and impressions of scribe program impacts. Questions were a mix of categorical and ordinal variables including Likert scales and continuous variables; some variables were recoded for analysis. The survey instruments are included as supplementary material.

Outcomes

We evaluated multiple outcomes for each line of inquiry. For ED throughput, change in ED LOS pre- to post-intervention was the primary outcome, and pre- to post-intervention changes in the rate of patients leaving WBS and AMA were secondary outcomes. For provider productivity the primary outcome was average provider-level pre-to-post change in monthly average RVUs per hour, and average provider-level changes in monthly average patients per hour and RVUs per patient were secondary outcomes. We evaluated these changes for the entire sample and stratified by site. For teaching, the primary outcome was pre-to-post changes in self-reported estimates of time spent teaching residents and medical students, and changes in time spent teaching at the bedside for both learner types were secondary outcomes. For provider experience, the primary outcomes were pre-to-post changes in self-reported estimates of average time spent charting after a shift and self-reported job satisfaction. Secondary outcomes were self-reported estimates of impacts on charting and pre-to-post changes in time spent charting outside the ED.

Analysis

We performed data analysis using SPSS version 20 (SPSS Inc., Chicago, IL). ED throughput data for each site were aggregated by month and monthly values were compared pair-wise for each site and in aggregate. We compared the significance of observed differences using paired-sample T-tests for continuous variables and chi-square tests for categorical variables. Provider productivity data were de-identified and monthly pair-wise comparisons for each provider were made in aggregate and stratified by site and evaluated using paired-sample T-tests. Survey data were analyzed using descriptive statistics and pre- to post-intervention changes in primary and secondary outcomes for categorical variables were compared using chi-square tests and for ordinal variables were compared using Wilcoxon signed-rank tests. Differences were reported as point estimates with 95% confidence intervals. Statistical significance was determined at the α=0.05 level.

RESULTS

Seventy-four faculty members were eligible to for the pre-intervention survey and 71 for the post-intervention survey. The pre-intervention survey response rate was 76.1%, and the post-intervention survey response rate was 69.0%. The main characteristics of the respondent groups and differences between the pre- and post-intervention survey groups are listed in Table 1.

The average monthly clinical workload in the pre- and post-groups sampled was 56 hours and 52 hours, respectively, with a p of 0.58 for the difference. There was a significant pre-to-post shift from dictation to relying on scribes to document patient encounters.

Provider Perceptions of Scribe Activities

Providers' impressions of the activities scribes performed demonstrated that scribes most consistently documented physical exams, test results, and discussions with family and

other providers. Providers felt that scribes were less consistent in checking on test progress and documenting procedures by other providers, and that they rarely alerted providers regarding chart underdocumentation, prompted for critical care billing, or assisted with medication reconciliation.

General Perceptions of Intervention Impacts and Provider Experience

In the pre-intervention survey there was a bimodal distribution in job satisfaction, with a small subset reporting low job satisfaction and a larger subset reporting high satisfaction. Post-intervention there was a higher proportion of "very satisfied" responses, but the changes were not statistically significant (p=0.09).

In general, providers enjoyed working with scribes, with 61.9% of respondents stating that they "liked" or "loved" working with scribes in the post-intervention survey. Of those responding, 73.8% reported an overall positive or very positive attitude toward the scribe intervention, and 64.2% stated that they would be moderately or very disappointed if they could no longer work with scribes in the ED. The acclaim was not universal, however, as 9.5% of respondents had very negative or negative perceptions of the intervention and 14.3% of respondents stated they would not be disappointed at all if not able to work with scribes going forward.

More specifically, providers largely reported a positive impact on their charting efficiency, accuracy, and completeness with the most positive change being attributed to charting efficiency; 82% claimed "positive" or "very positive" changes to their efficiency, while less than 9% stated "negative" or "very negative" effects on their efficiency. The most tepid effect was on chart accuracy, with just over 54% of providers claiming that scribes positively or very positively affected their accuracy, whereas 25% felt that scribes negatively or very negatively impacted their chart accuracy.

Additionally, providers almost unequivocally felt that the scribe intervention freed up more time to teach and to spend with patients and also (in their eyes) improved patient satisfaction. In particular, 60% of providers felt that scribes positively or very positively affected their teaching time and 76% felt similarly about the scribes' effects on their ability to spend time with patients. Sixty percent thought scribes positively or very positively improved patient satisfaction. Notably, while some providers felt that scribes had no effect in one or more of these areas, no providers all thought that scribes had a negative or very negative effect on time for teaching, time with patients or patient satisfaction.

Pre-post Intervention Changes in Time Spent with Patients

There was a statistically significant pre-to-post increase in the amount of time providers reported spending face-to-face with patients (Figure 1). The weighted average of self-reported time spent with patients went from 37% pre-intervention to 48% post-intervention, an absolute increase of 11% (4%-17%, p<0.01) and a relative increase of 30% (11%-46%).

Pre-post Intervention Changes in Teaching Medical Students and Residents

Post-intervention, respondents indicated that scribes positively affected their teaching and evaluation habits with both medical students and residents. Forty-two percent of faculty reported spending more time in bedside teaching of medical students, and 28% reported spending more time in bedside teaching of residents. Thirty-three percent of faculty noted they gave more verbal feedback to medical students, and 40% noted they gave more verbal feedback to residents.

Reported changes in the frequency of certain teaching activities bore out some of these perceptions but contradicted others. Regardless, nearly all reported changes were of a small magnitude and not statistically significant. With medical students there was a slight trend toward longer discussion of individual cases and likelihood of teaching at the bedside, but neither change was statistically significant. There was a significant increase in likelihood of giving feedback and identifying specific learning objectives after patient presentations (p<0.01; results not shown). With residents there were drops in the likelihood of seeing patients at the bedside, length of case discussions, and length of time spent giving verbal feedback, none of which was significant. Time spent teaching residents at the bedside showed a nonsignificant increase, and there was no perceptible difference in likelihood of suggesting specific learning objectives for residents (results not shown).

Pre-to-post Intervention Changes in Time Spent Charting

In general, post-intervention providers reported spending considerably less time documenting both during and after shifts. In particular, there was a statistically significant decrease in the percent of time spent documenting on-shift (Figure 2; p<0.01). Respondents reported spending a weighted average of 44% of their time charting pre-intervention and 28% post-intervention, for an absolute reduction of 16% (11%-22%, p<0.001) and a relative reduction of 36% (25%-50%).

Respondents also generally reported a lower frequency of leaving charts undone at the end of their shifts, although this result was not statistically significant (p=0.23). There was a statistically significant increase in the proportion of respondents signing charts at the end of their shifts (results not shown; p=0.01). Respondents also reported reductions in the time spent documenting in the ED and outside the ED after shifts but these differences were not statistically significant (p=0.29 and p=0.12, respectively).

ED Throughput

Changes in ED throughput metrics for each site are presented in Table 2, which presents data aggregated for the entire four-month pre- and post-intervention periods; trends were similar for monthly data at each site. Year-on-year

Table 1. Main characteristics of the study population, study sites, and pre-post differences with regard to the impact of the use of scribes on provider experience.

	Pre		Post		Sample		
	N	%	N	%	N	%	p for χ^2
Clinical site							
Academic tertiary	26	48.1	21	42.9	47	47.0	0.59
Academic community	28	51.9	28	57.1	56	54.4	
Years in this practice							
0-5	32	59.3	28	57.1	60	58.3	0.83
>5	22	40.7	21	42.9	43	41.7	
Clinical activity (hours per month)							
≤40	16	30.8	24	50.0	40	38.8	0.10
41-80	30	57.7	18	36.7	48	46.6	
>80	6	11.5	7	14.3	13	12.6	
Ever used scribes							
Yes	3	5.6	49	100.0	52	50.5	<0.01
No	51	94.4	0	0.0	51	49.5	
Dictation frequency							
Rarely	39	72.3	45	91.9	84	81.6	0.02
Sometimes	8	14.8	2	4.1	10	9.7	
Frequently	7	13.0	2	4.1	9	8.7	
Total sample	54	100.0	49	100.0	103	100.0	

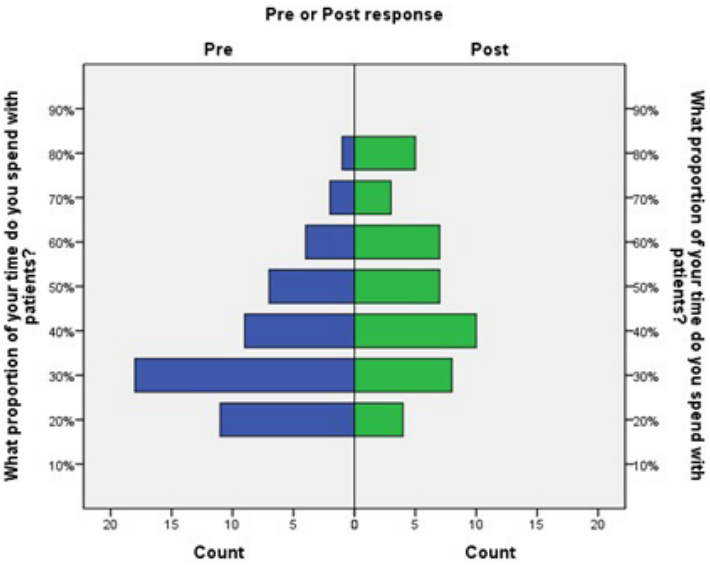

Figure 1. Pre- and post-intervention frequency distributions of reported proportion of shift time spent with patients.

volume increased over the study period at both sites in the range of 3-6%. The rate of patients leaving WBS increased at each site, and the changes at both sites were both operationally and statistically significant. The rate of patients leaving AMA, however, dropped at each site, again at magnitudes that were operationally as well as statistically significant. Patient LOS increased marginally at each site, but the increases were neither operationally nor statistically significant.

Productivity

Monthly pair-wise changes in raw and normalized productivity metrics for the entire practice are presented in Table 3. Data for individual sites exhibited similar trends. Generally, there was a pre-to-post increase in provider productivity across all metrics in the range of just over 5%. All increases in raw and most increases in normalized RVU/hr were statistically significant, while raw and normalized increases in RVU/pt achieved statistical significance only in certain months. Increases in raw and normalized patients/hour were not statistically significant, although all data showed a consistent trend towards more patients/hour.

DISCUSSION

Scribes were well received at our sites and resulted in less time charting after shifts, more time spent at the bedside with patients, and more time spent teaching medical students and residents. The intervention was associated with increases in productivity, largely through increased RVUs per patient encounter, and a decreased rate of patients leaving AMA. The scribe program seemed to positively impact all of the core activities of our academic EM practice and was a strategic

investment from a management perspective. In general our findings seem in accord with previous literature, although there are some noteworthy differences between our findings and those of prior studies.

For instance, Arya et al. found that, one year post-implementation, for every hour spent with a scribe, providers increased their RVUs/hr by 0.24 and their patients/hr by 0.08.[20] Full scribe utilization would thus result in increases of 2.4 RVUs/hr and 0.8 patients/hr. We documented a less dramatic productivity increase at our sites six months into the scribe intervention, with an average increase of 0.31 RVUs/hr and 0.1 patients/hr, respectively.

The reason for the difference in magnitude is unclear, though there are several possibilities. First, we evaluated the intervention at our site after only six months and it is possible that full increases in productivity had yet to be realized. Second, it is possible that differences in the scribe programs are partly responsible. Third, ED crowding at our sites constrains patient throughput and did not allow us to take full advantage of the extra leverage that scribes can provide. This is reflected in our left WBS rates that did not fall, yet our AMA rate declined. Once a patient had contact with the MD/scribe team they were more likely to complete their ED care. Given that the number of patients seen per hour increased so modestly at our sites, it is likely that throughput factors were dominant, and that if throughput could be increased to the degree possible at Arya et al.'s site we may have observed similar increases in RVUs/hr.

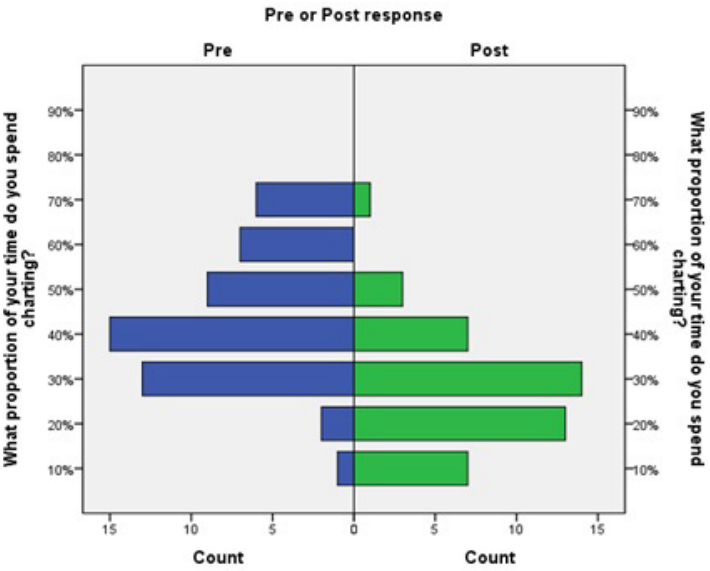

Figure 2. Pre- and post-intervention frequency distributions of reported proportion of shift time spent charting.

Marshall et al. found an average decrease in ED LOS of 14.4 minutes and an increase in throughput of 0.28 patients/hr.[21] Only an abstract is available, which limits comparisons. At our sites we saw a non-statistically significant increase in ED LOS of 8.4 minutes and throughput increase of 0.1 patients/hr and observed an average increase of 0.15 RVUs/patient. Again, the reason for the differences is unclear, although the above-mentioned throughput constraints were likely at least partially responsible for the different observations regarding throughput. The comparison of physician charges is difficult without additional information, but may again result from differences in scribe programs at different sites or be the result of different charting and/or billing practices in the two study settings. Additionally, as several outcomes such as ED LOS are multifactorial,[27] it is possible that other factors known to affect these measures exert differential influence at specific sites.

Bastani et al. evaluated scribe impacts on ED throughput and patient and provider satisfaction.[22] At their community site, scribes were implemented shortly after computerized-physician order entry (CPOE), which had worsened ED

Table 2. Pre-post differences in emergency department flow metrics at each site and for the combined sample.

Site	Metric	2011 Mean	2012 Mean	Difference	% Change	95% CI	p-value
Academic	Total patients*	698.89	720.50	21.61	3.1	-6.1-49.3	0.12
	% Left AMA	1.26	0.92	-0.34	-27.0	-0.7--0.0	0.04
	% Left WBS	1.50	2.81	1.31	87.3	0.7-1.9	<0.01
	LOS (hrs)	5.69	5.84	0.14	2.5	-0.2-0.4	0.32
Community	Total patients*	1099.39	1166.61	67.22	6.1	31.6-102.9	<0.01
	% Left AMA	1.54	1.28	-0.26	-16.7	-0.5--0.0	0.04
	% Left WBS	3.85	5.39	1.54	40.0	0.7-2.4	<0.01
	LOS (hrs)	5.15	5.29	0.13	2.5	-0.0-0.3	0.13
Combined	Total patients*	1798.28	1887.11	88.83	5.0	31.8-145.9	0.04
	% Left AMA	1.43	1.14	-0.29	-20.3	-0.52--0.06	0.02
	% Left WBS	2.94	4.41	1.47	50.0	0.83-2.11	<0.01
	LOS (hrs)	5.42	5.56	0.14	2.6	-0.05-0.33	0.15

AMA, against medical advice; *WBS*, without being seen; *LOS*, length of stay
*monthly average values for each period.

Table 3. Pre-post differences in seasonally-matched raw and normalized productivity metrics for the combined sample. Raw data are designated with an R and normalized with an N. Pair-wise comparisons could be done for all months for 62 providers.

Metric	Month paired	2011 Mean	2012 Mean	Diff	95% CI	% change	p-value
RVU/hr	September (R)	5.81	6.44	0.32	0.32-0.93	5.51%	<0.01
	September (N)	0.0013	0.0014	$0.8x10^{-4}$	$0.1x10^{-4}$-$1.4x10^{-4}$	8.06%	0.03
	October (R)	5.45	6.00	0.21	0.21-0.88	3.85%	<0.01
	October (N)	0.0015	0.0017	$1.6 x10^{-4}$	$0.7x10^{-4}$-$2.5x10^{-4}$	13.6%	<0.01
	November (R)	5.49	5.99	0.18	0.18-0.82	3.28%	<0.01
	November (N)	0.0013	0.0014	$1.0 x10^{-4}$	$0.1x10^{-4}$-$1.8x10^{-4}$	10.2%	0.03
	December (R)	5.48	5.99	0.52	0.22-0.81	9.49%	<0.01
	December (N)	0.0017	0.0017	$0.3 x10^{-4}$	$-0.6x10^{-4}$-$1.1x10^{-4}$	2.64%	0.57
RVU/pt	September (R)	2.88	3.09	0.21	0.12-0.31	7.29%	<0.01
	September (N)	0.0007	0.0007	$0.1 x10^{-4}$	$-0.1x10^{-4}$-$0.3x10^{-4}$	1.84%	0.39
	October (R)	2.86	3.07	0.21	0.10-0.32	7.34%	<0.01
	October (N)	0.0008	0.0009	$0.7 x10^{-4}$	$0.3x10^{-4}$-$0.1x10^{-4}$	7.83%	<0.01
	November (R)	2.91	2.98	0.07	-0.21-0.15	2.41%	0.14
	November (N)	0.0007	0.0007	0	$-0.2x10^{-4}$-$0.2x10^{-4}$	-0.33%	0.98
	December (R)	2.92	3.04	0.12	0.02-0.22	4.11%	0.02
	December (N)	0.0009	0.0009	$-0.3 x10^{-4}$	$-0.6x10^{-4}$-$0.0x10^{-4}$	-3.45%	0.08
Pt/hr	September (R)	2.05	2.13	0.09	-0.05-0.22	4.39%	0.21
	September (N)	0.0005	0.0005	0	$-0.3x10^{-4}$-$0.3x10^{-4}$	2.41%	0.86
	October(R)	1.92	1.99	0.07	-0.08-0.21	3.65%	0.37
	October (N)	0.0005	0.0006	$0.2 x10^{-4}$	$-0.2x10^{-4}$-$0.5x10^{-4}$	7.37%	0.36
	November(R)	1.92	2.04	0.12	-0.01-0.25	6.25%	0.71
	November (N)	0.0004	0.0005	$0.2 x10^{-4}$	$-0.1x10^{-4}$-$0.5x10^{-4}$	8.45%	0.23
	December (R)	1.89	2.01	0.12	-0.00-0.23	6.35%	0.06
	December (N)	0.0006	0.0006	$-0.1 x10^{-4}$	$-0.5x10^{-4}$-$0.2x10^{-4}$	-0.76%	0.37

RVU, relative value units; *Pt*, patient

throughput;[28] scribes were an attempt to address these deficits. Evaluating the scribe program roughly three months after implementation, they found that the scribe program returned their flow metrics to the pre-CPOE baseline and, for certain metrics (time from seeing a provider to being admitted, LOS for admitted and discharged patients), there was an improvement beyond the baseline. Compared with their pre-CPOE baseline, LOS declined by 13 minutes for admitted patients (2.9%) and 14 minutes for discharged patients (4.9%). This occurred alongside an increase in ED census. It is not clear why their site saw improvements in these ED throughput metrics when ED LOS at our sites increased slightly. Unmeasured differences in the scribe program and/or the study setting are likely responsible.

There is little additional data against which we can benchmark our findings. In two other studies, physicians responded quite positively to scribe programs,[24,29] but the methods used in these studies do not allow direct comparisons. Interestingly, in the Koshy et al. study and ours a non-trivial proportion of providers (approximately 20% and 10%, respectively) did not see scribes as an improvement. Further investigation needs to be done to identify characteristics that might be associated with providers who do not feel their practice is improved by scribes, as our surveys did not bear out clear indications as to why these providers were unhappy with the intervention.

As teaching is central to the mission of academic medical centers, the question of whether scribe programs free up time for clinical teaching activities is an important one. Our results suggest that faculty perceived that the scribe program significantly freed up time for teaching both medical students and residents, but when queried regarding specific teaching activities, the results suggest a more modest impact. A recently published abstract supports the contention that scribes increase teaching time for residents,[19] though both the structure of the intervention and the outcome studied were different than in our study. Our findings require validation, perhaps via direct observation, to obtain more precise estimates impacts on teaching.

Another important question raised by our findings is how

patients perceive scribe interventions and whether scribe programs may increase patient satisfaction. Our respondents felt that patient satisfaction increased, but we did not assess patient responses to the intervention. To the extent that scribes can improve throughput and thereby decrease waits and LOS and free up physician time to improve patient communication and engagement, there is clearly potential for an impact, but this was outside the scope of our study. Future work might explore impacts on patient satisfaction as well.

Finally, there is the question of financial viability of scribe services. While we are not at liberty to share specific financial information regarding the cost of the intervention, the increase in RVU productivity appears to have been adequate to defray the cost of the scribe program going forward.

STUDY LIMITATIONS

Our study has several potential limitations. First, while the prospective design limits bias, the study is observational and therefore susceptible to influence from various unobserved factors. As process changes are ongoing in every ED, most management interventions do not occur in isolation. During our study period no other significant changes were made. Regardless, we believe the majority of observed impacts are indeed attributable to the scribe program, but it is impossible to determine if some unobserved factors may have biased or confounded the results.

A second potential limitation relates to the use of self-administered surveys, which increases the risk of certain types of bias including non-respondents, recall, and self-interest. Though the response rate was relatively high, non-responders could have significantly differed from responders. There is no way to assess this since the responses were anonymous. Recall bias should have been relatively minor as respondents were asked to report on their practice experience around the time of the surveys. The potential for self-interest bias, which could have resulted in respondents overstating the intervention's impacts in various areas, is difficult to assess. Additionally, since survey respondents were anonymized, we were not able to pair providers who took both the pre-scribe survey and the post-scribe survey to assess if there were intra-provider attitude changes from scribe implementation. However, the demographics of the two groups (i.e., pre-scribe respondents and post-scribe respondents) were very similar, suggesting the survey respondents per se were very similar pre-to-post. Therefore, we suspect that the aggregate data do reflect, at least to a certain extent, intra-provider effects on attitudes and perceptions of scribes.

A third potential limitation relates to the study time frame and the fact that we assessed faculty response to the intervention relatively shortly after its implementation. We chose this approach to minimize the possibility of bias from other administrative interventions. As faculty were likely still adjusting their practice styles to take full advantage of scribes, however, our findings may be underestimates of true impacts of a mature scribe intervention. As scribe skills mature further and faculty continue to adapt their practices to maximize the potential benefits of working with scribes, we anticipate further improvement in both our throughput metrics and subjective measures.

Finally, our study was limited by the fact that there were no validated instruments available for assessing several of the outcomes we were interested in, and we had to develop and pilot survey-based measures. In most cases our results suggest internal consistency, but the differential shifts in time available for teaching residents and medical students, which theoretically should have shifted in tandem, is difficult to explain and may bring into question the validity of the approach used to measure these outcomes.

CONCLUSION

Scribes were well received in our academic EM practice, substantially reducing provider charting burdens during and after shifts. Providers reported devoting the time gained to patient care and, to a lesser degree, teaching. The intervention increased provider productivity, primarily the result of increased RVUs per hour and per patient, although it had modest impacts on ED throughput. Findings are largely consistent with prior studies and suggest generally positive impacts on most aspects of academic practice, although some productivity increases may be limited by larger contextual factors. Impacts on teaching and patient satisfaction require validation and future study.

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Identifying Patient Door-to-Room Goals to Minimize Left-Without-Being-Seen Rates

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Introduction: Emergency department (ED) patients in the leave-without-being-seen (LWBS) group risk problems of inefficiency, medical risk, and financial loss. The goal at our hospital is to limit LWBS to <1%. This study's goal was to assess the influence on LWBS associated with prolonging intervals between patient presentation and placement in an exam room (DoorRoom time). This study's major aim was to identify DoorRoom cutoffs that maximize likelihood of meeting the LWBS goal (i.e. <1%).

Methods: We conducted the study over one year (8/13-8/14) using operations data for an ED with annual census ~50,000. For each study day, the LWBS endpoint (i.e. was LWBS <1%: "yes or no") and the mean DoorRoom time were recorded. We categorized DoorRoom means by intervals starting with ≤10min and ending at >60min. Multivariate logistic regression was used to assess for DoorRoom cutoffs predicting high LWBS, while adjusting for patient acuity (triage scores and admission %) and operations parameters. We used predictive marginal probability to assess utility of the regression-generated cutoffs. We defined statistical significance at $p<0.05$ and report odds ratio (OR) and 95% confidence intervals (CI).

Results: Univariate results suggested a primary DoorRoom cutoff of 20', to maintain a high likelihood (>85%) of meeting the LWBS goal. A secondary DoorRoom cutoff was indicated at 35', to prevent a precipitous drop-off in likelihood of meeting the LWBS goal, from 61.1% at 35' to 34.4% at 40'. Predictive marginal analysis using multivariate techniques to control for operational and patient-acuity factors confirmed the 20' and 35' cutoffs as significant ($p<0.001$). Days with DoorRoom between 21-35' were 74% less likely to meet the LWBS goal than days with DoorRoom ≤20' (OR 0.26, 95% CI [0.13-0.53]). Days with DoorRoom >35' were a further 75% less likely to meet the LWBS goal than days with DoorRoom of 21-35' (OR 0.25, 95% CI [0.15-0.41]).

Conclusion: Operationally useful DoorRoom cutoffs can be identified, which allow for rational establishment of performance goals for the ED attempting to minimize LWBS.
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INTRODUCTION

Patients who leave the emergency department (ED) without being seen (LWBS cases) have been identified for many years as a high-risk group in terms of medical and operational outcomes (e.g. patient satisfaction).[1,2] In the current era of ED crowding, there is growing concern about LWBS.[1,3] The literature still identifies this area as being among the most important performance measures relating directly to the patient.[4-6] Progress is being reported for specific populations (e.g. psychiatric "holds," pediatric patients),[7,8] but

broad-based efforts to eliminate LWBS have been summarized as having had success that is "modest, at best."[9]

One of the most intuitively obvious variables influencing LWBS rates is the time interval from the patient's initial ED presentation to being seen by a physician.[10] Previous work focusing on ED length of stay (LOS) and related operations parameters have identified prolonged "wait times" as the most important factor driving LWBS rates.[11,12]

Using Emergency Severity Index (ESI) triage levels[13] to stratify patients, previous investigators have calculated desirable wait times to enable achievement of an LWBS goal of <2%.[11] ESI 3 (mid-range acuity on the 1-5 ESI scale) patients are recommended to have wait times of <45 minutes; ESI 4/5 patients' wait time target should be <60 minutes.[11]

We undertook the current study to characterize the relationship between DoorRoom and LWBS at one institution. The aim was to assess incremental DoorRoom timeframes, while adjusting for potential confounders, to determine optimal target DoorRoom for our ED.

METHODS

There was no collection of patient identifiers, protected health information (PHI), or any clinical information on individual cases. The institution's ethics review board exempted the study.

Design

This was a retrospective analysis of data collected and entered into an administrative database, on a daily basis.

Setting and time frame

The study was conducted over one year (8/2013-8/2014) at a 700-bed hospital with and annual ED census of 50,000. The ED is staffed by emergency medicine (EM)-boarded physicians and residents. LWBS cases are those patients who check in to the ED and who leave (with or without being triaged) before being seen by a physician. (The ED does not use mid-level providers.)

Data collected and units of analysis

For this study, the unit of analysis was the "day." The major variables of interest were daily LWBS and daily mean DoorRoom. For each of the 365 study days, we categorized LWBS dichotomously as to whether the institutional goal (<1%) was met. DoorRoom is the time elapsed between a patient's being "signed in" to the ED to be seen, and that patient's being placed in any ED room/bay to be seen by a physician. The ED information reporting system calculates DoorRoom mean times for each day; these daily means constituted this study's DoorRoom variable. DoorRoom was collected as a continuous variable (i.e. a mean DoorRoom time was ascertained for each study day) and then analyzed as both a continuous and categorical variable as described below.

We incorporated daily ED census dichotomously, with the goal of adjusting for the study days on which there was low volume (and thus which historically have been associated with very low LWBS at the study ED). Using an a priori cutoff of 116 patients per day based upon historical data (this census number is roughly the bottom quartile of ED census spread in the study hospital), we coded the ED census covariate dichotomously to allow for the model to control for low-census days.

We also recorded daily inpatient hospital occupancy as a continuous variable. This occupancy rate was assessed and reported by the hospital's information system at 0700 each morning. The study also included hospital operations data on daily means for ED LOS for all patients.

We assessed P=patient acuity using the ESI triage scale (1, most urgent, through 5 as least urgent). ESI categories 1 and 2 were categorized as "more urgent" acuity; the proportion of ESI 1 or 2 cases each day was used as a marker of overall ED acuity. As an additional representative of daily ED acuity level, we incorporated admission percentage for each study day into modeling.

Analysis approach

For the main analysis, the dichotomous endpoint of interest (i.e. dependent variable) was "met LWBS goal" (i.e. coded as being met if the day's LWBS was under 1%). The main independent variable was DoorRoom.

We initially assessed DoorRoom as a continuous variable. In order to assess the endpoint in operationally applicable categories each study day's mean DoorRoom was also placed into one of a dozen ordinal "time bins." The first time bin was delineated by DoorRoom times within 10 minutes. The second bin contained DoorRoom times of 11-15 minutes, the third bin DoorRoom times 16-20 minutes, and so on through the 12th and final bin containing days with mean DoorRoom exceeding an hour.

We used skewness-kurtosis testing to assess data normality. For normally distributed data, central tendency is reported as mean±standard deviation (SD), with 95% confidence interval (CI) reported for the mean. For non-normal data, central tendency is reported as median with interquartile range (IQR).

Proportions data are reported with binomial exact 95% CIs. We assessed categorical data using chi-square testing or (if cell values fell below 5) Fisher's exact test. The nonparametric trend test was used as an initial approach to assessment of whether there was a trend between increasing DoorRoom and LWBS.

After univariate testing, we used multivariate logistic regression to adjust for potential confounders while exploring the association between the major independent variable DoorRoom and the LWBS endpoint. Results were reported as odds ratio (OR) with 95% CI. Model comparisons and individual variables' significance were performed using the likelihood ratio test.

To account for skewness in the continuous variables assessed, we calculated and used robust standard errors

for 95% CI calculations around ORs. As model-building proceeded, potential confounders were reintroduced into the model for assessment as per standard approaches of assessing for >20% change in the β point estimate (regardless of statistical significance).[14]

We assessed logistic regression model performance with the goodness-of-fit test of Hosmer and Lemeshow.[14] Classification performance was assessed by assessing the area under the curve (AUC) for the receiver operator characteristic (ROC) curve. We assessed the utility of previously identified DoorRoom cutoffs using the multivariate logistic regression model and predictive marginal probability analysis.[15]

RESULTS

Descriptive statistics

Table 1 shows summary statistics for the study data. The median LWBS was just under the ED LWBS target maximum of 1% and the LWBS goal was met in 211 of 365 days (57.8%). Low-census days (ED census below 116) occurred 99 times, constituting 27.1% of the study n of 365 days. Other variables were not normally distributed and are reported in Table 1 with median and IQR.

Basic analysis

Univariate analysis entailed separating the n=365 study days' DoorRoom times into bins as previously described, and then for each time bin determining the proportion of the bin's days for which the LWBS goal was met. For example, there were 48 days in which the mean daily DoorRoom fell between 16 and 20 minutes, and the LWBS goal was met in 41 (85.4%). Results are shown in Table 2.

The above analysis provides proportions of study days meeting the LWBS target for individual bins of time frames. There was a significant association between DoorRoom bin and likelihood of meeting the LWBS goal ($p<0.001$).

As seen in the Table 2 data, there is an initial fall-off in LWBS performance between groups 3 and 4. This suggests maximal benefit in setting DoorRoom target within 20 minutes (i.e. to prevent the fall-off associated with changing the target from 20 minutes to 25 minutes). After a continuing drop in LWBS performance as DoorRoom increases through 25, 30, and 35 minutes, there is another precipitous drop in LWBS performance as DoorRoom time moves from 35 to 40 minutes (between groups 6 and 7). This suggests that while the primary DoorRoom goal for the study facility should be 20 minutes, a secondary aim should be to keep DoorRoom within 35 minutes.

The next univariate analysis was intended to complement the individual time-bin analysis by providing information on the cumulative LWBS performance at incremental DoorRoom cutoffs. Whereas the Table 2 results depict LWBS performance by each time bin (e.g. group 3 corresponds to DoorRoom of 16-20 minutes), the cumulative analysis depicts summed LWBS performance for the time bins up to a given cutoff. For example, in Table 3, the third row corresponds to the cumulative LWBS performance for all time bins up to 20 minutes; the third row, therefore, also includes all study days with DoorRoom means within 20 minutes. The time groups in Table 3 are thus additive, with each cumulative group containing all of the time bins up to the group's cutoff.

Table 3 confirms the utility of the primary DoorRoom cutoff at 20 minutes: the LWBS goal was met in 87.5% of study days with mean DoorRoom within 20 minutes. The cumulative-time in Table 3 suggests some utility of the secondary DoorRoom goal of ≤35 minutes, since at this cutoff the LWBS goal was met 77% of the time.

The final step in univariate analysis was to assess the association between DoorRoom and LWBS goals, to see if the positive association was in fact a trend (i.e. there was lower LWBS rate associated with decreasing DoorRoom). The nonparametric trend test revealed a statistically significant ($p<0.001$) trend between improving DoorRoom and LWBS, thus strengthening the case for proceeding with multivariate modeling.

Analytic statistics: Logistic regression with endpoint "met LWBS goal (of <1%)"

After the univariate basic analysis revealed a clear relationship between improvement in DoorRoom and likelihood of meeting the institution LWBS goal, the next step was to build a logistic regression model that allowed further exploration of the DoorRoom/LWBS association while adjusting for covariates.

In the univariate logistic regression model, the DoorRoom group was significantly ($p<0.001$) associated with likelihood of meeting the LWBS goal. Moving up each group number (e.g. from Group 1 to Group 2) was associated with an 18% drop in odds of meeting the LWBS goal (OR 0.72, 95% [0.67-0.78]).

Bivariate logistic regression including the primary independent variable (DoorRoom group) and the other covariates was then executed with standard model-building cutoff of $p<0.20$ for inclusion in the model.[14] Adjustment for acuity (by ESI) and operations parameters of ED census and LOS resulted in exclusion (through non-significant p and through lack of confounding) of the covariates for day-of-week, admission percentage, and inpatient occupancy. Thus, the final model included the major independent covariate of interest (DoorRoom group), as well as covariates allowing adjustment for patient load (ED census) and acuity (proportion of ESI 1 or 2), as well as hospital and ED operations improvements over time (study month) and daily ED throughput (LOS) (Table 4).

With regard to the main predictor variable, the model indicates that each 5-minute increment in a day's mean DoorRoom corresponds to a 23% reduction in the chances that the day's LWBS will fall under the goal of 1%. The model's AUC of 0.82 indicated "excellent" discrimination.[14] Goodness-of-fit testing failed to reject the null hypothesis of lack of fit ($p=0.64$).

Table 1. Descriptive statistics for n=365 study days.

Variable	Median (IQR)
LWBS (%)	0.8 (0-1.7)
Admit (%)	25 (23-28)
Inpatient bed occupancy (%)	90 (85-94)
ESI Level 1 or 2 (%)	15.9 (13.0-18.9)
Time intervals (in minutes) from presentation ("door") time	
Door to triage	16 (13-20)
Door to room	30 (20-44)
Door to departure from ED (i.e. LOS)	213 (190-238)

LWBS, left-without-being-seen; *ESI*, emergency severity index triage level (1 or 2 representing highest acuity)13; *ED*, emergency department; *LOS*, length of stay

Based upon the graphic suggestion of useful cutoffs at 20 and 35 minutes, we performed marginal analysis with the DoorRoom times categorized into categories of ≤20 minutes, 21-35 minutes, and ≥35 minutes. Increase of a day's mean DoorRoom from within 20 minutes to the 21-35 minute time-frame was associated with a marked and statistically significant reduction in the chances of that day's meeting LWBS targets; adjusting for other covariates in the final model, the OR for 21-35 time frame as compared to ≤20 minute time frame was 0.26 (95% CI [0.13-0.53], p<0.001). Similarly, prolonging a day's DoorRoom mean from the 21-35 time frame to longer than 35 minutes was associated with another precipitous drop in likelihood of that day's meeting the LWBS goal (OR adjusting for other covariates of 0.25 with 95% CI [0.15-0.41], p<0.001). Figure 1 depicts the probabilities of a given day's meeting

Table 2. Likelihood of meeting the left-without-being-seen goal of <1%, by door-to-room (DoorRoom) time frame.

DoorRoom group (time frame)	Study days with mean DoorRoom in time frame	Study days in time frame for which LWBS goal was met; 95% confidence interval
1 (<10 minutes)	8	7/8 (87.5%, 47.3-99.7%)
2 (11-15 minutes)	40	36/40 (90.0%, 76.3-97.2%)
3 (16-20 minutes)	48	41/48 (85.4%, 72.2-93.9%)
4 (21-25 minutes)	52	37/52 (71.2%, 56.9-82.9%)
5 (26-30 minutes)	40	24/40 (60.0%, 43.3-75.1%)
6 (31-35 minutes)	36	22/36 (61.1%, 43.5-76.9%)
7 (36-40 minutes)	32	11/32 (34.4%, 18.6-53.2%)
8 (41-45 minutes)	26	9/26 (34.6%, 17.2-55.7%)
9 (46-50 minutes)	20	5/20 (25.0%, 8.7-49.1%)
10 (51-55 minutes)	18	7/18 (38.9%, 17.3-64.3%)
11 (56-60 minutes)	14	4/14 (28.6%, 8.4-58.1%)
12 (>60 minutes)	31	8/31 (25.8%, 11.9-44.6%)
All study days	365	211/365 (57.8%, 52.6-62.9%)

LWBS, left-without-being-seen

Table 3. Probability of meeting left-without-being-seen goal (<1%) at different door-to-room (DoorRoom) cutpoints.

DoorRoom cumulative time group	DoorRoom time	Study days with mean DoorRoom in time frame	% study days with mean DoorRoom within cumulative timeframe, that met LWBS goal (with 95% confidence interval)
UpTo10	≤10 minutes	8	7/8 (87.5%, 47.3-99.7%)
UpTo15	≤15 minutes	48	43/48 (89.6%; 77.3-96.5%)
UpTo20	≤20 minutes	96	84/96 (87.5%; 79.2-93.4%)
UpTo25	≤25 minutes	148	121/148 (81.8%; 74.6-87.6%)
UpTo30	≤30 minutes	188	145/188 (77.1%; 70.4-82.9%)
UpTo35	≤35 minutes	224	167/224 (74.6; 68.3-80.1%)
UpTo40	≤40 minutes	256	178/256 (69.5%; 63.5-75.1%)
UpTo45	≤45 minutes	282	187/282 (66.3%; 60.5-71.2%)
UpTo50	≤50 minutes	303	193/303 (63.7%; 58.0-69.1%)
UpTo55	≤55 minutes	320	199/320 (62.2%; 56.6-67.5%)
UpTo60	≤60 minutes	334	203/334 (60.8%; 55.3-66.0%)
AllTimes	All study days	365	211/365 (57.8%; 52.6-62.9%)

LWBS, left-without-being-seen

Table 4. Variables included in final logistic regression model: association of door-to-room (DoorRoom) time bin group with likelihood of meeting left-without-being-seen goal.

Variable	OR (95% CI)	p
DoorRoom group (incremental time bin)	0.77 (0.68-0.88)	<0.001
Study month	1.21 (1.13-1.31)	<0.001
Low ED census	2.2 (1.16-4.36)	0.015
% low-acuity (triage index 1 or 2)	1.08 (1.01-1.14)	0.017
ED length of stay	0.99 (0.97-1.00)	0.026

ED, emergency department; *OR*, odds ratio

the institutional LWBS goal (<1%) at the cutoffs of mean DoorRoom within 20 minutes, 21-35 minutes, and >35 minutes. Lack of overlap of 95% CIs indicates these are reasonable cutoffs for operational planning.

DISCUSSION

Medical outcomes problems (including medical-legal risk issues) are at the top of the list of LWBS concerns.[1,16,17] Other problems may include decreased patient satisfaction scores,[18] financial loss to the hospital,[3,19] and even system-based efficiency issues such as repeated patient presentation after the initial LWBS episode.[20]

A variety of factors can potentially impact LWBS. This study intended to adjust for a number of these factors, while focusing on one specific item: the time elapsed between the patient presentation to the ED and the patient being placed in a room (defined as DoorRoom for this study).

For various reasons we selected DoorRoom as the a priori endpoint of main interest for this study. First, it is intuitive. Second, although it's clear that faster rooming of patients will decrease LWBS likelihood, the precise point that represents the best goal for DoorRoom is not known with certainty. Third, at the study institution, DoorRoom is a consistently measured and reported ED operations parameter. The more directly LWBS-relevant time interval of door-to-doctor is not accurately reported at the study institution.

Others have reported that LWBS can be significantly improved by placement of a physician or mid-level provider (MLP) at triage.[19,21,22] These programs seem to usually, although not invariably, result in a statistically significant reduction in LWBS.[23] Similarly favorable impact on LWBS has been reported with the institution of a "fast track" area of the ED, at which location less-critical patients are seen.[24] The study ED did not have a physician in triage, but did operate a fast-track daily from noon to midnight. Placement of a patient in a "room" was said to occur whether the room was a fast track bay or a room in the main ED. Regardless as to whether the initial evaluation occurs in triage ("out-front"), a fast track, or in the main ED, the major goal for those wishing to reduce LWBS seems to be minimizing the time interval between presentation and initial physician (or MLP) interaction.[17]

Previous preliminary work suggested that goals for overall wait times should be set depending on ESI level; 45 minutes (for ESI 3 cases) or 60 minutes (for ESI 4 or 5 cases).[11] Studies around the world have demonstrated that triage acuity is regularly implicated as an important variable impacting LWBS rates.[5,25-27] The internal and external validity of the current study is enhanced by the fact that much of the ED LWBS literature also uses the ESI to assess triage acuity.[1,11]

We undertook the current analysis to complement the existing literature, using a different multivariate methodology that adjusted for ESI as well as other operations parameters. Given the fact that previously suggested cutoffs for DoorRoom would result in high rates of failure of the study ED to meet LWBS goals, the current analysis was undertaken to try and identify DoorTime goals that would be operationally useful at the study institution. The primary aim was to identify an early cutoff, the meeting of which DoorRoom time would be associated with very high likelihood of meeting the LWBS goal. A secondary aim was determination as to whether there were an additional cutoff for a secondary DoorRoom time goal that would be associated with adequate (if not ideal) performance with regard to meeting LWBS goals.

The selection of time intervals and spacing, while executed a priori as part of study planning, was arbitrary. Operations group discussions prior to the study's commencement identified 5-minute windows as the narrowest time frame for practical analysis. Experience at the study ED was that patients were so rarely "roomed" within five minutes that there would be no utility to establishing a "time bin" in the within-5-minute range. Therefore, the initial time bin was set at DoorRoom within 10 minutes. The next 11 categories were logically determined as succeeding 5-minute intervals were defined, but the last category (>60 minutes) was something of a catch-all. The reason this last DoorRoom time bin was set with such a large range was that the overall n of these longer-DoorRoom days was small and there was benefit in not having large numbers of sparsely populated time bins at the longer end of the DoorRoom spectrum. Furthermore, in study planning it was determined that there would be little to gain (in terms of setting ED operations goals) from proving the undesirability of taking over an hour to get patients roomed.

The study did not set out to identify what other parameters besides DoorRoom are related to LWBS. It is acknowledged that many variables influence LWBS, but incorporation of these covariates in the current study's modeling was intended only to adjust for these factors and allow focus on the primary independent variable of interest: DoorRoom. The study's concentration on DoorRoom was not intended to imply these other factors are not important, but rather to allow the establishment of data-driven goals for the study ED on a parameter – DoorRoom – that is clearly defined and easily discussed with staff. It is for this operational reason that the continuous variable DoorRoom was categorized into 5-minute

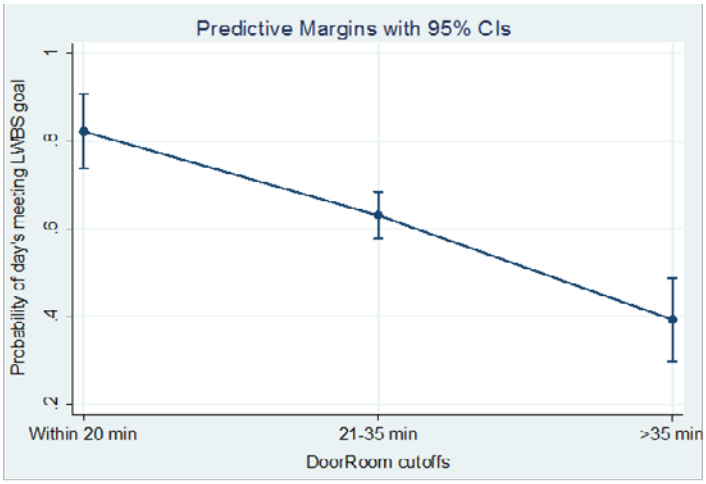

Figure 1. Multivariate logistic regression model predictions of likelihood, with 95% confidence intervals, of meeting left-without-being-seen (LWBS) goal (of <1%) at door-to-room (DoorRoom) cutoffs of 20 and 35 minutes.
CI, confidence interval

windows for the study's main analyses.

The covariate "study month" was statistically significant, and this finding warrants brief explanation. As is the case at many hospitals, multiple operations improvement measures were ongoing (or instituted) during the study period. Even measures that were not ED-based (e.g. increased surge capacity for bed availability) could still have downstream or indirect impact on ED operations and LWBS. Furthermore, ED operations improvement efforts continued throughout the study period on a number of fronts. As a coarse method of adjusting for these improvement efforts, the current analysis incorporated the chronological variable ("study month"), which was in fact statistically significant (showing that overall performance was improving solely as a function of ongoing work and passage of time).

There was a marked drop in the proportion of days meeting LWBS goals when DoorRoom exceeded 20 minutes, and a slightly lesser drop after 35 minutes. The univariate association between prolonging DoorRoom time and LWBS was confirmed in multivariate modeling, which also confirmed utility of the 20- and 35-minute DoorRoom cutoffs. The statistically significant cut points at both of these timeframes were also operationally significant: after each time cutoff the chances of meeting LWBS goals dropped by nearly 75%. The study methodology was insufficiently precise to support a claim that the 20- and 35-minute cutoffs are the only cutoffs that would be useful, but the results of the analysis do support institution of these cutoffs as a reasonable next step for the study institution's ED operations group.

The numbers identified for the study ED remain to be assessed in a prospective analysis, and even if the cutoffs identified in this analysis work for the study ED, the utility of this report for other EDs lies more in its potential application of methodology, than in the particular results found at the study institution. In fact, some covariates in the study ED that were not identified as being statistically significant, have been specifically identified as important in other analyses. For example, weekend presentation has been identified as being independently associated with high LWBS in previous work (from locations as disparate as Australia and Switzerland).[28,29] This finding was not replicated in the current analysis (p for day of week=0.53), emphasizing the importance of applying the analytic principles outlined here (and elsewhere) to one's own patient population to determine the most important factors driving LWBS.

There is an additional issue with respect to extrapolation of this study's results to other EDs. Because of the hospital and nursing administration focus on identifying a target to get patients "roomed," DoorRoom was set as this study's a priori endpoint. The small size of the ED during this project (30 beds plus an 8-bed fast track), meant that in our facility patients are seen within minutes of being "roomed." In fact, the mean time interval from patients being placed in an ED room (main ED or fast track) and being seen by a physician was both rapid (11.1 minutes) and narrowly dispersed (95% CI for mean, 10.4-11.9). Therefore, the general results should be easily extrapolatable in other centers with similarly predictable association between DoorRoom and DoorDoctor.

LIMITATIONS

The selection of variables assessed in the current analysis was somewhat limited, in that the operations database that was used as a data source included only limited information. Another major study limitation associated with the way the database is populated, is the use of the "day" as the unit of analysis. Another major study limitation was the use of the "day" as the unit of analysis for collecting LWBS and other information. It is certainly the case that, within a given day, there are variations in "risk" of high LWBS. The use of the day as unit of analysis was dictated by the data collection and reporting methods of the study ED's administrative database, but it is acknowledged that follow-up studies should further narrow the analytic window and examine "within-day" LWBS.

Other study limitations are related to the study's endpoint itself. First, the LWBS target endpoint of <1% in this study is arbitrary. Others have used different endpoints (e.g. <2%).[11] There is no concrete "correct" LWBS endpoint, but the <1% target set by the study hospital administration (well before this research project's institution) is consistent with ED literature from hospitals of similar characteristics as the study facility.[30]

An additional set of limitations regarding the study endpoint are related to the lack of any actual "impact" measurements in the current study. There was no information on actual financial or clinical impact of improving LWBS. As previously reported, the study hospital system uses an averaged-out "value" for an individual LWBS case (about $200),[3] but this average value is understood to be both imperfect and not necessarily generalizable. Therefore, the

authors emphasize that the endpoint of "meeting LWBS goal" is the major aim of this analysis, with the extrapolation of the value of meeting that goal left for future discussion.

Other study limitations stress this report's utility only as a preliminary report. First of all, the data analysis was based upon only a year of data at a single center. Since the results were statistically significant, the relatively low n of weeks was not viewed by the authors as a major constraint. However, there are plans to continually monitor and reanalyze these data as part of ongoing operational improvement efforts. Furthermore, the single-center nature of the study should give pause to those considering extrapolation of the results to different settings.

CONCLUSION

Despite the limitations as noted, the study does provide some direction for forward-looking operations improvement efforts. First, the cutoffs identified are both consistent with common sense and also perceived to be reasonably achievable at the study institution. Using 20 minutes as a primary goal and 35 minutes as a secondary DoorRoom target, there are clearly delineated targets that can be easily communicated with staff during operations education. Follow-up analyses will determine the results of applying these operations goals at the study institution, and the study methods are offered as one potential route for other ED operations groups to analyze and optimize their performance with respect to the critical endpoint of minimizing LWBS.

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Identify-Isolate-Inform: A Modified Tool for Initial Detection and Management of Middle East Respiratory Syndrome Patients in the Emergency Department

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Middle East respiratory syndrome (MERS) is a novel infectious disease caused by a coronavirus (MERS-CoV) first reported in Saudi Arabia in September 2012. MERS later spread to other countries in the Arabian Peninsula, followed by an outbreak in South Korea in 2015. At least 26 countries have reported MERS cases, and these numbers may increase over time. Due to international travel opportunities, all countries are at risk of imported cases of MERS, even if outbreaks do not spread globally. Therefore, it is essential for emergency department (ED) personnel to be able to rapidly assess MERS risk and take immediate actions if indicated. The Identify-Isolate-Inform (3I) tool, originally conceived for initial detection and management of Ebola virus disease patients in the ED and later adjusted for measles, can be adapted for real-time use for any emerging infectious disease. This paper reports a modification of the 3I tool for use in initial detection and management of patients under investigation for MERS. Following an assessment of epidemiologic risk factors, including travel to countries with current MERS transmission and contact with patients with confirmed MERS within 14 days, patients are risk stratified by type of exposure coupled with symptoms of fever and respiratory illness. If criteria are met, patients must be immediately placed into airborne infection isolation (or a private room until this type of isolation is available) and the emergency practitioner must alert the hospital infection prevention and control team and the local public health department. The 3I tool will facilitate rapid categorization and triggering of appropriate time-sensitive actions for patients presenting to the ED at risk for MERS. [West J Emerg Med. 2015;16(5):619-624.]

INTRODUCTION

Middle East respiratory syndrome coronavirus (MERS-CoV) is a new respiratory virus that was first reported in Saudi Arabia in September 2012. Health officials later determined that the first known cases of MERS occurred in Jordan in April 2012. The outbreak extended to other countries in the Arabian Peninsula followed by another outbreak in Korea in May 2015. As of June 18, 2015, when Thailand described a case in a traveler returning from Oman, at least 26 countries have reported MERS cases (Figure 1). There have been at least 1,338 persons infected and 484 deaths (36% mortality) as of June 20, 2015.[1] Transmission of the virus has occurred in healthcare facilities in Saudi Arabia and Korea, raising concerns such as those seen during the prior severe acute respiratory syndrome (SARS) outbreak first recognized in February 2003. Outside of the isolated outbreak regions, the vast majority of MERS cases have been detected in travelers returning from the Middle East. The list of affected countries may change over time, which can affect the exposure criteria for identifying suspected cases.

In May 2014, the Centers for Disease Control and Prevention (CDC) confirmed two unlinked imported cases of MERS in the U.S. states of Indiana and Florida. Both patients were believed to have been infected in Saudi Arabia where they worked as healthcare providers. They both required hospitalization and fully recovered.

While previously healthy individuals with mild illness may be asymptomatic, MERS typically presents with fever and symptoms of a respiratory illness or acute respiratory

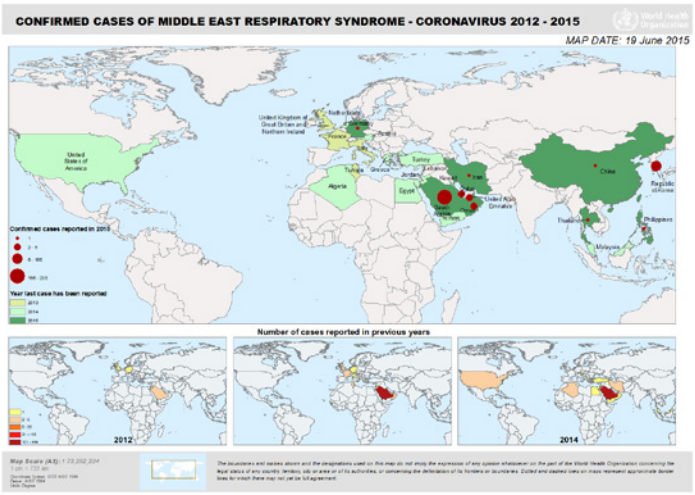


Figure 1. Countries with confirmed MERS cases as of June 19, 2015.
MERS, Middle East respiratory syndrome

distress syndrome (ARDS) in severe cases. Suspect patients must be immediately isolated with airborne precautions concurrent with work up and laboratory confirmation of disease. In addition, emergency physicians must promptly inform both hospital infection control and the local health department of suspected MERS cases.

As with all emerging infectious diseases,[2] healthcare workers must keep up to date with information about how to detect and manage MERS. Using the Identify-Isolate-Inform (3I) tool, emergency physicians will be better prepared to detect and manage MERS patients presenting to the emergency department (ED). Following a brief review of MERS, this paper describes the adaptation of the 3I tool, initially developed for Ebola virus disease,[3-4] and modified for measles[5] for use in the initial detection and management of potential MERS patients in the ED. While the MERS 3I tool is designed for use in EDs affiliated with an inpatient facility, it can be used in outpatient settings such as urgent care clinics, physicians' offices and prehospital environments with minor modifications, e.g. if airborne isolation is not immediately available. The model presented is consistent with CDC guidelines for the management of suspected MERS patients.[6]

Clinical Presentation

Signs and Symptoms

MERS-CoV infection presents as a nonspecific acute respiratory illness. Patients typically have fever, cough and shortness of breath. Gastrointestinal symptoms can include nausea, vomiting and diarrhea. Severely ill patients may develop pneumonia, ARDS and renal failure. Mortality is reported to be about 30-40% and occurs more commonly in people with underlying medical conditions. Some patients may be infected and fully recover, having either no symptoms or a mild respiratory illness without progression to severe disease. This cohort, however, is less likely to present to the ED.

The incubation period for MERS ranges from 2-14 days, typically about 5-6 days. This is the reason for screening for risk factors within 14 days prior to symptom onset. Comorbidities, such as diabetes, cancer, and chronic heart, lung, and kidney disease, portend a greater risk of contracting MERS and of progressing to more severe illness.

Transmission

While it is unclear exactly how MERS is contracted, it is likely to spread via an infected person's respiratory secretions like other coronaviruses. To date, there has not been widespread sustained community human-to-human transmission. It appears that close contact with an infected person is necessary for disease transmission. Close contact is defined as encountering a patient without appropriate protective gear within six feet or being in a care room for prolonged periods or having direct exposure to infected secretions. Healthcare facilities have reported spread from person-to-person much more so than in communities, possibly when suboptimal infection control was practiced for patients with higher viral loads than those not hospitalized.[7]

Reported cases have been linked to countries in and near the Arabian Peninsula either for persons who live in, have traveled to, or have had contact with an infected person who had been in the region. MERS is a zoonotic virus that is transmitted from animals to humans. It is believed to have originated in bats and then to have been transmitted to camels sometime in the distant past. According to epidemiologic and surveillance data, there is a strong likelihood that dromedary (one-hump) camels (Figure 2) serve as a reservoir for zoonotic transmission of the virus to humans.[8] This has resulted in warnings to avoid close contact with camels and not drink raw camel milk or urine, or ingest raw camel meat.

People Who May Be at Increased Risk for MERS

In addition to persons who have had close contact with infected dromedary camels within 14 days before symptom onset, the following groups are at risk for contracting MERS:

- Travelers from the Arabian Peninsula (note that geographic regions of concern may change over time)
- Close contacts of an ill traveler from the Arabian Peninsula
- People who have been in a healthcare facility in the Republic of Korea
- Close contacts of a confirmed case of MERS

Elderly and immunocompromised patients are at higher risk of becoming infected with MERS than healthy hosts if they are exposed to the conditions described above.

Work-Up

MERS can be confirmed at a state or CDC laboratory via polymerase chain reaction (PCR) assays performed on respiratory samples. In addition, serum antibody titers can be measured for both acute infection as well as evidence of prior exposure and immunity. Serologic testing includes (1)

enzyme-linked immunosorbent assay (ELISA) as a screening test, (2) immunofluorescent assay (IFA) for confirmation, and (3) neutralizing antibody assay as a definitive confirmatory test that takes longer to process.

Differential Diagnosis

As MERS presents initially with a non-specific influenza like illness, the differential diagnosis can include many other respiratory and gastrointestinal infections. The key action is to identify a potential exposure within 14 days prior to symptom onset at initial patient presentation so that MERS can be considered.

Treatment

Treatment for MERS is primarily supportive care. Hydration and antipyretics, such as in other viral illnesses, are the mainstays of therapy. If a secondary bacterial infection such as pneumonia develops, appropriate antibiotics are indicated. While drugs for treatment of severe acute respiratory syndrome such as beta interferons and protease inhibitors are reported to be under investigation,[9] there are currently no approved specific treatments or vaccines for MERS.

Prevention

Prevention of MERS-CoV transmission involves avoiding exposure. Travelers to regions where MERS has been detected should avoid close contact with potentially infected persons or dromedary camels. Healthcare personnel must practice strict standard, contact, and airborne precautions while caring for patients under investigation (including symptomatic close contacts) as well as patients with probable or confirmed MERS infections. Laboratory workers and others collecting and handling specimens for potential MERS patients should adhere to the same guidelines. Adequate respiratory protection is particularly important when performing aerosolizing procedures.

Patient Disposition

Admission criteria for patients who are at risk for MERS are similar to those for any other patient. If patients do not meet medical criteria for hospitalization, they may be isolated at home during the evaluation period. Emergency physicians must notify local public health authorities so that appropriate monitoring and community protective measures can be instituted. Return precautions should include attention to any signs or symptoms of pneumonia, ARDS or renal failure.

Identify-Isolate-Inform

The Identify-Isolate-Inform tool initially developed for Ebola virus disease and subsequently adapted for measles can be modified for the ED evaluation and management of patients under investigation (PUI) for MERS (Figure 3). A PUI is a person who has both clinical features of MERS and an epidemiologic risk factor. The MERS tool could be accessed real-time on a triage nurse's computer screen or printed as a poster for display in the triage area. The first step is to identify patients with a possible MERS-CoV exposure within 14 days before symptom onset. CDC and the World Health Organization (WHO) provide case definitions that are comprehensive,[10,11] but do not lend themselves to use by frontline emergency personnel who must make rapid risk assessments. Therefore, the 3I tool provides a concise and simplified version of exposure types coupled with symptoms for both severe and milder illness.

Figure 2. Photo from camel market outside Riyadh, Saudi Arabia where MERS-CoV(Middle East respiratory syndrome-Coronavirus) was first detected. Dromedary (one-hump) camels are strongly linked to having a role as a MERS-CoV reservoir and source of zoonotic transmission to humans.

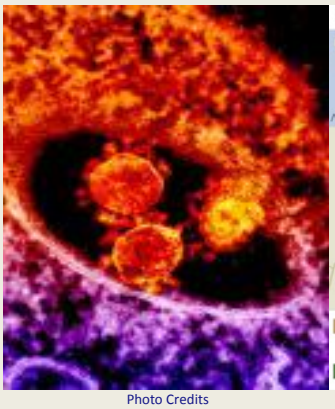
If a patient is not identified as having an exposure risk coupled with symptoms, triage may proceed as usual. A caveat is that the Vital Sign Zero[12] concept must be applied to all patients before direct patient contact is made to measure traditional vital signs. Vital Sign Zero refers to a mindset of first determining whether the patient may be a risk to expose or contaminate healthcare personnel prior to them having contact with the patient in order to measure traditional vital signs. By first assessing whether the patient is contaminated or contagious, the healthcare provider can don risk-appropriate personal protective equipment before continuing with a full evaluation.

For patients who have positive exposure plus symptom findings, the second step in the algorithm is to immediately "isolate." A surgical mask should be placed on such patients and they should be directed to an airborne infection isolation room. (If airborne isolation is not available, the patient should be placed in a private room until transfer to an appropriate facility can be arranged.) Staff entering the room should adhere to standard, contact and airborne precautions. They should don appropriate PPE to include a fit-tested N95 respirator or equivalent, eye protection, gown and gloves. Isolated patients should have samples obtained urgently and sent to the local public health department laboratory for disease confirmation.

The final action of the tool is to "inform." In addition to notifying the hospital infection prevention and control team, emergency physicians should promptly report suspected

Identify, Isolate, Inform

Emergency Department Evaluation and Management of Patients Under Investigation (PUIs) for MERS Coronavirus



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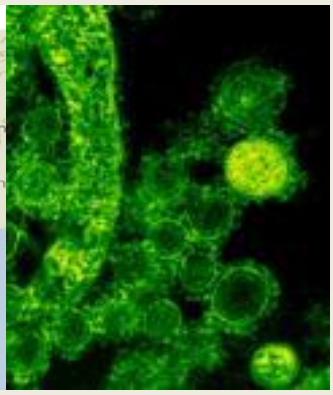
http://wwwnc.cdc.gov/travel/notices/alert/coronavirus-saudi-arabia-qatar



http://phil.cdc.gov/phil/quicksearch.asp

EXPOSURE WITHIN 14 DAYS

- Travel in or near Arabian Peninsula [a]
- Been in a healthcare facility in the Republic of Korea [a]
- Close contact with a symptomatic (fever plus respiratory illness) traveler to above regions or patient with confirmed MERS [a]
- PUI by health authorities for potential MERS infection [a]
- Close contact with dromedary camels [a]
- Been in a healthcare facility in or near Arabian Peninsula with confirmed healthcare-associated MERS patient [b]
- Close contact with symptomatic confirmed MERS patient [c]

IDENTIFY
Exposure PLUS Symptoms

SYMPTOMS

- [a] Fever *and* pneumonia or acute respiratory distress syndrome
- [b] Fever *and* symptoms of respiratory illness
- [c] Fever *or* symptoms of respiratory illness

ISOLATE*

- Place surgical mask on patient
- Place patient in airborne infection isolation room
- Practice standard, contact and airborne precautions plus face shield/eye protection
- Use fit-tested N95 respirator or equivalent when entering patient room

INFORM

Report immediately to
- Hospital Infection Prevention
- Local Health Department

a Severe illness b Milder illness c Milder illness (http://www.cdc.gov/coronavirus/mers/case-def.html)

***Ill patients who do not require hospitalization may be isolated at home while being evaluated for MERS infection.**

The Identify-Isolate-Inform tool was conceived by Dr. Kristi L Koenig, Director, Center for Disaster Medical Sciences, UC Irvine

Figure 3. Koenig's Identify-Isolate-Inform tool adapted for Middle East respiratory syndrome.

MERS patients to the local public health department at all times of the day or night. Additional stakeholders, including hospital leadership, occupational health, and the laboratory would need notification through established communications processes at the facility.

Patients who do not meet medical criteria for admission can be isolated at home during the evaluation phase. However, as MERS is a serious contagious disease, an assessment of the home environment must first be performed. The patient needs to be reliable and compliant with home isolation. The home environment needs to have adequate support to offer proper care, including the means for a rapid return for reevaluation if the patient's condition deteriorates. Health department officials can assist with providing such patients with appropriate public health monitoring and measures to prevent infection transmission.

Areas of Ambiguity

While the WHO uses the terminology MERS-CoV, they specifically suggest that the name should be avoided, stating that such nomenclature may have "unintended negative impacts by stigmatizing certain communities or economic sectors."[13] In addition, as has been the case for other emerging infection diseases such as the 2009 H1N1 pandemic, even purely science-based guidance from authoritative bodies is sometimes conflicting. For example, WHO recommends droplet precautions (surgical mask) unless an aerosolizing procedure is being performed, whereas the U.S. CDC endorses airborne precautions (N95 respirators or equivalent) for all circumstances. Even though there is no good evidence that the virus is transmitted by airborne routes (in the absence of aerosolizing procedures), some would argue that, to avoid transmission, it is better to be more conservative. However, this approach is not without downsides as, if the virus becomes more widespread, it could result in shortages of N95 respirators. Such shortages occurred during the 2009 H1N1 pandemic leading to concerns that respirators might be unavailable for patients with clear indications, such as those with tuberculosis. There is also a substantial cost both for purchasing and stockpiling and for training and fit testing for each new brand of N95 respirator if this approach is used.

Another challenging area is that of lack of standardization in case definitions. WHO and CDC information overlap but is not entirely the same. For example, CDC makes no mention of close contact with dromedary camels in the 14 days prior to symptom onset as a MERS risk factor.

As with all contagious infectious diseases, the question of when to use the public health tools of quarantine and isolation is critical.[14,15] While it is clear that ill patients should be immediately isolated, the efficacy of the use of quarantine is more ambiguous. In general quarantine of asymptomatic patients is only beneficial in cases where the infected person is contagious prior to the onset of symptoms. For example, in the case of Ebola, other public health monitoring tools would make more scientific sense than quarantine as the disease becomes contagious only after symptom onset.[4,14,15] As with other respiratory viruses, MERS may be contagious prior to symptom onset, but it does not seem to be easily transmissible from person to person. Furthermore, if it can be transmitted prior to symptom onset, it is unclear how many days prior. Given the current state of knowledge, avoidance of exposure, and, if exposed, implementation of public health monitoring measures other than quarantine are probably appropriate.

CONCLUSION

MERS is an emerging infectious disease that is not yet fully understood in terms of mode of transmission and potential for widespread dissemination. As with any novel infection, it is important not only to identify and treat individual patients, but also to protect healthcare providers and the public health. The Identify-Isolate-Inform tool can be used real-time on the front lines to rapidly detect and manage patients at risk for MERS presenting to the ED. As with the similar 3I tools for Ebola and measles, it can be applied in any acute care setting such as clinics and prehospital environments. Use of the 3I tool will aid emergency physicians and other emergency personnel in performing rapid and appropriate screening for MERS.

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Tuberculoma-Induced Seizures

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Seizures in human immunodeficiency virus (HIV) patients can be caused by a wide variety of opportunistic infections, and, especially in developing countries, tuberculosis (TB) should be high on the differential. In India, TB is the most common opportunistic infection in HIV and it can have several different central nervous system manifestations, including intracranial tuberculomas. In this case, an HIV patient presenting with new-onset seizure and fever was diagnosed with tuberculous meningitis and multiple intracranial tuberculomas. The patient received standard TB medications, steroids, and anticonvulsants in the emergency department and was admitted for further care. [West J Emerg Med. 2015;16(5):625-628.]

INTRODUCTION

While traditionally thought of as a primarily pulmonary process, tuberculosis (TB) can affect a variety of organ systems, including the central nervous system (CNS). CNS manifestations include tuberculous meningitis (TBM), spinal tuberculous arachnoiditis, and intracranial tuberculomas.[7] Intracranial tuberculomas are understood to be caused by hematagenous spread of bacillus into the brain, establishing tubercles that can coalesce and grow. Tuberculomas can exhibit as a single large mass or as multiple masses throughout the brain, and are more likely to be found in the posterior fossa.[12]

Tuberculomas are of growing clinical importance as ever-increasing globalization leads to increased migration and expansion of TB. The World Health Organization estimates there are approximately nine million new cases of TB each year, with over 20% of these cases demonstrating extrapulmonary disease.[9] Intracranial tuberculomas are currently relatively rare in the Western world, comprising approximately 0.15%-0.18% of all brain tumors and are found largely in adults suffering from TB reactivation.[5] Tuberculomas are significantly more common in the developing world and are estimated to compromise of 20%-30% of all brain masses[1,5] They are also more common in children and associated with concurrent human immunodeficiency virus (HIV) infection.[12] TB is the most common cause of death in HIV-infected patients, and approximately 24% of all TB deaths worldwide are associated with HIV.[4,14]

CASE REPORT

A patient was brought in by relatives to the emergency department (ED) of the BJ Civil Medical Center in the city of Ahmedabad in Gujurat, India. The patient and his family complained of a single generalized tonic-clonic seizure, altered mental status, and four episodes of emesis throughout the day. Upon further history, the patient and his relatives detailed a history of HIV diagnosed in 2003. The patient had been prescribed anti-retroviral therapy (ART) with Efavirenz and Lamivudine. However, he had been non-compliant with his medication for the past two weeks. His last CD4 count checked two years ago was 276. On review of systems, the patient also complained of a fever and a headache for the last 1.5 months for which he had not sought medical attention.

On presentation to the ED, the patient's vital signs were a blood pressure of 112/80mmHg, a pulse of 108 beats per minute, a respiratory rate of 20 breaths/min and an oxygen saturation of 99% on room air. His temperature was 102 degrees Fahrenheit. On physical exam, the patient was confused and irritable; he was alert and oriented to person only. His neurological exam failed to demonstrate any localized neurological deficit, with a normal Babinski reflex and no neck rigidity. The patient's ophthalmologic/fundal exam demonstrated no papillaedema. His lungs were clear to

auscultation bilaterally. In the ED, the patient did not have any seizure activity.

While the patient's laboratory results were pending, he was started on prophylactic treatment of meningitis with intravenous ceftriaxone 2 grams, vancomycin 1 gram. Additionally, he was treated with ondansetron 4 milligrams, phenytoin 1 gram, and acetaminophen 325 milligrams.

The patient's blood work demonstrated a complete blood count with a white blood count of 11,070/mm^3 and no neutrophil predominance, and a hemoglobin 12.5 grams. Additional pertinent laboratory results included an erythrocyte sedimentation rate of 70mm/hr and a CD4 count of 59. The patient's liver function tests were normal. The patient's chest radiograph did not demonstrate any evidence of pulmonary infiltrates, cavitations, or consolidations.

The patient underwent a magnetic resonance imaging (MRI), which was concerning for tuberculous leptomeningitis with multiple tuberculomas in the left occipital parasagittal region with enhancement of infective granulomatous tissue in the left sylvian fissure (Figure). A lumbar puncture was performed and cerebrospinal fluid (CSF) examination revealed elevated protein (162mg/dL), low levels of glucose (33mg/dL), and a total cell count of 90/mm^3 with an 80% lymphocyte predominance.

The patient was determined to have TBM and intracranial tuberculomas. He was started on isoniazid 10mg/kg daily, rifampin 10mg/kg daily, pyrazinamide 35mg/kg daily, streptomycin 15mg/kg intramuscular 3 times per week, and pyridoxine 50mg daily. He was also started on intravenous steroids: dexamethasone 8mg every eight hours for three days and then switched to prednisolone 40mg daily. The patient additionally received prophylactic trimethoprim/sulfamethoxazole and valproic acid.

On day 3, the patient defervesced; his mental status returned to baseline on day 5. He was restarted on ART on day 7 and discharged home on day 8.

DISCUSSION

The workup for an HIV positive patient who presents with altered mental status often focuses on more common etiologies, including toxoplasmosis, bacterial or fungal meningitis, or neurocystercercosis. In the West, intracranial tuberculomas are an uncommon cause of seizure. These tuberculomas often remain clinically silent until they exhibit a mass effect on the brain and present as seizures, headaches, gait disturbances, and visual fields defects.[5,7] These patients often have a normal neurological exam, though papillaedema can be present if the intracranial pressure is sufficiently elevated. Sixth nerve palsies are the most frequently appreciated neurological deficit.[12]

Patients with intracranial tuberculomas often lack a history of TB infection or conversely may even be on TB medications at the time of presentation.[5,12] As countries with the most prevalent cases of TB often administer the BCG vaccine, a PPD at the time of presentation is not traditionally very helpful.[5] The presence of active pulmonary TB on chest radiograph ranges from 30 to 50% in one series.[10]

Diagnostic imaging is important when investigating the possibility of a CNS TB infection. A computed tomography of the head with intravenous contrast is often sufficient. Tuberculomas appear as an avascular low-density mass lesion. Often, they will exhibit greater than expected surrounding cerebral edema.[5,7] Late-

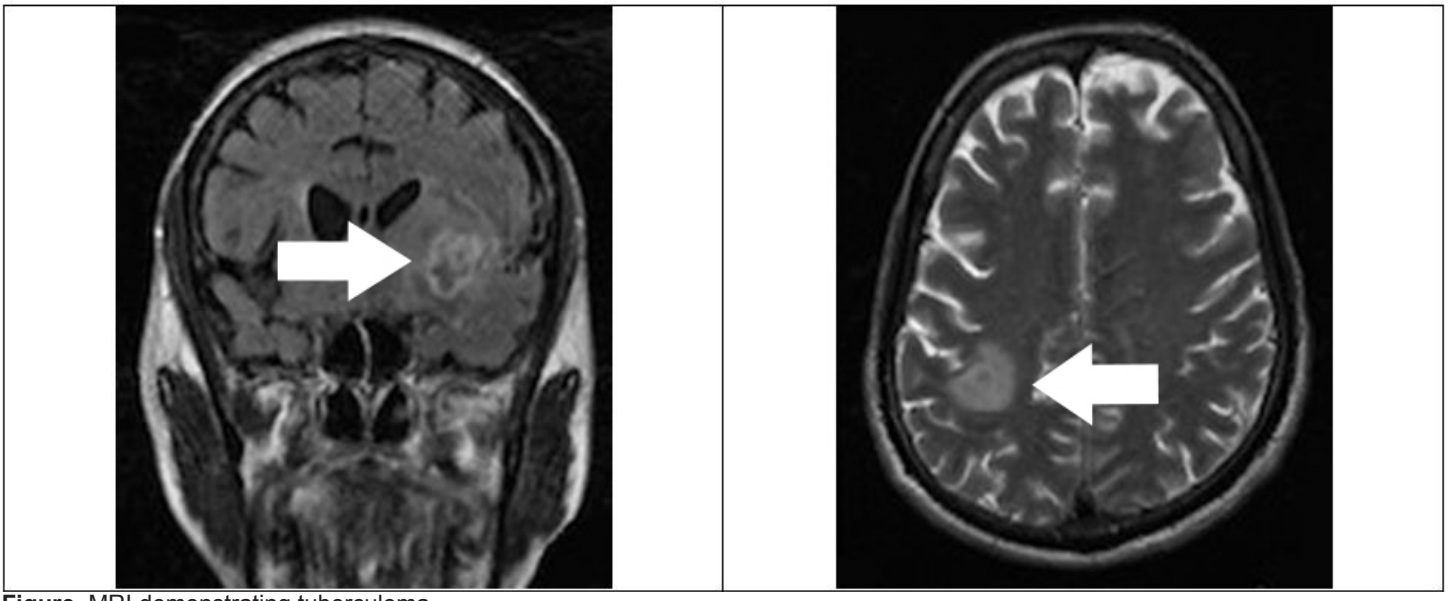

Figure. MRI demonstrating tuberculoma.
MRI, magnetic resonance imaging

stage tuberculomas are well encapsulated and have peripheral ring enhancement. This can lead to a common misdiagnosis of neurocystercercosis, especially if multiple tuberculomas are present.[7] An MRI of the brain is also a useful adjunct imaging modality in distinguish between the two entities.

Generally, lumbar punctures should be avoided as the space occupying mass of the tuberculoma can theoretically cause herniation[5,7] Furthermore, CSF results are often unremarkable-although in our patient, the CSF did demonstrate an elevated protein level, leukocytosis, and a decreased glucose level.[5]

The treatment for intracranial tuberculomas is predominantly medical. There are several case series of surgical interventions for confirmed tuberculomas with relatively high mortality and increased risk for severe meningitis following surgical excision.[7,12,13] Surgery may be warranted in cases with concern for obstructed hydrocephalus, compression of the brainstem, or impending herniation.[7,12]

First-line medications for intracranial tuberculomas mirror those for TB meningitis. Isoniazid, rifampin, and pyrazinamide all have adequate CSF penetration and are bactericidial.[7] Ethambutol and streptomycin are considered second line on account of their poor CNS penetration and their adverse effects. In the case of intracranial tuberculomas, the duration of treatment doubles to 18 months. Given the prolonged length of treatment, the physician should remain alert to side effects including isoniazid-induced hepatitis and neurotoxicity.[5,7]

Corticosteroids also play a prominent role in the medical treatment of intracranial tuberculomas. Many of the symptoms of intracranial tuberculomas are secondary to increased intracranial pressure from the disproportionate cerebral edema caused by the lesions. In randomized control trials, dexamethasone and prednisone have both been shown reduce cerebral edema and reduce mortality in TB meningitis.[3,8,11] They play a similar role in intracranial tuberculomas and are strongly indicated.[5,7]

Upon diagnosis, tuberculomas carry a positive prognosis. All the literature examined showed complete or near-complete recovery for all patients on medical treatment, and neither surgically nor medically treated patients had any recurrence after 28 months.[1,5,12]

CONCLUSION

In an immunocompromised patient who presents with seizures, especially if from an area with endemic TB, a physician should consider the diagnosis of intracranial tuberculomas. Computed tomography (CT) imaging remains the diagnostic modality of choice, and a lumbar puncture should be withheld until a space-occupying lesion has been ruled out and a physician looks to evaluate for TB meningitis. Treatment in the ED should focus on anti-seizure medications, standard anti-TB regimens with isoniazid, rifampin, and ethambutol, and early corticosteroid administration with dexamethasone or prednisone. Surgical intervention should be reserved to patients with signs of obstructive hydrocephalus or brainstem compression. Response to treatment can be followed by repeat CT imaging to visualize decreased cerebral edema and reduction in intracranial tuberculoma size. The disease process carries a good prognosis.

As TB and HIV/acquired immune deficiency syndrome continue to affect a larger geographic area and international travel becomes easier and more prevalent, a high index of suspicion is required to diagnose and treat intracranial tuberculomas.

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Diagnosis of Aortic Dissection in Emergency Department Patients is Rare

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Introduction: Aortic dissection is a rare event. While the most frequent symptom is chest pain, that is a common emergency department (ED) chief complaint and other diseases causing chest pain occur much more often. Furthermore, 20% of dissections are without chest pain and 6% are painless. For these reasons, diagnosing dissections may be challenging. Our goal was to determine the number of total ED and atraumatic chest pain patients for every aortic dissection diagnosed by emergency physicians.

Methods: Design: Retrospective cohort. Setting: 33 suburban and urban New York and New Jersey EDs with annual visits between 8,000 and 80,000. Participants: Consecutive patients seen by emergency physicians from 1-1-1996 through 12-31-2010. Observations: We identified aortic dissection and atraumatic chest pain patients using the International Classification of Diseases 9th Revision and Clinical Modification codes. We then calculated the number of total ED and atraumatic chest pain patients for every aortic dissection, along with 95% confidence intervals (CIs).

Results: From a database of 9.5 million ED visits, we identified 782 aortic dissections or one for every 12,200 (95% CI [11,400-13,100]) visits. The mean age of dissection patients was 66±16 years and 38% were female. There were 763,000 (8%) with atraumatic chest pain diagnoses. Thus, there is one dissection for every 980 (95% CI [910-1,050]) atraumatic chest pain patients.

Conclusion: The diagnosis of aortic dissections by emergency physicians is rare and challenging. An emergency physician seeing 3,000 to 4,000 patients a year would diagnose an aortic dissection approximately every three to four years. [West J Emerg Med. 2015;16(5):629-631.]

INTRODUCTION

Emergency physicians (EPs) strive never to miss the diagnosis of aortic dissection because this can be devastating to the patient and also stressful to the physician.[1] However, aortic dissection is a rare disease and identifying dissection may be challenging. Its symptoms, most commonly chest pain, often overlap those of conditions much more commonly found in the emergency department (ED), including acute coronary syndrome and pulmonary embolus.[2] It is easy to order and perform the diagnostic test most commonly used to diagnose dissection, computerized tomography (CT) angiography of the chest. However, ordering a CT for everyone for whom dissection is a consideration, even those with a remote possibility, may not be the best strategy. Patients may suffer adverse effects from a CT angiogram, such as acute renal failure or allergic reactions, and all will have radiation exposure with consequent cancer risks.[3] Also, CTs are costly, lengthen patient stays, and inconvenience patients.

The rarity of dissection makes it inevitable that EPs will miss or delay diagnosing some. Our goal was to estimate

the magnitude of this problem by studying how seldom dissections are diagnosed in the ED. We did not find previous studies addressing this in the literature. An estimate of the incidence may be useful for clinicians as they weigh the risks and benefits of ordering CTs**,** and for physicians currently involved in litigation regarding failure or delay in diagnosing aortic dissection.

METHODS

Design and setting

We conducted a retrospective cohort study of patients at 33 suburban and urban New York and New Jersey EDs, with annual visits between 8,000 and 80,000. Our institutional review board approved this study.

Selection of participants

We included consecutive patients seen by EPs from January 1, 1996 through December 31, 2010.

Methods and measurements

EPs documented diagnoses in their charts at the time of patient encounter. Trained coders in the billing department then assigned International Classification of Diseases 9th Revision and Clinical Modification (ICD-9) codes to the chart. We identified aortic dissection visits from ICD-9 codes (441.00, 441.01, 441.02, and 441.03), and then exported visit information to Excel (Microsoft Corporation, Redmond WA) for analysis. *A priori*, we generated an expansive list of ICD-9 codes for atraumatic chest pain. Since the pain in aortic dissection patients can have varying quality, location, and intensity, we included all diagnoses with presenting symptoms that aortic dissection patients could have.

Analysis

We calculated the number of total ED and atraumatic chest pain patients for every aortic dissection, along with 95% confidence intervals (CIs).

RESULTS

The ED database contained a total of 9,533,827 patient visits. Of these, there were 782 aortic dissections, or one for every 12,200 visits (95% CI [11,400-13,100]). The mean age of aortic dissection patients was 66±16 years and 38% were female.

Seventy-three ICD-9 codes were determined to meet criteria for presentation of symptoms potentially having a diagnosis of aortic dissection. These included diseases such as cholecystitis, cardiac tamponade, acute myocardial infarction, and heartburn, as well as unspecified chest pain, epigastric pain, etc. (A full list of ICD-9 codes used is available in the Appendix.) Of the total ED visits there were an estimated 763,000 (8%) with atraumatic chest pain diagnoses. There was one dissection for every 980 atraumatic chest pain patients (95% CI [910-1,050]).

DISCUSSION

Aortic dissection is one of the most important diseases not to miss, yet its diagnosis in the ED is very rare. We found one aortic dissection for every 12,200 ED patients and one for every 980 patients with atraumatic chest pain. An EP seeing 3,000 to 4,000 patients a year[4] would diagnose an aortic dissection approximately once every three to four years.

In addition, aortic dissections often present with a wide range of symptoms. One study found only 71% of patients with type A dissections had anterior chest pain and 6% had no pain at all.[2] Furthermore, aortic dissection may present with symptoms, such as heart failure, neurologic deficits, syncope, or vascular insufficiency, which are found more commonly in other diseases.[5] Kurabayashi et al. found aortic dissections were misdiagnosed in 16% of cases presenting to the ED.[6] This is likely an underestimate as patients with dissection, particularly those who die, may never receive the correct diagnosis.

History and physical examination alone is unreliable in diagnosing aortic dissections as physicians correctly suspect aortic dissection after the initial clinical evaluation in only 65% of patients.[7] While sudden onset of severe pain with elevated blood pressure and pulse deficits suggest dissection, absence of these findings does not exclude it.[8] Consequently, researchers have devised scoring systems to risk stratify patients; however, none have performed well or achieved widespread use.[9-10] D-dimer may be suitable as a "rule-out" tool with a useful negative likelihood ratio, though the positive likelihood ratio is not helpful.[11] Chest radiograph can be used as a screening tool, as finding multiple abnormalities has a sensitivity of 90% in detecting aortic dissection.[8] However individual findings, such as abnormal aortic contour and widened mediastinum, have sensitivities from 9% to 71%.[8] Another study found chest radiograph sensitivity and specificity for aortic dissection of only 67% and 70%, respectively.[12]

None of the approaches above is sufficient for diagnosing aortic dissection, and performing chest CT imaging on every patient may not be the best strategy. Unfortunately, failure or delay in diagnosis may lead to significant morbidity and mortality. In addition, this may lead to litigation: in a series of aortic dissection lawsuits, 58% were related to failure or delay in diagnosis.[13] Patients and their families blame physicians for poor outcomes and then seek high monetary compensation.[14] This is distressing to the practitioner, and fear of litigation may lead to the diversion of resources in a futile effort to achieve diagnostic perfection.[1] Like other relatively rare diseases such as bacterial meningitis and subarachnoid hemorrhage, delay in treating or failure to diagnose aortic dissections carries significant morbidity, mortality, and litigation implications. Nevertheless, if we miss the diagnosis, the patient may die

– an outcome that no physician wants to see. Unfortunately, the argument that "it is a rare diagnosis" is not likely to be an effective defense in court.

LIMITATIONS

Our study was limited by its retrospective nature. We identified aortic dissections from a database using ICD-9 codes based on EP diagnoses. The better way would be to define prospectively which patients to include as having an aortic dissection. However, given the relative rarity of the diagnosis, a prospective study would need to enroll a very large number of patients. For example, accumulating 100 dissection patients would require a total ED patient volume of 100 times 12,200, which is about 1.2 million patients – an overwhelming task. Additionally, using ICD-9 codes may have led to over or under counting; however, we do not believe that this would greatly change our results. In addition, many diagnoses of dissection are not made in the ED, but after admission, for example during interventional angiography performed for suspected acute coronary syndrome.

In our study, we identified atraumatic chest pain patients using an expansive list of diagnoses because the characteristics of chest pain associated with aortic dissections are varied. Using a narrower list of diagnoses would have identified 5% to 6% of all ED patients as having chest pain. This would have led to an estimate of one aortic dissection for every 600 to 700 patients presenting with chest pain.

CONCLUSION

We found aortic dissections to be rare, diagnosed approximately once for every 12,200 ED patients and once for every 980 atraumatic chest pain patients. Although ordering CTs in low-probability patients may not be the best strategy, missing the diagnosis can have devastating consequences for the few patients that actually have a dissection. These findings may be useful for clinicians as they weigh the risks and benefits of ordering CTs, and also for physicians currently involved in litigation regarding failure or delay in diagnosing aortic dissection.

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Not Just an Urban Phenomenon: Uninsured Rural Trauma Patients at Increased Risk for Mortality

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Introduction: National studies of largely urban populations showed increased risk of traumatic death among uninsured patients, as compared to those insured. No similar studies have been done for major trauma centers serving rural states.

Methods: We performed retrospective analyses using trauma registry records from adult, non-burn patients admitted to a single American College of Surgeons-certified Level 1 trauma center in a rural state (2003-2010, n=13,680) and National Trauma Data Bank (NTDB) registry records (2002-2008, n=380,182). Risk of traumatic death was estimated using multivariable logistic regression analysis.

Results: We found that 9% of trauma center patients and 27% of NTDB patients were uninsured. Overall mortality was similar for both (~4.5%). After controlling for covariates, uninsured trauma center patients were almost five times more likely to die and uninsured NTDB patients were 75% more likely to die than commercially insured patients. The risk of death among Medicaid patients was not significantly different from the commercially insured for either dataset.

Conclusion: Our results suggest that even with an inclusive statewide trauma system and an emergency department that does not triage by payer status, uninsured patients presenting to the trauma center were at increased risk of traumatic death relative to patients with commercial insurance. [West J Emerg Med. 2015;16(5):632-641.]

INTRODUCTION

In 2012, approximately 48 million people living in the United States (18% of U.S. citizens) lacked health insurance.[1,2] Studies of the uninsured have consistently shown that lack of insurance is associated with increased mortality, both when all causes of death were included[3-5] and when chronic health conditions such as cancer[6-12] and heart failure[13-15] were independently examined. Researchers hypothesize that the differences in mortality between uninsured and commercially insured patients may be due to a variety of reasons, including treatment delay, improper triage, under-performance of diagnostic tests and decreased health literacy.[1,16]

With respect to traumatic injury, studies using the National Trauma Data Bank (NTDB) have shown that uninsured Americans have a 1.3- to 3.3-fold higher risk of traumatic death, as compared to patients with commercial or private insurance.[1,17-25] These prior studies have been limited to intentional injuries,[24,26,27] to injuries with greater severity,[21,22,28] or to a subset of injury mechanisms such as motor vehicle crashes[29] or pedestrian deaths.[25] In addition, NTDB data represent predominately urban trauma centers; i.e. 80% of NTDB-recorded incidents occurred in

metropolitan counties with core populations of 50,000 or more.[17-25] No study to date has examined the risk of trauma-related death as a function of insurance status in a largely non-metropolitan, rural population.

Rural America represents approximately 59 million people, 19.3% of the population.[30] Proportionally, more rural Americans are uninsured (9.9%) than urban Americans (8.5%) and poverty rates are higher in rural areas.[31] Both of these factors put rural citizens at higher risk of poor health.

Despite these risk factors, we hypothesized that uninsured trauma patients presenting to an American College of Surgeons-certified Level 1 trauma center in a state with an inclusive trauma system would not be at increased risk of traumatic death, as compared to insured patients from the same population. This hypothesis was based on the fact that the statewide trauma system triages patients based on mechanism of injury, injury types and available resources rather than by payer status. It was also based on a recent study of trauma-related emergency department (ED) visits suggesting that rural settings were more likely to appropriately triage a patient than urban settings.[16] To test this hypothesis, we performed studies of traumatic death as a function of insurance status among adult, non-burn patients presenting to a trauma center ED. For comparison, we did parallel analysis on the same patient population in the NTDB database.

METHODS

Study Populations

The primary patient population was composed of trauma victims presenting to a Level 1 trauma center in a rural state (2003-2010) who were over 17 years of age, not suffering a burn injury, and not dead on arrival. We excluded patients if insurance status was missing. The final trauma center population was 13,680 patients. The initial NTDB population represented all trauma patients from 2002 through 2008. Patients were excluded if they were less than 18 years of age, dead on arrival at the ED, suffering a burn trauma, had missing or inconsistent survival status at ED or hospital discharge, or were missing insurance status. The final NTDB analysis sample was 380,182 trauma patients. Our institutional review board approved this study.

Variables

Demographics included age, sex, and ethnicity. We categorized insurance status as commercial (managed care, commercial insurance, workers compensation), Medicare, Medicaid, and uninsured. Although patients covered by workers compensation may be otherwise uninsured, for the treatment received following their traumatic injury they had insurance coverage and were combined with the commercial insurance group as previously done.[1,26,32]

Injury intention was coded using the Centers for Disease Control and Injury Prevention Matrix of E-code groupings (http://www.cdc.gov/injury/wisqars/ecode_matrix.html) and was categorized as intentional, unintentional or unknown. We combined self-inflicted and assault-related injuries into intentional injuries. Injury severity was measured using validated scales. The Injury Severity Score (ISS)[33] ranges from 0 to 75 and the Glasgow Coma Scale (GCS) from 3-15.[34] Higher ISS and lower GCS scores indicate greater injury severity. All reported GCS scores were at the time of ED admission.

To determine rurality, we assigned patient resident and injury zip codes the zip code approximation for the Rural Urban Commuting Area coding system.[35] Rurality was categorized as urban, large rural, small rural, and isolated rural.

Data Analysis

We conducted analysis using SAS® software, Version 9.3 of the SAS System for Microsoft, SAS Institute Inc., Cary, NC, USA. Frequencies of demographic characteristics by insurance status were calculated. No bivariate statistical tests are reported (e.g., chi-square test for proportions), as the large sample sizes resulted in statistically significant results on all variables.

The primary outcome measure was death following a traumatic injury, excluding those who died before ED arrival. For NTDB data, patients with an ED discharge disposition of "Died" and a hospital discharge disposition of "NA" or a hospital discharge of "Expired" and trauma center patients with an ED discharge disposition of "Died" and hospital discharge disposition of missing or of "Died" were coded as a traumatic death. For secondary outcome analysis, we created a variable for the location of death with values of (a) "Death in ED", ED disposition of "died"; (b)"Inpatient Death", ED disposition "not died", hospital discharge "expired" (NTDB) or "died" (trauma center), and (c) "Alive at Discharge", both ED and hospital dispositions of "not died" or "not expired".

To estimate the relative odds of death following a traumatic injury, we calculated adjusted odds ratios (aOR) and 95% confidence intervals (CI). We excluded from analysis patients with missing data on any variable included in the model. Variables included in the model were based on *a priori* knowledge or on an association between the variable and mortality in an unadjusted model. Covariates for both patient populations were age, race, sex, injury intent, penetrating injury (Yes/No), ISS, GCS, rurality of residence, and insurance status. The co-morbidities of diabetes, cardiovascular disease, lung disease, and stroke were also included in the trauma center model. Obesity was not found to have an association with mortality in the unadjusted model and was not included. Given that the risk of mortality was likely to differ by hospital, the odds ratios using NTDB data were determined using hierarchical multivariable logistic regression analysis, controlling for correlation within a hospital.

We chose the patient's residence zip code for the primary logistic regression model because of the following: although 61% of patient injury zip codes (8376 of 13680) were missing, among those with both zip codes (n=6191), over 63% (n=3912)

had an identical injury and resident zip code. Furthermore, among the 37% (n=2,279) of patients with different injury and home zip codes, the majority (98%, 2,210 of 2,279) were state citizens injured in another area of the state.

To examine more directly whether distance from the injury zip code to the treating trauma facility affected risk of traumatic death, we then performed a logistic regression using only patients with injury zip codes. No patient zip codes were available in the NTDB, so this variable was not included in the model.

RESULTS

Demographics

Approximately 9% and 28% of adult, non-burn trauma center and NTDB patients were uninsured, respectively (Table 1a and 1b). The mean age of uninsured trauma center and NTDB patients was similar. As expected, Medicare patients were significantly older on average than other groups. Conversely, the mean ages for Medicaid and uninsured patients within each population were similar and several years younger than that of patients with commercial insurance. Overall, NTDB patients were more racially diverse than trauma center patients. In addition, for both trauma center and NTDB patients, there was a higher proportion of males and a lower proportion of Whites among the uninsured, as compared to the commercially insured. Among uninsured trauma center patients, 57% lived in urban, 19% in large rural, 12% in small rural and 12% in isolated rural zip codes.

Injury Characteristics

The highest proportions of injuries for both patient populations were unintentional, regardless of insurance status (Table 2). However, uninsured and Medicaid patients from the trauma center and NTDB populations had higher proportions of intentional and of penetrating injuries, as compared to patients with commercial insurance or Medicare. In addition, when we compared uninsured patients from the trauma center with those from the NTDB, the latter had a higher proportion of intentional injuries (20% vs. 30%) and penetrating injuries (10% vs. 24%). In contrast, injury severity, as indicated by ISS and GCS scores, did not show clinically significant differences by insurance status.

Mortality

Overall, the proportion of patients who died from traumatic injuries was similar for the trauma center (4.3%) and NTDB (4.8%). See Table 3. For both patient populations, the highest mortality rate was among Medicare patients followed by uninsured patients. Additionally, both of these mortality rates were higher than those for patients with commercial insurance or Medicaid. Among trauma center patients, a higher proportion of uninsured patients died in the ED, as compared to patients with insurance. A higher proportion of Medicare patients died after hospital admission. We saw a similar pattern among NTDB patients.

Adjusted Odds Ratios for Traumatic Death

The relative odds of death from traumatic injury increased with age for both trauma center and NTDB patient populations (Table 4). As compared to White patients in the NTDB, Black patients were 19% more likely to die from traumatic injury (95% CI [1.03-1.38]). Among the NTDB patient population, males were 33% more likely than females to die from traumatic injury (95% CI [1.24-1.42]). Conversely, there were no differences by race or by sex for trauma center patients.

Penetrating injury was over three-fold more likely than non-penetrating injury to result in death for trauma center patients (95% CI [1.58-6.64]) and for NTDB patients (95% CI [3.36-4.29]). Increasing ISS and decreasing GCS were also associated with a higher risk of death.

With respect to co-morbidities, diabetes, cardiovascular disease, and stroke were all associated with increased odds of traumatic death among trauma center patients. Lung disease appeared to be associated with increased risk in the unadjusted model, but was not found to be so in the adjusted model. Finally, obesity was not associated in either the unadjusted or adjusted model (data not shown). None of these co-morbidities were individually associated with an increased risk of death for NTDB patients and were not included in the model.

Uninsured trauma center patients were almost five times more likely to die from traumatic injury (95% CI [2.93-8.18]) relative to patients with commercial insurance. For the NTDB, there was a 75% higher odds of traumatic death (95% CI [1.47-2.09]) among uninsured patients versus those commercially insured.

For trauma center and NTDB Medicare patients, the relative risk of death was 61% (95% CI [1.12-2.30]) and 35% (95% CI [1.22-1.51]) higher, respectively, as compared to patients with commercial insurance. There were no differences in the risk of traumatic death between patients commercially insured and those with Medicaid. Similarly, no differential risk was found among trauma center patients by rurality of patient residence.

In a sub-analysis of trauma center patients with an injury zip code (Model N=6184), there were no rurality-based differences in risk of traumatic death, after controlling for all covariates found in Table 4 (data not shown). However, the relationship between traumatic death and insurance status persisted in this model, with an almost four-fold increase in traumatic death among the uninsured (95% CI [1.96-7.82]), as compared to patients with commercial insurance.

DISCUSSION

We observed similar demographic differences between uninsured and insured patients for trauma center and NTDB patients. The uninsured were younger than those with commercial insurance and more likely to be male. They were also more likely to be non-White. These data are consistent with 2011 U.S. census data showing that people ages 19-

Table 1a. Demographics of adult, non-burn trauma patients from a Level 1 trauma center in a rural state (2003-2010) and the National Trauma Databank (NTDB) (2002-2008) by type of insurance.

	All	Commercial[1]	Medicare	Medicaid[2]	Uninsured
	N	n (row %)[3]	n (row %)[3]	n (row %)[3]	n (row %)[3]
Trauma center	13,680	6,996 (51%)	3,236 (24%)	2,206 (16%)	1,242 (9%)
NTDB	380,182	155,517 (41%)	89,985 (24%)	30,129 (8%)	104,551 (28%)
Age in years: Mean (SD)					
Trauma center	48 (22)	42 (17)	75 (14)	37 (13)	34 (13)
NTDB	46 (20)	43 (17)	69 (17)	39 (15)	36 (13)

[1]All commercial insurance including workman's compensation.
[2]Includes state-based, income-based insurance programs.
[3]Row totals may not equal study population totals due to missing values.

Table 1b. Demographics of adult, non-burn trauma patients from a Level 1 trauma center in a rural state (2003-2010) and the National Trauma Databank (NTDB) (2002-2008) by type of insurance.

	All	Commercial[1]	Medicare	Medicaid[2]	Uninsured
	n (col %)[4]	n (col %)[4]	n (col %)[4]	n (col %)[4]	n (col %)[4]
Sex					
Trauma center					
Male	8,765 (64%)	4,657 (67%)	1,536 (48%)	1,559 (71%)	1,013 (82%)
Female	4,915 (36%)	2,339 (33%)	1,700 (52%)	647 (29%)	229 (18%)
NTDB					
Male	248,094 (65%)	104,404 (67%)	42,132 (47%)	18,692 (62%)	82,866 (79%)
Female	131,818 (35%)	51,063 (33%)	47,826 (53%)	11,363 (38%)	21,566 (21%)
Race/ethnicity					
Trauma center					
White	11,758 (91%)	6,020 (92%)	3,085 (97%)	1,816 (96%)	837 (74%)
Black	437 (3.4%)	145 (2.2%)	34 (1.1%)	149 (7.1%)	109 (9%)
Hispanic	425 (3.3%)	184 (2.8%)	18 (0.6%)	88 (4.2%)	135 (12%)
Other	328 (2.5%)	180 (2.8%)	45 (1.4%)	48 (2.3%)	55 (5%)
NTDB					
White	244,502 (67%)	109,065 (73%)	72,057 (83%)	15,220 (54%)	48,160 (48%)
Black	59,947 (17%)	16,786 (11%)	8,484 (10%)	7,733 (27%)	26,944 (27%)
Hispanic	27,719 (7.6%)	9,387 (6%)	1,803 (2%)	2,505 (9%)	14,024 (14%)
Other	32,282 (9%)	13,565 (9%)	4,401 (5%)	2,979 (11%)	11,337 (11%)
Ruralty[5]					
Urban	5,560 (50%)	3,036 (52%)	1,070 (42%)	861 (48%)	593 (57%)
Large rural	2,058 (18%)	909 (16%)	568 (22%)	385 (21%)	196 (19%)
Small rural	1,687(15%)	831 (14%)	433 (17%)	295 (16%)	128 (12%)
Isolated rural	1,918 (17%)	1,050 (18%)	466 (18%)	272 (15%)	130 (12%)

[1]All commercial insurance including workman's compensation.
[2]Includes state-based, income-based insurance programs.
[4]Column totals may not equal study population totals due to missing values.
[5]Based on 2006 Rural Urban Commuting Area (RUCA) codes for the residential zip code of the patient.

Table 2. Injury characteristics for adult, non-burn trauma patients from a Level 1 trauma center (2003-2010, N=13,680) and the National Trauma Databank (NTDB) (2002-2008, N=380,182) by type of insurance.

	All	Commercial[1]	Medicare	Medicaid[2]	Uninsured
	n (col %)[3]	n (col %)[3]	n (col %)[3]	n (col %)[3]	n (col %)[3]
Injury intent					
Trauma center					
Intentional	1,037 (8%)	293 (4%)	72 (2%)	423 (20%)	249 (20%)
Unintentional	12,596 (92%)	6,689 (96%)	3,158 (98%)	1,768 (80%)	981 (80%)
Unknown	29 (0.2%)	12 (0.2%)	4 (0.1)	8 (0.4%)	5 (0.4%)
NTDB					
Intentional	53,848 (14%)	9,658 (6%)	5,119 (6%)	7,771 (26%)	31,300 (30%)
Unintentional	324,634 (85%)	145,516 (94%)	84,648 (94%)	22,144 (73%)	72,326 (69%)
Unknown	1,698 (1%)	343 (0.2%)	217 (0.2%)	214 (1%)	924 (1%)
Penetrating injury					
Trauma center					
Yes	756 (5%)	343 (5%)	74 (2%)	219 (10%)	120 (10%)
No	12,924 (95%)	6,653 (95%)	3,162 (98%)	1,987 (90%)	1,122 (90%)
NTDB					
Yes	43,468 (11%)	8,790 (6%)	3,806 (4%)	5,677 (19%)	25,195 (24%)
No	336,714 (89%)	146,727 (94%)	86,179 (96%)	24,452 (81%)	79,356 (76%)
ISS[4] mean (SD)					
Trauma center	12 (10)	11 (11)	13 (8.4)	11 (10)	8.6 (9.3)
NTDB	11 (10)	11 (10)	11 (8.7)	11 (11)	10 (11)
GCS[5] mean (SD)					
Trauma center	14 (3.1)	14 (3.1)	13 (8.4)	11 (10)	14 (3.1)
NTDB	13 (4.4)	13 (4.2)	13 (4.7)	13 (4.8)	13 (4.4)

[1]All commercial insurance including workman's compensation
[2]Includes state based insurance such as State papers and Iowa Cares
[3]Column subtotals may not equal column total due to missing values.
[4]The Injury Severity Score (ISS) is an anatomically based scoring system to provide an overall severity score for patients with multiple injuries.
[5]The Glasgow Coma Scale (GCS) is a neurological scale that assesses an individual's level of consciousness recorded at time of emergency department admission.

34 represented the highest percentage (38%) of uninsured.[2] They are also consistent with previous research on traumatic injury among the uninsured that showed disproportionate representation by the young and by males.[32] Non-Whites were also over-represented among trauma center patients relative to their percentage of the state's population.

Trauma center patients who were uninsured or on Medicaid had higher proportions of intentional and penetrating injuries than commercially insured patients. This suggests a similar association in our state between economic insecurity and increased prevalence of intentional injury, as previously observed.[36,37] Lack of information on socioeconomic class in the trauma center trauma registry did not allow us to test this hypothesis. Although the intent (intentional vs. unintentional) and type (penetrating *vs*. non-penetrating) of injury were different for uninsured and Medicaid patients versus commercially insured and Medicare patients, there were no clinically relevant differences in injury severity by insurance status.

Increased mortality from traumatic injury among the uninsured has been previously observed for patient populations from largely urban areas where providing emergency medical services can be challenging. Additionally, Haider et al. showed that uninsured racial minorities and penetrating trauma victims clustered at medical centers with higher mortality rates.[38] We hypothesized that an increased risk of traumatic death might not be observed for our population from a rural setting with many fewer cases of penetrating trauma. Furthermore, our state has an organized, inclusive trauma system where all hospitals are categorized (Level I-IV) based on hospital resources and capabilities. Trauma patients receive care based on clearly defined, standardized out-of-hospital and in-hospital triage criteria.

Contrary to our expectations, we found a dramatically increased adjusted risk of traumatic death among uninsured

Table 3. Mortality for adult, non-burn trauma patients from a Level 1 trauma center (2003-2010, N=13,680) and the National Trauma Databank (NTDB) (2002-2008, N=380,182) by type of insurance.

	All	Commercial[1]	Medicare	Medicaid[2]	Uninsured
	n (col %)[3]	n (col %)[3]	n (col %)[3]	n (col %)[3]	n (col %)
Death					
Trauma center					
Yes	589 (4.3%)	200 (3%)	305 (9%)	36 (2%)	48 (4%)
No	13,091 (95.7%)	6,796 (97%)	2,931 (91%)	2,170 (98%)	1,194 (96%)
NTDB					
Yes	18,142 (4.8%)	5,264 (3%)	6,219 (7%)	1,122 (4%)	5,537 (5%)
No	362,032 (95.2%)	150,253 (97%)	82,766 (93%)	29,006 (96%)	99,007 (95%)
Death by location					
Trauma center					
Death in ED	71 (0.5%)	26 (0.4%)	28 (1%)	1 (0.1%)	16 (1.3%)
Inpatient death	518 (3.8%)	174 (2.5%)	277 (9%)	35 (1.6%)	32 (2.6%)
Alive at discharge	13,091 (95.7%)	6,796 (97.1%)	2,931 (90%)	2,170 (98.3%)	1,194 (96.1%)
NTDB					
Death in ED	2,988 (0.8%)	823 (0.5%)	454 (0.5%)	91 (0.3%)	1,620 (1.6%)
Inpatient death	15,154 (4%)	4,441 (2.9%)	5,765 (6.4%)	1,031 (3.4%)	3,917 (3.7%)
Alive at discharge	362,032 (95.2%)	150,253 (96.6%)	82,766 (93.1%)	29,006 (96.3%)	99,007 (94.7%)

ED, emergency department
[1]All commercial insurance including workman's compensation.
[2]Includes state based insurance such as State Papers and Iowa Cares.
[3]Column subtotals may not equal column total due to missing values.

patients in our state relative to commercially insured patients. These data verify that the increased risk among the uninsured is not just a phenomenon of urban communities or of communities with more loosely organized trauma systems.

Similar to the results of Rosen et al.,[1] we found that patients with Medicaid coverage were not at significantly increased risk of death following traumatic injury when compared to those with commercial insurance. Also like Rosen et al., uninsured trauma center patients and those with Medicaid were similar demographically, with a lower mean age than those commercially insured. This suggests that among younger populations having any type of insurance coverage may reduce mortality risk.

Potential Basis for Increased Risk

Previous hypotheses to explain insurance-dependent differences in risk of death include treatment delay and differential care.[1] In 1986, the Emergency Medical Treatment and Active Labor Act (EMTALA) was enacted requiring emergency care be provided regardless of the ability to pay. This landmark legislation afforded patients of all backgrounds and circumstances the right to receive a medical screening examination and initial stabilization care for their illness, injury or labor. Despite the proven benefits of this strong anti-dumping law, there continue to be episodes where patients are inappropriately triaged, transferred to other facilities, and/or receive worse care, based on ability to pay.[16] Stronger enforcement is clearly needed to reduce these violations of patient rights.

Because of the state's trauma system, it is unlikely that EMTALA violations account for the increased mortality risk observed for uninsured trauma center patients. Provision of emergency medical services (EMS) care and triage of trauma patients in our state follow specific guidelines that are independent of insurance status, and all patients in our data set were cared for at a single trauma center. In fact, neither EMS nor ED providers are generally aware of a patient's insurance status at the time of treatment.

Health literacy has also been postulated as a contributor to mortality differences between commercially insured and uninsured patients.[1] Income inequality is the major contributor to differences in overall adult literacy,[39] and may be a determinant of health literacy. However, our state has fewer disparities in educational quality than many states. Moreover, income inequality and reduced health literacy might be expected to impact the mortality rate among Medicaid patients as well as the uninsured. We observed no differences in mortality between trauma center Medicaid patients and those commercially insured.

Does insurance status drive decision-making about seeking emergency care; i.e. are uninsured individuals or their families less likely or slower to dial 911? If so, that could

Table 4. Adjusted odds ratios of traumatic death for trauma center (2003-2010, Model N=13,644) and for NTDB (2002-2008, Model N=378,484) patient populations.

	Trauma center		NTDB	
	aOR[1]	95% CI	aOR[2]	95% CI
Age				
Continuous	1.05	1.04-1.06	1.04	1.03-1.04
Race				
White	1.0 (ref)	1.0 (ref)	1.0 (ref)	
Non-White[3]	0.71	0.40-1.25	NA	NA
Black			1.19	1.03-1.38
Hispanic	Combined		1.07	0.90-1.19
Other			0.96	0.77-1.19
Sex				
Male	1.23	0.95-1.59	1.33	1.24-1.42
Female	1.0 (ref)		1.0 (ref)	
Injury intent				
Intentional	0.96	0.48-1.89	Not included	
Unintentional	1.0 (ref)			
Penetrating injury[4]				
Yes	3.24	1.58-6.64	3.79	3.36-4.29
ISS				
Continuous	1.08	1.07-1.09	1.10	1.09-1.11
GCS				
Continuous	0.74	0.72-0.77	0.85	0.83-0.87
Diabetes				
Yes	1.47	1.07-2.04	Not included	
Cardiovascular disease[4]				
Yes	1.83	1.32-2.52	Not included	
Lung disease[4]				
Yes	1.34	0.94-1.91	Not included	
Stroke				
Yes	2.89	1.58-5.30	Not included	
Insurance status				
Commercial	1.0 (ref)		1.0 (ref)	
Medicare	1.61	1.12-2.30	1.35	1.21-1.51
Medicaid	0.69	0.42-1.12	0.90	0.69-1.16
Uninsured	4.90	2.93-8.18	1.75	1.47-2.08

NTDB, National Trauma Data Bank; *ISS*, Injury severity score; *GCS*, Glasgow Coma Scale; *aOR*, adjusted odds ratios; *CI*, confidence interval

[1]Adjusted Odds Ratios (aOR) and 95% Confidence Intervals (95% CI) were determined using logistic regression, controlling for all variables in the column. Patients were excluded if they had missing values for one or more variables.
[2]aOR was determined using hierarchical logistic regression analysis to control for correlation within hospitals.
[3]Due to the small number of non-Whites, other races were combined to allow for comparison.
[4]Variable reference is No.

Table 4. Continued.

	Trauma Center		NTDB	
	aOR[1]	95% CI	aOR[2]	95% CI
Rurality[5]				
Urban	1.0 (ref)			
Large rural	0.84	0.62-1.15	Zip codes not	
Small rural	1.03	0.73-1.46	Available	
Isolated rural	0.89	0.63-1.26		

NTDB, National Trauma Data Bank; *aOR*, adjusted Odds Ratios; *CI*, confidence interval
[1]Adjusted Odds Ratios (aOR) and 95% Confidence Intervals (95% CI) were determined using logistic regression, controlling for all variables in the column. Patients were excluded if they had missing values for one or more variables.
[2]aOR was determined using hierarchical logistic regression analysis to control for correlation within hospitals.
[5]Rurality results based on residential zip code. No differences seen if model run with only patients having documented injury zip code.

contribute to delayed care. Studies would be needed to test this hypothesis.

We speculate that the uninsured are not a homogenous group but are rather a number of groups that may have overlapping but also unique characteristics. These groups would include healthy individuals who choose not to carry insurance because of costs or other factors, less healthy individuals who would like insurance but find it unaffordable, and individuals unable to get or have lost insurance because of pre-existing conditions.

Healthy individuals who choose not to carry insurance or who are not able to afford insurance may be younger than insured populations. Younger individuals, particularly young men, may exhibit more risk-taking behaviors that contribute to the likelihood of traumatic injury.[40] However, once injured, it is not clear why this population would be at greater risk of death, especially as they are demographically similar to Medicaid patients who are not at increased risk and we saw no insurance-dependent differences in injury severity.

Individuals with health problems may include those unable to afford insurance and those denied coverage because of pre-existing conditions. Although we controlled for several co-morbidities in our analysis, uninsured trauma victims may have undiagnosed or undocumented co-morbidities because of lack of primary healthcare and/or inadequate health records.[41] In addition, there may be a higher proportion of other co-morbidities among the uninsured that were not available for inclusion in our model that contribute to the observed differences in mortality rates. Finally, we cannot rule out the possibility that immeasurable factors exist that account for the increased risk among the uninsured.

Relevance to Public Policy

There is an ongoing inability to identify all of the factors that contribute to insurance status-dependent differences in mortality rate, as well as proven disparities in emergency care for some uninsured patients. These are extremely difficult challenges to overcome. Studies estimating the cost effectiveness of extending health insurance coverage to the uninsured support this approach.[42] Using state level data for all 50 states from 1990-2000, researchers found that a 10% increase in coverage would predict a 1.69%-1.92% decrease in mortality and that extending private health insurance to all uninsured Americans would save over 75,000 lives and more than $400 billion each year.[42]

The stated goal of the Patient Protection and Affordable Care Act (ACA) of 2010 is to reduce the number of uninsured Americans. Provisions include prohibiting insurance companies from denying or cancelling coverage for pre-existing conditions, mandating insurance coverage for individuals and businesses, providing options through federally-subsidized healthcare exchanges, and expanding the number of those eligible for Medicaid coverage.[43] In addition, the ACA calls for the establishment of new trauma center programs that strengthen ED and trauma care, support emergency medicine research, and develop innovative models for emergency care systems to reduce injury morbidity and mortality.

An important metric for measuring the effectiveness of ACA implementation will be its ability to reduce the number of uninsured and this should be accompanied by reduced mortality, including mortality specifically from traumatic injury. Having data prior to ACA implementation, such as this study, will be valuable in determining the success of the ACA.

LIMITATIONS

Data related to potential contributors and confounders for the primary outcome (i.e. mortality) were not always available or consistent in our datasets. For example, a large proportion of NTDB records were missing information on alcohol and drug use, on the time between injury and definitive care, and whether the incident occurred in a rural or urban county. Neither trauma center nor NTDB datasets had information on household income or level of education.

In addition, there is selection bias in the NTDB because

hospitals contributing data are predominately urban, have different criteria for which data are reported (e.g. deaths on admission, deaths in the ED) and different criteria for designating patients as trauma patients. With respect to generalizability, the trauma center population is largely rural and demographically homogenous and this is a single center study. These characteristics may limit the generalizability of the results. However, the observation that insurance status impacts risk of traumatic death in both the urban, racially diverse NTDB population and the rural, racially homogenous trauma center population suggests that studies looking at other sample populations are likely to find similar results. In addition, distance from and time to the treating trauma center could not be calculated due to missing data. For the trauma center population, we completed a sub-analysis for patients with an injury zip code and found no effect by rurality. However, we realize that this is an imprecise estimation of distance and time to the treatment center. Lastly, including those covered by worker's compensation in the commercially insured group as was previously done, may have introduced bias; i.e. they may not have been otherwise insured.

CONCLUSION

In summary, contrary to our hypothesis, uninsured trauma center patients had a higher risk of traumatic death than commercially insured patients. In contrast, Medicaid patients who were demographically similar to the uninsured and had similar types of injury were not at higher risk. Emergency medical services for trauma patients in the state and trauma care at the trauma center occur prior to knowledge of insurance status, and thus, these factors are unlikely to account for the differences. The inability to identify the basis for differences in mortality rates provides strong justification for insuring all citizens. Of note, our studies will also provide a baseline for determining the impact of the Affordable Care Act on the risk of traumatic death in our state.

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Treatment Failure Outcomes for Emergency Department Patients with Skin and Soft Tissue Infections

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Introduction: Skin and soft tissue infections (SSTIs) are commonly evaluated in the emergency department (ED). Our objectives were to identify predictors of SSTI treatment failure within one week post-discharge in patients with cutaneous abscesses, as well as to identify predictors of recurrence within three months in that proportion of participants.

Methods: This was a sub-analysis of a parent study, conducted at two EDs, evaluating a new, nucleic acid amplification test (NAAT) for *Staphylococcus aureus* in ED patients. Patients ≥18 years receiving incision and drainage (I&D) were eligible. Patient-reported outcome data on improvement of fever, swelling, erythema, drainage, and pain were collected using a structured abstraction form at one week, one month, and three months post ED visit.

Results: We enrolled 272 participants (20 from a feasibility study and 252 in this trial), of which 198 (72.8%) completed one-week follow up. Twenty-seven additional one-week outcomes were obtained through medical record review rather than by the one-week follow-up phone call. One hundred ninety-three (73%) patients completed either the one- or three-month follow up. Most patients recovered from their initial infection within one week, with 10.2% of patients reporting one-week treatment failure. The odds of treatment failure were 66% lower for patients who received antibiotics following I&D at their initial visit. Overall SSTI recurrence rate was 28.0% (95% CI [21.6%-34.4%]) and associated with contact with someone infected with methicillin resistant *S. aureus* (MRSA), previous SSTI history, or clinician use of wound packing.

Conclusion: Treatment failure was reduced by antibiotic use, whereas SSTI recurrence was associated with prior contact, SSTI, or use of packing. [West J Emerg Med. 2015;16(5):642-652.]

INTRODUCTION

Skin and soft tissue infections (SSTIs) are common reasons patients seek medical care in the emergency department (ED).[1] Between 2006 and 2010, there were 34.8 million outpatient visits for SSTIs, one-third of which were seen in the ED.[2] Patients with cutaneous abscesses are more likely to be younger in age, of racial and ethnic minorities, and of low-income status.[3] Although there are many risk factors associated with SSTI acquisition, these infections commonly affect otherwise healthy individuals.[4]

Patients with SSTIs are subject to the potential of both treatment failure and recurrence. Recurrences occur in 30-70% of persons following an initial SSTI, with rates greater than 50% in certain populations.[5-8] Given the high rate of recurrence, SSTIs represent a significant healthcare burden to U.S. EDs, specifically in terms of increased cost, morbidity, and mortality. However, in spite of the high incidence of SSTIs in ED settings, very little is known about factors associated with treatment failure and recurrence in these patients.

Our primary objectives included the following: identify predictors of SSTI treatment failure in patients with a cutaneous abscess within one week of their initial ED visit, identify the proportion of ED patients with cutaneous abscess who develop recurrence within three months, and identify predictors of recurrent infections.

METHODS

Data for this investigation were taken from a larger parent clinical trial of adults 18 years of age and older who were treated for a cutaneous abscess with incision and drainage (I&D) that will be reported in a separate manuscript (under review). This study, registered on clinicaltrials.gov (# NCT01523899) was conducted in two urban academic EDs from January 2011 through April 2014. The parent study was a randomized controlled trial comparing antibiotic selection in patients being screened using a new, FDA-cleared Xpert *Staphylococcus aureus* SSTI nucleic acid amplification test (NAAT) (Cepheid, Sunnyvale, CA) during their ED visit compared to standard-of-care testing. This study also included data from an additional 20 participants enrolled in a feasibility/pilot study that was run to ensure all data forms were usable and that the study could be conducted at both ED locations. Here we evaluated the factors associated with treatment failure and recurrence within that study population.[9]

Study personnel, stationed in the ED at both sites during daytime hours (generally 9 AM to 8 PM), consecutively screened potentially eligible patients for inclusion and exclusion criteria. Inclusion criteria included the following: 18 years of age and older, capable of providing written informed consent, complained of symptoms consistent with a possible abscess (e.g. abscess, SSTI, wound, ulcer, insect bite), and were receiving I&D for their abscess. Wound, nares, and inguinal site specimens were obtained and cultured for *S. aureus* during the enrollment visit. We excluded patients if they had received treatment for the same abscess within 14 days (including I&D), had taken systemic antibiotic therapy within 14 days, those with surgical site or post-procedure infections, or those whose abscesses did not yield purulent material for testing.

Potentially eligible patients were identified by research assistant screening the ED electronic tracking board for patient chief complaints and/or direct ED clinician referral. Patients who met criteria for enrollment were approached for written informed consent and collection of demographic, clinical, and diagnostic testing data. The institutional review boards at both ED sites approved this study.

A structured data abstraction form was completed by trained research staff during the ED visit from patients who provided written consent. Data collected included the following: demographic information (age, gender, race, comorbidities, insurance type); epidemiologic factors and exposures (antibiotic use in past six months, hospitalization in past year, living situation, number of household contacts including children under 18); abscess characteristics (size, location, presence of systemic symptoms), and choice and duration of antimicrobial therapy. All follow-up data were collected through phone calls via a structured survey created prior to study initiation. Follow-up telephone calls were conducted at 2-7 days, one month, and three months post-discharge and brief structured data abstraction forms were used. Patient-reported data at the one-week follow up included questions regarding improvement in erythema, swelling, pain, fever, and drainage. SSTI recurrence at one or three months was described by the reappearance of one or more symptoms consistent with a cutaneous abscess including swelling, erythema, pain and/or fever, reported during the one- and/or three-month follow-up telephone calls.

Patients who did not respond to the one-week follow-up phone call and did not have a record of returning to the ED for their two-day follow-up wound check were excluded from analysis. We did not include patients in recurrence analysis if they did not respond to both the one-month and three-month follow-up phone call.

Wound Cultures

At clinical site A, wound culturing was performed as standard of care using direct plating per Clinical and Laboratory Standards Institute (CLSI) standards in the hospital microbiology laboratory. At clinical site B, wound swabs were stored at 4°C and shipped weekly on cold packs to Cepheid's laboratory in Sunnyvale, CA, weekly and underwent both direct plating and broth enrichment culturing, per CLSI standards.

Nasal and Inguinal Colonization Cultures

Nasal and inguinal swabs were immediately stored at 4°C and shipped weekly on cold packs to the Cepheid laboratory in Sunnyvale, CA, for broth enrichment culturing. Cefoxitin and oxacillin susceptibility was confirmed via disk diffusion using Mueller Hinton agar (Cat. #R01620, Remel, Lenexa, KS) as described by the CLSI.

Data Analysis

Our primary outcomes included the following: a) failure to improve within one week following initial treatment and b) patient reported SSTI recurrence at one and/or three months of treatment of the index (enrollment) SSTI. We defined treatment failure as no change in or increased pain, swelling, erythema, drainage of the current abscess, or new or persistent

fever greater than 100.4°F. SSTI recurrence was defined as presence of a new abscess (characterized by swelling, pain, redness or drainage) at the same or different location at least two weeks after resolution of the initial abscess. Operationally, these outcomes were determined by chart abstraction at the ED two-day follow-up visit (through ED provider documentation of patient's reported symptom improvement) or by patient self-report data collected during the follow-up phone call interview. Due to the large number of patients who missed at least one of the follow-up visits, patients were only considered lost to follow-up (LTFU) if they missed both the one- and three-month follow up. We used descriptive statistics (mean, frequency) to describe the demographics, clinical features, wound and colonization culture results of the study population compared to participants LTFU. Chi-square or Fisher's exact tests, as appropriate, were used for categorical variables and T-tests for continuous variables. Statistical significance was considered at the alpha=0.05 level.

To identify characteristics that were independently associated with treatment failure and infection recurrence, variables that were significant at a level of $p<0.10$ in the bivariate analyses were fitted in a logistic regression model using a backwards stepwise selection process. Models were examined for goodness of fit using the Hosmer-Lemeshow statistic. We conducted all analyses using Stata v. 13.1 (College Station, TX).

RESULTS

We enrolled 272 participants in the study (20 from a feasibility study prior to study initiation and 252 patients enrolled in this trial). One hundred ninety-eight (72.8%) participants completed the one-week follow up, with one-week outcomes for an additional 27 participants obtained through medical record review. One hundred fifty-six (57%) participants completed the one-month follow up and 136 (50%) completed the three-month follow up for a total of 193 participants (71%) that completed either the one-month or three-month follow up. Completed follow up was defined as completing either the one- or three-month follow-up phone call. The overall LTFU rate was 29.0%. We compared participant demographics, clinical features, and wound culture results between those that completed follow-up (n=193) and those LTFU (n=79).

We found that the participants LTFU were more likely to be homeless or treated by providers with less experience than those who were not LTFU. The mean age of participants was 36.3 years of age. Forty-two percent of participants had Medicaid insurance. Majority of participants (62%) reported a history of SSTI within the past 12 months. Most abscesses were less than 5 cm in diameter (93%). Demographic, clinical, and treatment characteristics of the study population and those LTFU are shown in Table 1.

The measured one-week treatment failure rate was 10.2% (23/225). Unadjusted odds of treatment failure were reduced in patients prescribed antibiotics and increased in patients treated by a resident physician compared to a physician assistant. Other factors, such as whether the *S. aureus* cultured was methicillin susceptible strains (MSSA) or methicillin resistant *S. aureus* (MRSA) or demographic characteristics, were not significantly associated with treatment failure at one week. After adjusting for prescription and abscess location, treatment by a resident was no longer significantly associated with higher odds of a negative outcome (Table 3).

The one- and three-month SSTI recurrence proportion was 22.4% (35/156) and 19.9% (27/136), respectively, among participants who were successfully contacted. Combined, SSTI recurrence occurred in 28.0% (CI [21.6%–34.4%]) of the 193 patients contacted at one or three months.

In the bivariate analysis, variables associated with SSTI recurrence included the following: previous contact with someone infected with MRSA (per patient self-report), prior history of SSTI within the past 12 months, and clinician use of wound packing. After adding additional variables with significance of $p<0.10$ into the model (Table 2, Table 4), predictors that were found to increase odds of recurrence were as follows: previous contact with someone infected with MRSA, clinician use of wound packing, prior history of SSTI in the past two and 3-6 months (compared to none). Patients with one MRSA-positive colonization site (compared to no MRSA sites) were found to have reduced odds of SSTI recurrence. Prior history of SSTI in the past 7-12 months, and comorbid conditions were not found to be associated with SSTI recurrence (Table 2, Table 4).

DISCUSSION

To our knowledge, our study is the first in the literature assessing rates of and factors associated with SSTI treatment failure and recurrence among ED patients. We found most patients with cutaneous abscesses recovered from their initial infection within one week, with only 10.2% of patients who completed follow up reporting treatment failure at one week. The odds of treatment failure was 66% lower for those patients who received antibiotics after I&D at their initial visit, while patients with buttock abscesses were more likely to have treatment failure, possibly due to the difficulty of draining these abscesses.

We reported high recurrence rates (28% within three months) of cutaneous abscess amongst ED patients, consistent with what is described in the literature from other settings.[5-8] Of those patients who completed both the one- and three-month follow-up visits, 34% experienced a recurrence. This is likely an underestimate given that patients LTFU were more likely to be homeless, a population previously identified at high risk for SSTIs. We also found that a self-reported history of SSTI within the past six months and prior contact with someone infected with MRSA were significantly associated with recurrence. Published data reveal that the vast majority of purulent SSTIs are caused by *S. aureus,* with greater than 50% caused by MRSA. In the United States, the predominant community-

Table 1. Demographic and clinical features of the participants.

Demographics	All participants, % (n=272)	Participants lost to follow-up, % (n=79)	Remaining participants, % (n=193)
Age, mean (SD)	36.3 (13.8)	36.7 (12.4)	36.1 (14.3)
Female	53.7	46.8	56.5
Race			
Black	69.9	72.2	68.9
White	13.2	15.2	12.4
Other	2.9	5.1	2.1
Missing	14.0	7.6	16.6
Insurance			
Private	38.6	32.9	40.9
Medicaid	41.9	49.4	38.9
Medicare	7.7	6.3	8.3
Other	0.4	0.0	0.5
Self-pay/uninsured	9.2	10.1	8.8
Missing	2.2	1.3	2.6
Any comorbidity	33.8	29.1	35.8
Comorbidities, type			
Diabetes	12.9	13.9	12.4
HIV/immunocompromised	6.6	6.3	6.7
Multiple	7.0	5.1	7.8
Other	7.4	3.8	8.8
Prior history of SSTI	61.8	53.2	65.3
Prior history, timing			
No prior history	25.3	31.8	22.8
Past 2 months	30.5	27.3	31.7
Past 3-6 months	14.2	10.6	15.6
Past 7-12 months	24.5	27.3	23.4
Unknown	5.6	3.0	6.6
Prior hospitalization	21.0	17.7	22.3
Household size			
2-4 in household	67.4	64.1	68.8
5 or more in household	16.9	16.7	16.9
Live alone	13.1	11.5	13.8
Homeless*	2.6	7.7	0.5
Children in household	42.3	43.0	42.0
Recent antibiotic use	37.1	30.4	39.9
Contact w/someone w/ SSTI	18.1	13.9	19.8

HIV, human immunodeficiency virus; *SSTI,* skin and soft tissue infections
*p=0.02.

associated MRSA (CA-MRSA) clone, USA300 MRSA, has been associated with an increasing incidence of CA-SSTI, which typically manifest as cutaneous abscesses.[10,11] Contrary to previous studies,[10] we found no difference in SSTI recurrence between patients with MRSA wound infections compared to those who did not have MRSA infection. Surprisingly, having a single site of MRSA colonization was, in fact, associated with decreased odds of recurrence. It is possible multiple sites

Table 1. Continued.

Clinical features	All participants, % (n=272)	Participants lost to follow-up, % (n=79)	Remaining participants, % (n=193)
Abscess location			
Axilla	24.6	20.3	26.4
Buttock	21.0	21.5	20.7
Extremities	17.3	27.8	13.0
Face	11.4	11.4	11.4
Perineum	9.2	5.1	10.9
Trunk	16.5	13.9	17.6
Multiple abscesses	12.5	11.4	13.0
Abscess diameter			
<1cm	8.8	5.1	10.4
1-2cm	39.0	39.2	38.9
3-5cm	44.9	49.4	43.0
>5cm	7.0	6.3	7.3
Missing	0.4	0.0	0.5
Erythema size			
<2cm	51.8	45.6	54.4
3-5cm	30.5	32.9	29.5
>5cm	16.2	20.3	14.5
Missing size	1.5	1.3	1.6
Prescribed antibiotics	75.4	76.0	75.1
Prescriptions			
Beta lactams	6.3	3.8	7.3
Clindamycin	41.9	48.1	39.4
TMP-SMX	15.8	11.4	17.6
TMP-SMX and beta lactams	9.9	10.1	9.8
Other	1.5	2.5	1.0
None prescribed	24.6	24.1	24.9
Packing used	83.1	83.5	82.9
Irrigation & debridement used	98.5	98.7	98.4
Provider type			
PA	55.2	49.4	57.5
Attending	27.6	35.4	24.4
Resident	17.3	15.2	18.1
Provider experience**†			
<10	14.1	20.3	11.6
10-50	26.9	31.7	24.9
>50	59.0	48.1	63.5
Received test (vs control)	53.7	51.9	54.4

TMP-SMX, trimethoprim-sulfamethoxazole; *PA*, physician assistant
**p=0.047.
†Number of prior incision and drainage procedures.

Table 1. Continued.

Pathogen Characteristics	All participants, % (n=272)	Participants lost to follow-up, % (n=79)	Remaining participants, % (n=193)
Wound culture result			
MRSA	28.3	30.4	27.5
MSSA	18.0	16.5	18.7
Other	47.4	46.8	47.7
No culture/no growth/missing	6.3	6.3	6.2
Any *S. aureus* colonization	47.8	49.4	47.2
S. aureus colonization sites			
None	52.2	50.6	52.8
One	22.8	26.6	21.2
Two	25.0	22.8	25.9
Any MRSA colonization	25.0	24.1	25.4
MRSA sites			
None	75.0	76.0	74.6
One	14.0	13.9	14.0
Two	11.0	10.1	11.4
One week follow-up			
Negative outcome	10.2	11.4	9.7

MRSA, methicillin-resistant *Staphylococcus aureus*; *MSSA,* methicillin-susceptible *Staphylococcus aureus*

of colonization may be associated with higher odds or that colonization may be transient in these patients.

While we hypothesized colonization by either MSSA or MRSA would be associated with recurrence, we did not find this to be the case. Several investigations in non-ED settings have found a relationship between MRSA nasal carriage and subsequent SSTIs and recurrence;[12,13] however, this relationship has not been consistently observed.[14,15] The lack of an observed association may be related to our relatively small sample size; however, it is also possible that it could be due to the transient nature of colonization, which may have been undetected during the ED visit. It is also plausible that in ambulatory settings, colonization is not associated with recurrence, as has been suggested by others.[11] The lack of a relationship between *S. aureus* colonization and SSTI in the outpatient setting is supported by interventional studies in which decolonization does not result in decreased infection rates.[16]

A recent multicenter double-blind, randomized clinical trial compared the use of trimethoprim-sulfamethoxazole (TMP-SMX) and placebo on uncomplicated I&D procedures and recurrence outcomes.[17] Follow ups were completed at two, seven, and 30 days following initial presentation. The study indicates that treatment with TMP-SMX does not reduce treatment failure but may decrease the recurrence of subsequent lesions.[17] Another trial done in pediatric patients showed no difference in treatment failure when using antibiotics or placebos, suggesting that antibiotics are not needed for SSTI resolution.[18] However, even though the vast majority of our outpatients had good clinical outcome, we did find that antibiotic therapy was associated with an improved outcome at seven days, suggesting a potential role for antibiotic treatment in patients with uncomplicated abscesses. Another recent clinical trial comparing placebo to TMP-SMX treatment in patients with uncomplicated cutaneous abscess found better outcomes in the latter group following I&D and are less likely to require hospitalization or have SSTI recurrence.[19] From a treatment perspective, antibiotic therapy was not associated with decreased recurrence risk in our study, but the practice of wound packing was associated with increased odds of recurrence. The reasons for this latter observation is unclear; however, other studies have shown that this practice may not improve outcomes and can lead to increased pain.[20]

The factors that fuel recurrent MSSA or MRSA SSTIs are not well understood. Data suggest poor hygienic practices are associated with an increased likelihood of MRSA infection.[21-23] Others have found minimal association between poor hygienic practices in patients with CA-MRSA or CA-MSSA infections and uninfected controls, although the scope of the question was limited to sharing towels and using antimicrobial soap.[24] While there are mounting data on the role of behavioral factors in increased MRSA infection risk, our understanding of the relative impact compared to colonization and other factors is limited.

Consistent with our findings that there was no association between a specific pathogen and recurrence, a recent

Table 2. Bivariate analysis of risk factors for recurrence of skin and soft tissue infection and negative one-week outcome.

	Recurrence (n=193)			Negative 1 week outcome (n=225)		
Demographic variables	OR	CI	P	OR	CI	P
Age	0.98	0.95–1.01	0.12	1.01	0.99–1.05	0.30
Gender, % female	1.62	0.84–3.10	0.15	1.02	0.43–2.44	0.96
Race						
Black	1	Ref		1	Ref	
White	0.43	0.14–1.35	0.15	2.03	0.68–6.07	0.20
Other	2.17	0.30–15.9	0.45	1.68	0.19–14.67	0.64
Insurance						
Medicaid	1	Ref		1	Ref	
Private	0.87	0.44–1.75	0.70	1.79	0.72–4.47	0.21
Medicare	0.32	0.07–1.5	0.16	1	(empty)	
Self-pay/uninsured	0.94	0.30–2.98	0.92	1.56	0.30–7.95	0.60
Any comorbidities	0.77	0.39–1.50	0.44	1.08	0.42–2.78	0.86
Comorbidities						
None	1	Ref		1	Ref	
Diabetes	1.18	0.46–2.99	0.734	1.96	0.65–5.86	0.23
HIV/immunocompromised	1.05	0.30–3.61	0.944	1	(empty)	
Multiple	0.86	0.26–2.86	0.799	1.12	0.13–9.58	0.91
Other	0.15	0.02–1.15	0.068	0.75	0.09–6.15	0.79
Prior history of SSTI	4.24	1.86–9.65	<0.001	1.13	0.46–2.79	0.79
Prior history, when						
No prior history	1	Ref		1	Ref	
Unknown	1.54	0.44–5.37	0.50	0.3	0.06–1.62	0.17
Past 2 months	4.68*	1.58–13.90	<0.01	0.98	0.31–3.14	0.97
Past 3-6 months	4.84*	1.43–16.40	0.01	0.55	0.11–2.84	0.47
Past 7-12 months	1.98	0.60–6.57	0.26	0.94	0.29–3.00	0.91
Prior hospitalization (Y/N)	0.73	0.33–1.6	0.43	0.48	0.14–1.69	0.25
Household size						
Live alone	1	Ref		1	Ref	
2-4 in household	1.48	0.55–3.97	0.43	0.46	0.14–1.58	0.22
5 or more in household	0.77	0.22–2.75	0.69	1.68	0.44–6.48	0.45
Homeless	1	(empty)		1.00	0.09–10.66	1.00
Children in household	1.04	0.55–1.96	0.91	1.40	0.59–3.32	0.45
Recent antibiotic use	1.30	0.69–2.45	0.42	1.16	0.48–2.81	0.74
*Contact with someone with MRSA/boils	2.24	1.07–4.70	0.03	0.65	0.18–2.29	0.50

HIV, human immunodeficiency virus; *SSTI,* skin and soft tissue infections; *MRSA*, methicillin-resistant *Staphylococcus aureus*

investigation demonstrated that 51% of 330 index patients, and 13% of household contacts suffer recurrent infection within six months of treatment of the index patient for a *S. aureus* skin infection.[21] Recurrent infections in that study were not associated with an initial infection caused by MRSA, MSSA, USA300 MRSA, or with having a CA-*S. aureus* infection, consistent with our findings of a lack of association of pathogen with outcomes.[10,25] While that study found an association with recent hospitalization, cephalexin use, diabetes mellitus, and recent skin infection, Miller et al also show an association with household *S. aureus* or MRSA fomite contamination.[21] This potential important factor was not assessed in this study. Although there is evidence that *S. aureus* contamination in households is common,[26-28] and that

Table 2. Continued.

	Recurrence (n=193)			Negative 1 week outcome (n=225)		
Clinical features	OR	CI	P	OR	CI	P
Abscess location						
Axilla	1	Ref		1	Ref	
Buttock	0.64	0.26–1.57	0.33	3.28	0.80–13.52	0.10
Extremities	0.53	0.18–1.56	0.25	1.98	0.42–9.40	0.39
Face	0.37	0.11–1.27	0.12	0.79	0.08–8.00	0.84
Perineum	1.04	0.36–2.96	0.95	0.79	0.08–8.00	0.84
Trunk	0.36	0.13–1.03	0.06	3.57	0.86– 4.76	0.08
Multiple sites	1.25	0.50–3.09	0.63	2.06	0.70–6.06	0.19
Abscess diameter						
<1cm	1	Ref		1	Ref	
1-2cm	0.95	0.30–2.97	0.93	2.82	0.34–23.26	0.33
3-5cm	1.22	0.40–3.73	0.73	2.04	0.25–16.92	0.51
>5cm	3.00	0.70–12.88	0.14	1.27	0.07–21.97	0.87
Erythema size						
<2cm	1	Ref		1	Ref	
3-5cm	1.06	0.52–2.16	0.87	0.93	0.33–2.61	0.89
>5cm	0.68	0.25–1.85	0.45	1.53	0.50–4.68	0.46
Prescribed antibiotics	0.91	0.45–1.84	0.79	0.34	0.14–0.82	0.02
Prescriptions						
Clindamycin	1	Ref		1	Ref	
Beta lactams	1.63	0.51–5.20	0.41	1.02	0.11–9.10	0.98
TMP-SMX	0.46	0.17–1.27	0.14	2.79	0.72–10.73	0.14
TMP-SMX and Beta lactams	0.58	0.17–1.93	0.37	0.70	0.08–6.09	0.74
Use of packing	3.30	1.01–9.88	0.03	4.30	0.56–32.99	0.16
Use of irrigation and debridement	0.77	0.07–8.71	0.84	1	(empty)	
Provider type						
PA	1	Ref		1	Ref	
Attending	0.52	0.23–1.16	0.11	1.86	0.70 – 4.89	0.21
Resident	0.40	0.15–1.04	0.06	1.62	0.48 – 5.47	0.44
Provider experience*						
<10	1	Ref		1	Ref	
10-50	0.53	0.18–1.61	0.26	0.55	0.17–1.80	0.33
>50	0.66	0.26–1.73	0.40	0.42	0.14–1.26	0.12

TMP-SMX, trimethoprim-sulfamethoxazole; *PA*, physician assistant
*Number of prior incision and drainage procedures.

S. aureus can persist on fomites for months,[29] the relationship between fomite contamination and infection risk is unclear.[11]

LIMITATIONS

There were several important limitations to the study. First, while we attempted to enroll consecutive patients, patients were likely missed during the hours where research assistants were unavailable. Secondly, the study was conducted at two urban EDs, located in the same geographic region (Mid-Atlantic), which may not represent SSTI epidemiology nationwide. Finally, we may not have had sufficient power to assess all potential factors that might be associated with recurrent SSTI. We also had significant loss to follow up in our study population (29%). While there were no major significant differences other than homelessness between participants lost to follow up and those who completed follow

Table 2. Continued.

	Recurrence (n=193)			Negative 1 week outcome (n=225)		
	OR	CI	P	OR	CI	P
Pathogen parameters						
Wound culture result						
MRSA	1	Ref		1	Ref	
MSSA	1.27	0.51–3.16	0.61	0.83	0.23–3.02	0.78
Other	0.95	0.10–2.59	0.88	0.91	0.33–2.48	0.86
S. aureus colonization	0.95	0.51–1.79	0.88	1.07	0.45–2.54	0.88
S. aureus colonization sites						
None	1	Ref		1	Ref	
One	0.81	0.35–1.87	0.62	0.73	0.22–2.40	0.60
Two	1.08	0.51–2.27	0.84	1.40	0.53–3.69	0.50
MRSA colonization	0.91	0.44–1.88	0.79	1.02	0.38–2.72	0.97
MRSA sites						
None	1	Ref		1	Ref	
One	0.31	0.09–1.10	0.07	0.55	0.12–2.51	0.44
Two	2.09	0.84–5.22	0.11	1.76	0.54–5.77	0.35

MRSA, methicillin-resistant *Staphylococcus aureus*; *MSSA,* methicillin-susceptible *Staphylococcus aureus*

Table 3. Adjusted odds ratio of negative one-week outcome (n=225).

	OR	CI	P
Provider type			
PA	1	Ref	
Attending	2.23	0.78–6.39	0.13
Resident	1.23	0.34–4.46	0.75
Antibiotics prescribed	0.33	0.13–0.87	0.03
Abscess Location			
Axilla	1	Ref	
Buttock	4.36	1.00–19.06	0.05
Extremities	2.82	0.55–14.56	0.22
Face	0.71	0.07–7.55	0.78
Perineum	0.89	0.08–9.33	0.92
Trunk	3.89	0.90–16.75	0.07

PA, physician assistant; *CI*, confidence interval; *OR*, odds ratio

Table 4. Adjusted Odds Ratio of Recurrence (n=193).

	OR	CI	P
Contact w/someone w/ SSTI	2.87	1.19–6.93	0.02
Use of packing	4.64	1.39–15.46	0.01
Prior history of SSTI	4.25	1.79–10.12	<0.01
MRSA Sites			
None	1	Ref	
One	0.24	0.06–0.91	0.04
Two	1.67	0.59–4.71	0.33
Comorbidities			
None	1	Ref	
Diabetes	1.00	0.35–2.84	1.00
HIV/immunocompromised	0.54	0.14–2.11	0.38
Multiple	0.62	0.16–2.37	0.49
Other	0.17	0.02–1.45	0.11

SSTI, skin and soft tissue infections; *MRSA,* methicillin-resistant *Staphylococcus aureus*; *HIV,* human immunodeficiency virus; *CI*, confidence interval; *OR*, odds ratio

up, it is possible that the recurrence rate might be higher amongst homeless patients, given the potential role of close contact and poor hygiene in MRSA transmission. In addition, the small sample size and low number of recurrences limited the number of predictors assessed and the study may not have been adequately powered to detect small differences. This may have been confounding in that patients who did not receive packing may have had less concerning abscesses that were less likely to recur. Another limitation is the potential for bias related to the original randomized control trial.

CONCLUSION

In summary, to our knowledge this study was the first to describe factors associated with both clinical outcomes and recurrence of cutaneous abscess in the ED setting. We found treatment failure occurred in only 10.2% of our population

who completed follow up, while recurrence occurred in approximately one-third of patients within three months. Treatment failure, but not recurrence, was associated with antibiotic use, suggesting antibiotics may play a significant role in clinical management despite previous evidence that most uncomplicated abscesses do not require them. Predictors of recurrence included prior SSTI history and close contact with someone infected with a SSTI.

Interestingly, packing was associated with increased recurrence, warranting further investigation of this practice. While antibiotic use was associated with a slight improvement of short-term outcomes, we did not find any association with recurrence rates, and thus, there was insufficient evidence to change the recommended practice of limited antibiotic therapy to patients with complicated SSTI following I&D. Also, we did not find that the presence of MRSA or MSSA was more closely associated with recurrence. Despite great concern by ED providers regarding MRSA, there is, to date, insufficient evidence that cutaneous abscesses caused by MRSA have worse outcomes than those caused by other infectious etiologies.

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Accuracy of 'My Gut Feeling:' Comparing System 1 to System 2 Decision-Making for Acuity Prediction, Disposition and Diagnosis in an Academic Emergency Department

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Introduction: Current cognitive sciences describe decision-making using the dual-process theory, where a System 1 is intuitive and a System 2 decision is hypothetico-deductive. We aim to compare the performance of these systems in determining patient acuity, disposition and diagnosis.

Methods: Prospective observational study of emergency physicians assessing patients in the emergency department of an academic center. Physicians were provided the patient's chief complaint and vital signs and allowed to observe the patient briefly. They were then asked to predict acuity, final disposition (home, intensive care unit (ICU), non-ICU bed) and diagnosis. A patient was classified as sick by the investigators using previously published objective criteria.

Results: We obtained 662 observations from 289 patients. For acuity, the observers had a sensitivity of 73.9% (95% CI [67.7-79.5%]), specificity 83.3% (95% CI [79.5-86.7%]), positive predictive value 70.3% (95% CI [64.1-75.9%]) and negative predictive value 85.7% (95% CI [82.0-88.9%]). For final disposition, the observers made a correct prediction in 80.8% (95% CI [76.1-85.0%]) of the cases. For ICU admission, emergency physicians had a sensitivity of 33.9% (95% CI [22.1-47.4%]) and a specificity of 96.9% (95% CI [94.0-98.7%]). The correct diagnosis was made 54% of the time with the limited data available.

Conclusion: System 1 decision-making based on limited information had a sensitivity close to 80% for acuity and disposition prediction, but the performance was lower for predicting ICU admission and diagnosis. System 1 decision-making appears insufficient for final decisions in these domains but likely provides a cognitive framework for System 2 decision-making. [West J Emerg Med. 2015;16(5):653-657.]

INTRODUCTION

During the last few decades, advances in cognitive science have significantly impacted our understanding of the cognitive aspects of bedside decision-making,[1] particularly the observation of natural dual process behavior in clinical practice.[2] Dual process theory illustrates a modulated interaction between a mainly intuitive system (System 1) and an idealistically-described hypothetico-deductive system (System 2).[3] The first system, System 1, is rapid, automatic, almost completely unconscious, and requires minimal cognitive effort (your "gut feeling"). System 2, by comparison, is time and resource intensive, deliberate,

requires significant cognitive effort, and is associated with hypothesis creation and testing.[4]

Clinical decision-making, particularly in emergency medicine (EM), exists in an environment of "bounded rationality" where there are significant constraints in regard to the information available, certainty, analytic time and available solutions.[5] In this setting a skillful use of alternating System 1 and 2 decision processes can lead to efficient, economic and safe decision-making.[4,6]

Rapid recognition of a sick patient, along with fast and decisive decision-making, form the essence of EM.[7] However, emergency physicians (EPs) treat patients with a spectrum of disease that varies from the entirely benign to the unstable, with often just a curtain or glass door separating the two. Regardless of severity, there is a mandate to provide high quality, safe and efficient care in the current medical environment.[8]

Although previous studies have addressed aspects of cognitive decision-making in daily practice,[6] very few studies have described decision-making using the dual process theory[4] framework and the performance and ultimate impact on patient care. A better understanding of the interaction of System 1 and 2 processes can lead to better quality decision making.[9]

We hypothesized that EPs are able to predict patient acuity (sick vs. not sick) and final disposition with a high degree of accuracy based on a limited amount of information using a System 1 process. We also sought to compare the accuracy of a provisional diagnosis based on a System 1 process and to the final diagnosis after the deliberative effect of System 2. Finally, we postulated that EPs' performance in these domains improves with increasing experience and training.

METHODS

This was a prospective observational study of a convenience sample of physicians enrolled during clinical shifts at different times of the day and evening, Monday through Sunday, from September–December 2013, including all acuity levels and chief complaints. The study was conducted in an academic emergency department with 73,000 annual patient visits that is certified as a Level 1 trauma center.

The study was approved and deemed exempt by the local institutional review board, as the participants in the study were physicians making clinical assessments, not patients. Prior to the start of the study, we wrote a detailed protocol and had a run-in period to refine the physician survey and standardized data abstract form. The lead investigator (D.C.) also trained the observers (J.F.T., J.R.A and J.M.W) in data acquisition.

EM board-certified attendings and EM residents [Post-graduate year 1 (PGY1) through PGY3] were eligible to be enrolled in this study and were asked to participate while working clinical shifts. A convenience sample of patients was assessed after being assigned to the care of the previously identified physicians; they were roomed in all areas of the emergency department (ED). The study was restricted to adult patients; we excluded patients transferred from an outside institution with an established diagnosis, a psychiatric complaint, known pregnancy, prisoners, patients in extremis (i.e. requiring emergent, life-saving interventions), and Level I and II trauma activations; otherwise, we included patients with all types of complaints (medical, orthopedic, minor trauma, gynecological, etc.) and well acuity levels.

As soon as a patient was roomed, a member of the study group identified the physicians assigned to care for the patient and administered a standardized survey. Physicians were provided and reviewed the first set of vital signs (often obtained by ambulance or by the triage nurse), the documented chief complaint, gender, age, and mode of arrival. Physicians were permitted to observe the patient for no more than 30 seconds. A brief greeting (e.g. "hello," or "I will be right with you") was also permitted to establish rapport.

With the limited information provided, we asked observer physicians to predict the following outcomes: 1) sick vs. not sick; 2) likely disposition (possibilities included dismissal home, ED observation unit, non-monitored hospital bed, telemetry bed and intensive care unit (ICU)); and 3) the likely diagnosis of the patient.

As there is no definition of sick widely accepted in the literature, we provided the observers the following working definition to cognitively frame their assessment: "A patient is sick when he/she has a condition that, when left undiagnosed or untreated, may develop into a life or limb threat or cause disability."

One week after the index ED presentation, we assessed the clinical records of enrolled patients to evaluate outcomes and obtain follow-up data. For the variable sick vs. not-sick, we used and adapted previously published[4] objective criteria that include discrete procedure (e.g., intubation), outcomes (e.g., admission to an ICU), administrative data (e.g., critical care time billing) and commonly-accepted diseases processes associated with high acuity in the ED (Appendix). Two authors (J.F.T. and J.L.W.) reviewed each sick/not sick prediction and compared it to defined criteria to ascertain if the prediction was correct or not; when disagreement existed, the lead author adjudicated the classification (D.C.). Agreement between observes was calculated using Cohen's kappa coefficient.

For the variable of disposition, we grouped the responses into three categories to facilitate analysis: 1) dismissal, 2) admission to a non-ICU unit (ED observation unit, regular floor and telemetry), and 3) ICU. Two authors reviewed the disposition prediction and compared it to the final disposition.

For the variable diagnosis, two authors reviewed each predicted diagnosis and compared it either to the final ED diagnosis, bounce back within 72h diagnosis or final hospital diagnosis, using that order of hierarchy. If disagreement arose, the lead author adjudicated the outcome classification. Agreement between observers was calculated using Cohen's kappa coefficient.

We took the following steps to reduce the risk bias in our

study: (1) determined inclusion and exclusion criteria prior to data collection and analysis; (2) calculated power and sample size prior to the conducting the study; (3) developed and piloted a standardized data collection form before use in the study; (4) ensured all the patients had similar probability of selection as enrollment depended of the time of the day and not on patient characteristics (although we did enroll a convenience sample); (5) did not blind observers and data collectors to the study objectives and hypothesis (however, the verbal responses of the physicians did not depend on the judgment of study personnel); (6) performed a prospective study, so outcomes had not occurred at the time of data collection; (8) arranged for the data collectors to meet periodically with the primary investigator to review questions; (9) calculated inter-rater reliability and agreement for the outcome variables "sick" vs. not sick" and "final diagnosis;" and (10) discussed disagreements with the primary investigator who adjudicated outcome classifications.

Based on our previous published article,[4] we calculated power and samples size with an estimated difference of acuity of 15% and a sensitivity for attending physicians of 80%. We estimated that in order to detect meaningful differences between EM attendings and residents, we needed a total of 390 observations, two-thirds from the resident physicians and one-third from the attending physicians. The observed difference in acuity prediction sensitivity between attendings and residents was less than 6%.

We tabulated data in a Microsoft Excel spreadsheet, and statistical analyses were conducted using JMP software version 9.0, (S.A.S. Institute, Chicago). For normally distributed variables, we calculated mean and standard deviations (SD) and used parametric tests; for skewed data, median and interquartile ranges were reported and non-parametric tests were applied. We constructed two-by-two contingency tables to calculate prognostic performance estimates. We assessed sensitivity, specificity, likelihood ratios, positive and negative predictive values (PPV and NPV), and obtained 95% confidence intervals (CI) using Meta-DiSc software.[10] A statistician not involved in the study calculated power and sample size of the protocol and reviewed all data procedures and analyses.

RESULTS

We collected 662 observations from 289 patients. Among the 662 observations, 417 (63%) were performed by residents (PGY1 16%, PGY2 20% and PGY3 27%) and 245 (37%) by attendings. The rates of admission of acuity of the patients were similar to the historic data available for the department.

Participating physicians classified 37% (242) of the patients as sick, while the investigators classified 34.3% as fulfilling the sick definition. Inter-observer agreement between the two investigators applying the sick definition had a kappa of 0.97 (95% CI [0.95-0.99], p<0.0001).

For the sick vs. not-sick variable, physicians had an overall sensitivity of 73.9% (95% CI [67.7%-79.5%]), specificity of 83.3% (95% CI [79.5%-86.7%]), PPV of 70.3% and NPV of 85.7% when compared to the gold standard definition of sick (Table 1). Attendings had a sensitivity of 77.5% (95% CI [66.8-86.1%]), specificity of 83.1% (95% CI [76.6-88.5%]), whereas residents had a sensitivity of 72.0% (95% CI [64.1-79.0%]) and specificity of 83.5% (95% CI [78.4-87.7%]). The difference in sensitivity between attending and resident physicians was not statistically significant.

For the disposition variable (discharge versus hospital admission), 50.4% of patients were admitted, physicians overall had a sensitivity of 80.8% (95% CI [76.1-85.0%]) and a specificity of 75.3% (95% CI [70.4-79.8%]) (Table 2). Of the admitted patients 18% required an ICU bed; when analyzing admissions to ICU vs. non-ICU, the overall sensitivity was 33.9% (95% CI [22.1-47.4%]) and a specificity was 96.9% (94.0 to 98.7%). When comparing the performance between attending and resident physicians, attendings had a sensitivity of 42.9% (95% CI [21.9-66.0%]), specificity of 96.7% (95% CI [90.7-99.3%]), PPV of 75% (95% CI [42.8-94.2%]) and NPV of 88% (95% CI [80.0-93.6%]). Residents had a sensitivity of 29%, specificity of 97%, PPV of 68% and NPV 85%. The difference in performance between attending and resident physicians was not statistically significant.

Finally, for the diagnosis variable; the predicted diagnosis compared to the final diagnosis (ED final diagnosis, 72-hour bounceback diagnosis or hospital final diagnosis) was correct in 54% of the patients, 56.9% for attendings and 52.2% with no statistical difference (p=0.24) for residents. Inter-observer agreement between investigators had a kappa 0.91 (95% CI [0.87-0.94], p<0.0001). Attendings were able to predict the diagnosis correctly in 53.9% of the cases, while the residents were accurate 52.2% of the time. The difference in performance between attending and resident physicians was not statistically significant.

When analyzing vital signs we found that patients in the "sick" category had a higher median (IQR) temperature [36.7 (36.6-36.9) vs. 37.0 (36.6-37.3), p<0.0001]; higher mean (SD) heart rate [81.4 (16.6) vs. 90.1 (25.8), p<0.0001]; lower diastolic blood pressure [79.3 (14.9) vs. 74.5 (19.5), p=0.0005]; increased mean (SD) respiratory rate [17.1 (2.8) vs. 18.4 (5.6), p<0.0001] and a lower median (IQR) SO_2 [98 (96-99) vs. 97 (IQR 95-99), p=0.012] than not-sick patients.

LIMITATIONS

The dual process-theory model[3,11] is not a universally accepted paradigm to explain clinical decision-making. Although it is widely used and considered valid in EM,[1] some have challenged the usefulness and validity of the model[12] and proposed that an intertwined dichotomic approach cannot be observed in all aspects of decision-making. The nature of decision-making lies between the task itself and the mental model of the person performing the decision; it is likely that some decisions cannot be classified as belonging to System 1 or 2 and may be more appropriately described as quasi-rational.[12-13]

Table 1. Performance of the prediction of sick vs. not-sick patients by emergency physicians.

	All physicians (95% CI)	Attendings (95% CI)	Residents (95% CI)
Sensitivity	73.9% (67.7 to 79.5%)	77.5% (66.8 to 86.1%)	72.0% (64.1 to 79.0%)
Specificity	83.3% (79.5 to 86.7%)	83.1% (76.6 to 88.5%)	83.5% (78.4 to 87.7%)
PPV	70.3% (64.1 to 75.9%)	68.9% (58.3 to 78.2%)	71.1% (63.2 to 78.1%)
NPV	85.7% (82.0 to 88.9%)	88.5% (82.4 to 93.0%)	84.1% (79.1 to 88.3%)

PPV, positive predictive value; *NPV,* negative predictive value

Table 2. Performance of the prediction of disposition.

	All physicians (95% CI)	Attendings (95% CI)	Residents (95% CI)
Dismissal vs. admission			
Sensitivity	80.8% (76.1 to 85.0%)	80.4% (71.8 to 87.3%)	81.1% (75.0 to 86.2%)
Specificity	75.3% (70.4 to 79.8%)	80.6%(72.9 to 86.9%)	71.9% (65.3 to 77.9%)
PPV	75.2% (70.2 to 79.6%)	77.6% (68.9 to 84.8%)	73.9% (67.7 to 79.5%)
NPV	80.9% (76.2 to 85.1%)	83.1% (75.5 to 89.1%)	79.5% (73.0 to 85.0%)
ICU vs. non-ICU admission			
Sensitivity	33.9% (22.1 to 47.4%)	42.9% (21.9 to 66.0%)	29.0% (15.4 to 45.9%)
Specificity	96.9% (94.0 to 98.7%)	96.7% (90.7 to 99.3%)	97.0% (93.2 to 99.0%)
PPV	71.4% (51.3 to 86.7%)	75.0% (42.8 to 94.2%)	68.8% (41.4 to 88.9%)
NPV	86.6% (82.1 to 90.3%)	88.0% (80.0 to 93.6%)	85.8% (80.0 to 90.4%)

PPV, positive predictive value; *NPV,* negative predictive value; *ICU,* intensive care unit

There is no universally accepted definition of "sick" in the scientific literature. We developed a definition of sick based on financial, operational and educational rationale to classify the outcomes, adapting criteria used in previous literature.[4] Given the ambiguity of the concept, we attempted to provide the observers with a cognitive framework and gave them an a priori definition of "sick" when conducting the study.

Another limitation, bounded by this naturalistic approach, is the potential bias that asking observers to make a prediction may introduce. Asking observers to provide a prediction based on limited information may inappropriately anchor the observer, such that System 2 is subsequently unable to override System 1 decision-making process.[14] A possible study design involving a third non-clinically-related party making the sick vs. not-sick judgment although free of this bias will also be free of the environmental cognitive factors that affect decision making in a real-life scenario.

This study attempted to naturalistically observe real-time, clinical task performance in a very information- constrained System 1 decision-making model as it pertains to evaluation in the emergency setting. Although the literature has previous studies about the real-life performance of complex decision making, few studies[4] have been able to assess this process bounded by clinical constraints and this represent the most important strength of this study.

DISCUSSION

Physicians' performance using System 1 reasoning to predict acuity (i.e., sick vs. not-sick) had sensitivity of 73.9% and specificity of 83.3%. In terms of disposition prediction, performance was similar to the acuity prediction, with a sensitivity of 80.8% and specificity of 85.3%. This performance results in a positive likelihood ratio (+LR) of 4.4 and a negative likelihood ratio (-LR) of 0.31; the performance of the prediction for the disposition prediction yield a +LR of 3.27 and –LR of 0.25, while for the ICU vs. non-ICU yield a +LR of 11 and –LR 0.68. These test characteristics offer a favorable profile significantly improving the post-test probability of patients deemed to be sick by the observer and help predict disposition accurately. We observed no statistically significant difference between attendings and residents. Finally, the predictive accuracy for diagnosis was 53.9% overall; this is quite low and likely does not permit physicians to make definitive diagnoses solely based on a System 1 process alone.

This study had slightly different methodology compared to previous studies.[4,6] This time we provided the physicians with a short operational definition of the meaning of sick; we believe this represents an improvement in the methodology as it provided a clearer cognitive framework for the prediction. Another difference from previous studies was a larger observation collection, which we believe made the results more robust.[4]

CONCLUSION

The overall performance of nearly 80% sensitivity with a +LR of 4.4 for acuity appears to be appropriate given the limited information provided, but it is not powerful enough to make a final acuity assessment on these patients. System 1, however, appears to be appropriate to provide a cognitive framework for the later System 2 dysrationalia override.[1,11] Correctly predicting the disposition and acuity in four of every five patients, with +LR between 3.27 for admission and a very powerful +LR of 11 for ICU admission, appears to be appropriate enough to start a working disposition and evaluation while refining the overall clinical hypothesis.

Emergency medicine is defined by timely and accurate decision-making and the initiation of life-, limb-, or eyesight-saving interventions.[4,7] In an ideal scenario, the healthcare team should have sufficient time, information and resources to make the best possible decision regarding a patient. However, our decision-making is not truly rational, as not every single possible decision is considered and is bounded by the constraints of available resources.[5] Albeit far from a very accurate prediction power, the performance of System 1 reasoning appears to be adequate to provide a cognitive framework to enable emergency physicians to determine a provisional diagnosis, initiate early interventions, and make disposition decisions when resource are limited. However, this reasoning requires System 2 refinement later in the encounter to ensure the delivery of high quality care.

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Central Venous Catheter Intravascular Malpositioning: Causes, Prevention, Diagnosis, and Correction

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Despite the level of skill of the operator and the use of ultrasound guidance, central venous catheter (CVC) placement can result in CVC malpositioning, an unintended placement of the catheter tip in an inadequate vessel. CVC malpositioning is not a complication of central line insertion; however, undiagnosed CVC malpositioning can be associated with significant morbidity and mortality. The objectives of this review were to describe factors associated with intravascular malpositioning of CVCs inserted via the neck and chest and to offer ways of preventing, identifying, and correcting such malpositioning. A literature search of PubMed, Cochrane Library, and MD Consult was performed in June 2014. By searching for "Central line malposition" and then for "Central venous catheters intravascular malposition," we found 178 articles written in English. Of those, we found that 39 were relevant to our objectives and included them in our review. According to those articles, intravascular CVC malpositioning is associated with the presence of congenital and acquired anatomical variants, catheter insertion in left thoracic venous system, inappropriate bevel orientation upon needle insertion, and patient's body habitus variants. Although plain chest radiography is the standard imaging modality for confirming catheter tip location, signs and symptoms of CVC malpositioning even in presence of normal or inconclusive conventional radiography findings should prompt the use of additional diagnostic methods to confirm or rule out CVC malpositioning. With very few exceptions, the recommendation in cases of intravascular CVC malpositioning is to remove and relocate the catheter. Knowing the mechanisms of CVC malpositioning and how to prevent, identify, and correct CVC malpositioning could decrease harm to patients with this condition. [West J Emerg Med. 2015;16(5):658-664.]

INTRODUCTION

Central venous catheters (CVCs) are cannulation devices designed to access the central venous circulation and are inserted via wire guidance (i.e., via the Seldinger technique). In the emergent setting, CVCs are used to administer life-supporting fluids, potentially irritant drugs, blood products, and parenteral nutrition. In other settings, CVCs are used to provide access for hemodialysis, transvenous heart pacing, and monitoring of hemodynamics by measuring central filling pressure and cardiac output.[1] CVC placement requires training and experience and is not without risk for patients, even when performed by skilled professionals.

The most common adverse events associated with neck and thorax CVC insertion have been extensively addressed in the literature and include infection (5% to 26%), hematoma (2% to 26%), and pneumothorax (up to 30%).[2] Other complications of CVC placement include hemothorax, chylothorax, and extravasation of infusate, unrecognized arterial placement, cardiac tamponade, and mediastinal hemorrhage.[3-6] A less commonly described yet important complication of CVC placement is malpositioning of the tip of the CVC in a vessel other than the superior vena cava (SVC). This event has been described in approximately 7% of cases of thoracic CVC placement in the literature[3] and can lead to serious complications if not addressed. Placing the CVC tip in a vessel other than the SVC increases the risks of catheter wedging, erosion or perforation of vessel walls, local venous thrombosis, catheter dysfunction, and cranial retrograde injection, in which the infusate is directed to the head instead of the central circulation.[4]

The objectives of this review were to characterize the factors associated with neck and thorax CVC malpositioning and to offer ways of preventing, identifying, and correcting this error.

LITERATURE SEARCH

We performed a literature search of PubMed, Cochrane Library, and MD Consult in June 2014. By searching for "Central line malposition" we found 188 articles in PubMed, one article in the Cochrane Library, and one in MD Consult. By searching for "Central venous catheters intravascular malposition" we found seven articles in PubMed, none in the Cochrane Library, and one article in MD consult. Of these, we reviewed 178 articles written in English. We first selected the articles published in the past 10 years whose content was directly relevant to the objective of our review and then included a few older relevant articles that the articles published in the past 10 years had cited. We thus included 39 articles in our review.

MECHANISMS OF CVC MALPOSITIONING

While the mechanisms of CVC malpositioning are not well understood, it appears to be multifactorial. Some studies have shown that upon needle insertion, the bevel orientation facilitates the progression of the guide wire in the intended direction.[7] For example, when one attempts an internal jugular vein catheterization, orienting the needle bevel medially facilitates guide wire passage into the SVC.[8] With the same rationale, there have been small randomized controlled studies demonstrating an effect of bevel orientation in subclavian catheterizations, with a higher rate of correct placements when the bevel was oriented caudally.[8] Similarly, orienting the bevel medially when attempting internal jugular vein insertion may maximize the success rate.

Some hypothesize that difficult body habitus (e.g., obesity or large breasts) can contribute to tip migration and increase the risk of malpositioning. When the external segment of a catheter is sutured in redundant tissue and the patient changes position from supine to upright, the mediastinal structures lengthen and the abdominal contents descend, causing relative cephalad pulling of the catheter tip with respect to the SVC and right atrium. Indeed, it has been radiographically demonstrated that the catheter tip can significantly move up cephalad, from mid-right atrium to low SVC, when the patient sits up; this migration was greater for CVC placed in the subclavian veins in females and in obese patients.[9] Mild tip migration has also been described in association with breathing movements. A mean variation of 9mm of catheter tip movement was observed in expiration, but not in inspiration.[10] These positional and breathing related variations can be of combined effects and be of more clinical significance when the catheter tip is placed too far from the right atrium or in patients with vascular anatomical variants.

Other experts attribute malpositioning to variations in the venous anatomy. These variations can lead to catheter misguidance into vein tributaries that offer low-resistance routes for the entering catheter tip. Two types of variants in venous anatomy are recognized: congenital and acquired. In patients with CVCs, congenital variations are usually discovered incidentally on imaging after CVC placement.[11] Although these variations are usually asymptomatic, they can make the radiologic location of the CVC tip difficult to discern. A common congenital variation with clinical significance is a persistent left-sided SVC (Figure 1 and 2), which is seen in 0.3% of healthy patients and 4.3% of patients with congenital heart disease.[12,13] Other relevant congenital variations in venous anatomy include a dominant supreme (highest) intercostal venous drainage to the hemiazygos vein, dextrocardia, inferior vena cava variations, partial anomalous pulmonary venous drainage, and azygos vein abnormalities in origin, course, tributaries, anastomoses, and termination.[14]

Acquired variations in venous anatomy are more common than congenital variations and can be external or internal in origin.[6] More than 85% of external vessel distortions are caused by compression due to malignancy (often lung cancer, breast cancer, lymphoma, or germ cell tumors). Benign causes of external distortion include substernal goiter, thymoma, cystic hygroma, and histoplasmosis. Also, lung collapse or pleural effusions can shift venous structures such as the SVC away from the midline. Internal vessel distortion can be caused by thrombosis or stenosis. The risk of thrombosis can be increased by recent surgery, malignancy, immobilization, hemodialysis, chemotherapy, and pregnancy, and vessel stenosis has been associated with overuse of any vessel, subclavian cannulation, and central venous access from the left side of the neck.[15] (Figure 3).

CVC malpositioning is most common when a left internal jugular vein or subclavian vein is cannulated; a large prospective study by Schummer et al. of 1,794 central line catheterizations by experienced providers found that 6.7% of the catheter tips were intravenously malpositioned. Malposition was defined as CVC tip placement in a vein other than the SVC, or the right atrium, impingement with the lateral wall of the SVC (>40°) and arterial cannulation, most of which were inserted via the left internal jugular vein (12%), followed by right subclavian (9.3%), left subclavian (7.3%) and right internal jugular (4.3%).[3] The increased risk of malpositioning with this approach is presumably due to the presence of a long left brachiocephalic vessel, a more oblique course to the heart, and the presence of small tributaries in that region (Figure 4).[16] Using a CVC when its tip is located in a vessel of small diameter increases the risks of vascular perforation (incidence per catheter of 0.17%); other complications include catheter wedging, local venous thrombosis, catheter dysfunction, and cranial retrograde injection and should not be attempted.[4]

The probability of infection is another factor that has influenced the choice of CVC insertion site. It might explain why often a neck or thorax insertion site is preferred over

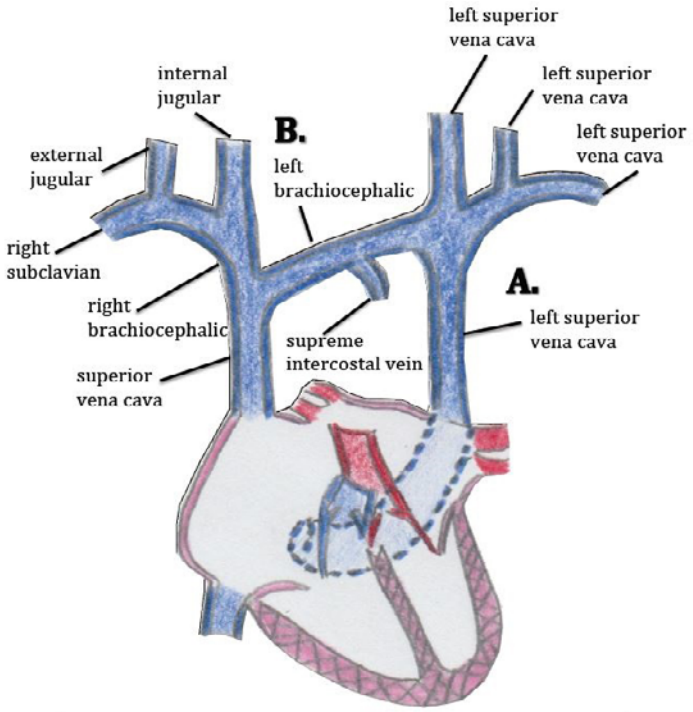

Figure 1. Common variants of clinical significance in the central venous anatomy, the congenital persistent left-sided superior vena cava.

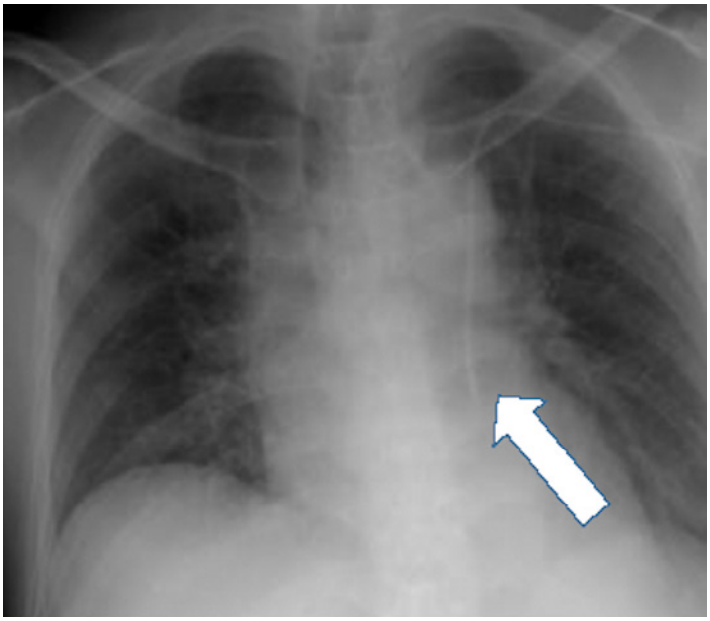

Figure 2. Portable chest radiograph showing a central line inserted in the left subclavian vein, catheter located at persistent left-sided superior vena cava (arrow). Patient was unaware of his congenital variant. He was always asymptomatic during line placement.

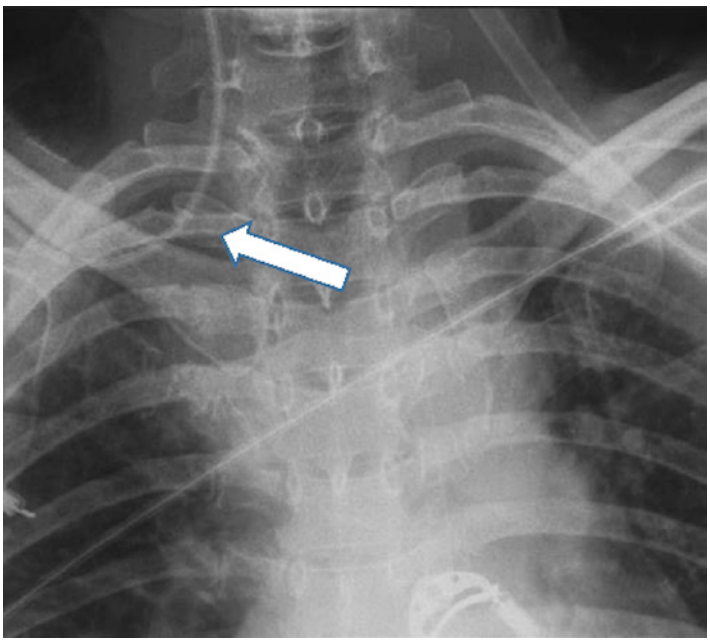

Figure 3. Portable chest radiograph showing a central line catheter placed on the right subclavian vein. The catheter migrated to the right internal jugular vein despite proper procedural technique. Mild resistance was experienced during the wire threading. The patient had history of chronic renal disease. A hemodialysis catheter had been placed in the right subclavian vein for several months and had been removed recently.

a femoral one despite the presence of technical challenges. A randomized controlled trial comparing complications of femoral and subclavian venous catheterizations found that the femoral approach was associated with a higher incidence rate of infectious complications (19.8% vs. 4.5%; p<0.001); however, many lines were placed prior to the implementation of strategies for the reduction central line blood stream infections and the indications for catheter removal were not predetermined.[5] In contrast, more recently, a meta-analysis by Marik et al. that included 113,652 catheter days showed no difference in the rates of catheter-related bloodstream infections between the femoral, subclavian, and internal jugular sites of cannulation.[17] Timsit et al. reported similar results, the colonization was higher in the femoral lines; however, the infections were 1.0 per 1,000 catheter-days for the internal jugular site and 1.1 infections per 1,000 catheter-days for the femoral site, with a hazard ratio of 0.63 [0.25-1.63].[18] None of these studies addressed CVCs inserted exclusively in the emergency department.

PREVENTING MALPOSITIONING

Selecting the vessel

The higher incidence of malpositioning in the left thoracic venous system than in the right side has been documented,[2] which suggests that the right side of the circulation should be considered of first preference for CVC insertion unless those insertion sites are contraindicated. Ultrasound guidance can

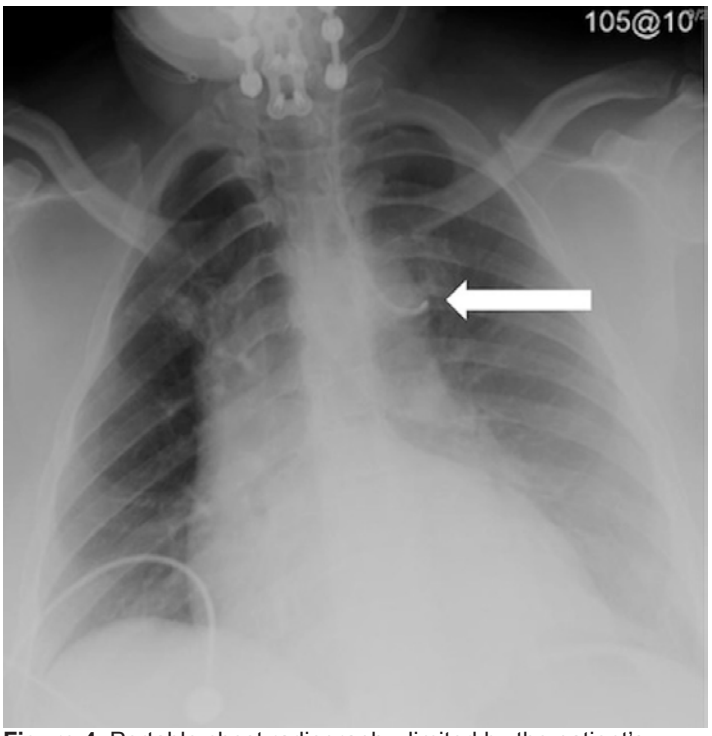

Figure 4. Portable chest radiography, limited by the patient's body habitus, showing bilateral retrocardiac opacities and mild cardiomegaly. A left internal jugular central venous catheter extends through the hemiazygos vein; the catheter tip is most likely located in a left intercostal vein (arrow). A chart review revealed that the same malpositioning was present two months earlier. The patient experienced burning pain in the chest during a crystalloid bolus infusion.

facilitate the identification of vessels but does not necessarily prevent CVC malpositioning.[19] When anatomical distortion of vessels is known or suspected, the affected vessels should be avoided. The presence of scar tissue, thoracic tumors, or a history of recurrent cannulation or of long-term catheter placements (e.g., in patients on hemodialysis) should warrant caution (Figure 3).

Choosing a technique

The appropriate catheter length should be selected on the basis of whether a right-sided or left-sided approach has been chosen. Improper catheter length increases the risk of catheter migration or displacement within the vessel.[20] When a subclavian approach is used, making certain that the J-tip of the guide wire must be pointed caudad during insertion improves its successful guidance.[8] Additionally, when a subclavian approach is attempted, lateral flexion of the head toward the insertion side narrows the os of the internal jugular vein, preventing the tip from entering the internal jugular circulation.[21] Similarly, if the patient's head is rotated away from the insertion site, then the internal jugular vein will be stretched and narrowed, which can maximize successful placement of the CVC in the intended vessel. Others have described the "finger in the fossa" technique of manually compressing the ipsilateral internal jugular vein to avoid its unintended cannulation.[22]

Confirming placement

Proper CVC placement should be clinically verified, and also confirmed with diagnostic imaging. During cannulation of the internal jugular vein, a flush test may be useful for confirming adequate access. Flushing the CVC with 5-10mL of normal saline should result in a thrill felt on palpation or an audible bruit on auscultation at the internal jugular region, suggesting proper cannulation.[23] Similarly, during a subclavian vein catheterization, the flush test has been used to accurately confirm correct tip placement; its presence in the neck could identify coiling in to the ipsilateral internal jugular circulation.[24]

Once a CVC is placed in the neck or thorax, radiography of the chest is the accepted way to confirm that the tip is adequately located in the atrio-caval junction and to rule out complications related to the procedure. Although, based on radiographic landmarks there is no clear consensus on the ideal positioning of the tip of the CVC, it is generally agreed that the tip should lie in the area of the junction of the SVC and right atrium to avoid contacting the pericardial reflection.[25] This position is believed to minimize the risk of complications during clinical use. In general, the tip of a CVC should lie in the long axis of a wide vein with high blood flow, away from both the vessel wall and junctions.[26]

Furthermore, advances in ultrasonography have shown promising results for verifying CVC tip positioning. Various studies have shown that the ultrasonographic visualization of bubbles (seen as opacification) in the right atrium after injection of 10mL of agitated normal saline via the CVC port can be used to adequately verify placement of the CVC tip.[27-29] Significant limitations of this technique include the inability to visualize the alignment of the catheter, and the presence of any aberrant course.

IDENTIFIYING MALPOSITIONING THROUGH SIGNS AND SYMPTOMS

Inadequate catheter function and, less frequently, certain symptoms can indicate CVC malpositioning. Chest pain has been described in association with infusion through a malpositioned CVC in small tributaries of large central veins. For example, retrosternal pain radiated to the back with the infusion of hypertonic fluids in the left internal mammary vein has been documented in multiple case series.[30] Pointing the tip of the catheter cephalad in the internal jugular vein and/or infusing near the intracranial structures can produce an "ear-gurgling" or "water running" sensation and headache,[31] and infusing hypertonic solutions through a brachial vein can produce shoulder or arm pain.[30]

Another warning sign of malpositioning is insufficient blood return at entry ports owing to the collapse of weaker vein walls on the distal port when blood drawing creates negative pressure. However, the free return of venous blood does

not guarantee proper CVC placement within a large vessel. Technical difficulty while threading the wire or inserting the catheter is an important sign of tip malpositioning. A lack of resistance to infusion is not a good indicator of malpositioning because positive pressure from the infusate easily overcomes the occlusion created by a malpositioned CVC. In a prospective observational study of patients undergoing CVC placement, Abood et al. found that clinical judgment based on comorbidities and the technical aspects of the procedure identified malpositioning correctly in only 20% of cases.[32]

CONFIRMING MALPOSITIONING USING IMAGING

Anterior-posterior chest radiography after CVC placement is an important ancillary tool used to diagnose catheter malpositioning.[33] Despite the high diagnostic accuracy of chest radiography for detecting CVC malpositioning, correct interpretation of these radiographs requires knowledge of the normal course and termination of mediastinal vessels related to the CVC.[34]

Undoubtedly, the 2D projections produced by conventional radiography, in contrast to those of computed tomography (CT), have limitations; for instance, the anatomical proximity of vessels to other structures can obscure whether the distal section of the catheter is in the intended location. If the CVC placement appears atypical on an anterior-posterior chest radiograph, then a lateral radiograph may be helpful. If there is still uncertainty, injecting a small amount of contrast material through the catheter during conventional radiography or performing CT may be necessary for precise radiographic localization.[35] For example, when a right internal jugular approach is used, the tip of the catheter may occasionally be malpositioned in the internal mammary vein. Anatomically, the internal mammary vein originates from the brachiocephalic vein, which overlies the SVC and travels along the posterior aspect of the anterior chest wall.[36] Thus, a catheter tip in the right internal mammary vein may appear to be within the SVC on a standard anterior-posterior chest radiograph (Figure 5, 6). CT, although expensive and impractical for routine use, can provide more definitive information than conventional radiography and is very useful for guiding the management of complications of CVC placement.

Another imaging technique used to diagnose CVC malpositioning is real-time radiograph imaging, which uses an image intensifier. This technique can guide wires and catheters centrally during CVC placement without the injection of contrast; unfortunately, its limitations are similar to those of plain radiography.[37]

FIXING MALPOSITIONING

The consensus among experts is that a malpositioned CVC is suboptimal. In most circumstances, if a catheter is malpositioned, a priority should be to reposition, replace, or remove as soon as it is practical.[26,38] In patients with difficult

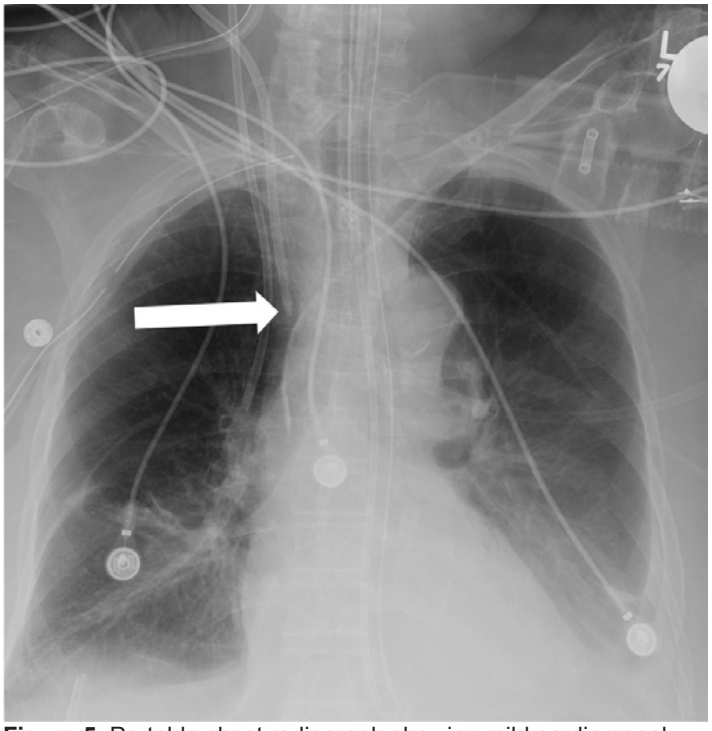

Figure 5. Portable chest radiograph showing mild cardiomegaly and bilateral basal lung opacities. A right internal jugular central venous catheter is shown with its tip apparently located at the superior vena cava. The emergency physician initially read the radiograph as showing the catheter as "adequately positioned." Poor blood return was observed from the ports during placement. Chest burning pain was present during a normal saline infusion.

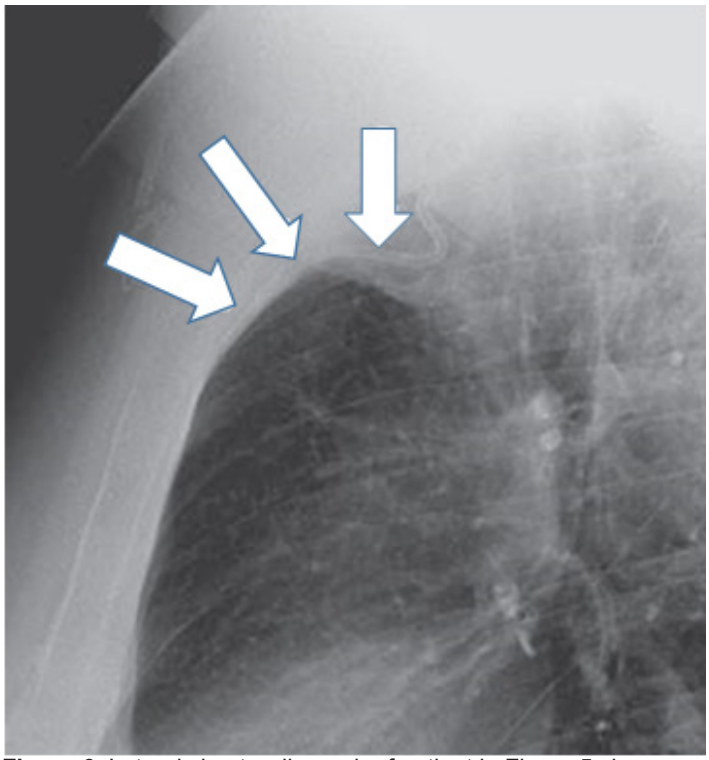

Figure 6. Lateral chest radiograph of patient in Figure 5 showing catheter (arrows) malposition coursing anteriorly along right internal mammary vein.

venous access and/or a high-value catheter, an objective evaluation of the risk-benefit situation should be done in order to determine whether to use the placed CVC. In addition, the insertion of a new catheter can be attempted after partial retrieval and redirecting of the wire guide, which may correct the malpositioning. Interestingly, in a prospective study in infants performed by Rastogi et al., in which 187 catheters inserted for long-term use were placed with a success rate of 98.9%, seven of all catheter tips were initially malpositioned (three in each internal jugular vein and one in the brachiocephalic vein), but all seven corrected themselves within one day, and a peripheral intravenous line was used until then in each case. The authors suggested that to avoid the stress of removing and replacing a malpositioned CVC, the CVC should be left in place since spontaneous correction may occur within one day.[39] No similar observation has been described in adults. For catheters cannulated in noncompressible arteries or those centrally visualized but not clearly intravascularly located, it is prudent to seek guidance from interventional radiology or vascular surgery specialists before removing the CVC. The infusion of hyperosmolar solutions or vasopressors through the CVC increases complications associated with a malpositioned CVC and should be avoided before the malpositioning is fixed. Specific complications of a neglected malpositioned CVC should be managed on an individual basis, depending on the patient and presentation.

CONCLUSION

CVC malpositioning is affected by congenital and acquired anatomical variants and by the techniques used to place and confirm placement of the CVC. Knowing the mechanisms of CVC malpositioning and how to prevent, identify, and correct CVC malpositioning could decrease harm to patients with this condition. Signs and symptoms of CVC malpositioning in a patient with apparently adequate CVC placement on plain radiographs should prompt more advanced diagnostic techniques. In general, repositioning, replacing or removing a malpositioned CVC should be done as soon as is possible.

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Pediatric Tape: Accuracy and Medication Delivery in the National Park Service

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Introduction: The objective is to evaluate the accuracy of medication dosing and the time to medication administration in the prehospital setting using a novel length-based pediatric emergency resuscitation tape.

Methods: This study was a two-period, two-treatment crossover trial using simulated pediatric patients in the prehospital setting. Each participant was presented with two emergent scenarios; participants were randomized to which case they encountered first, and to which case used the National Park Service (NPS) emergency medical services (EMS) length-based pediatric emergency resuscitation tape. In the control (without tape) case, providers used standard methods to determine medication dosing (e.g. asking parents to estimate the patient's weight); in the intervention (with tape) case, they used the NPS EMS length-based pediatric emergency resuscitation tape. Each scenario required dosing two medications (Case 1 [febrile seizure] required midazolam and acetaminophen; Case 2 [anaphylactic reaction] required epinephrine and diphenhydramine). Twenty NPS EMS providers, trained at the Parkmedic/Advanced Emergency Medical Technician level, served as study participants.

Results: The only medication errors that occurred were in the control (no tape) group (without tape: 5 vs. with tape: 0, p=0.024). Time to determination of medication dose was significantly shorter in the intervention (with tape) group than the control (without tape) group, for three of the four medications used. In case 1, time to both midazolam and acetaminophen was significantly faster in the intervention (with tape) group (midazolam: 8.3 vs. 28.9 seconds, p=0.005; acetaminophen: 28.6 seconds vs. 50.6 seconds, p=0.036). In case 2, time to epinephrine did not differ (23.3 seconds vs. 22.9 seconds, p=0.96), while time to diphenhydramine was significantly shorter in the intervention (with tape) group (13 seconds vs. 37.5 seconds, p<0.05).

Conclusion: Use of a length-based pediatric emergency resuscitation tape in the prehospital setting was associated with significantly fewer dosing errors and faster time-to-medication administration in simulated pediatric emergencies. Further research in a clinical field setting to prospectively confirm these findings is needed. [West J Emerg Med. 2015;16(5):665-670.]

INTRODUCTION

Since its inception in the 1980s, the pediatric emergency tape (commonly called the Broselow® Tape)[1] has been used as a method to quickly and safely determine medication doses for pediatric patients whose weight is unknown. There has been considerable research regarding the accuracy of medication dosing using the Broselow® Tape.[2-12] Relatively little research has investigated the

use of a length-based tape in the prehospital setting;[13-15] however, these studies have shown that prehospital providers can accurately use a length-based pediatric emergency resuscitation tape for medication dosing.[13-15]

Based on the concept of the Broselow® Tape and with the aid of a grant from the National Park Foundation, a novel length-based pediatric emergency resuscitation tape specifically tailored to the National Park Service (NPS) Emergency Medical Services advanced life support (ALS) scope of practice (SOP) was developed for use in the NPS. This SOP encompasses 32 medications, including cardiac drugs, narcotics, antibiotics and many others. The tape was also designed to be more durable in the austere environments encountered on a routine basis in the National Parks.

The austere and remote environments of the National Parks often lead to long transport times and extended patient contacts; for this reason, there is an expanded SOP for ALS providers in the NPS. These ALS providers are referred to as Parkmedics[16] and have a SOP between that of an advanced emergency medical technician and paramedic.

The aim of this study was to evaluate the accuracy of medication dosing as well as time to administration of medication dose by NPS Parkmedics using this novel length-based tape in simulated prehospital pediatric scenarios.

METHODS

Setting/Population

Every two years, a new group of Parkmedics is trained in Fresno, California, under the auspices of the UCSF-Fresno Emergency Medicine Department and Community Regional Medical Center. During their training course, along with standard training on medication calculation and administration, Parkmedic students were introduced to the novel length-based pediatric emergency resuscitation tape and received training regarding its use, including head-to-toe placement and locating corresponding medication doses. Each Parkmedic was invited to participate in the study at the end of his/her course; participation was completely voluntary and independent of their training program.

Study Design

The study was designed as a two-period, two-treatment crossover trial. Each Parkmedic participated in two simulated emergent pediatric scenarios. The 20 participants were randomly assigned to one of four groups by drawing cards. Half were assigned to case one (febrile seizure) first and case two (anaphylaxis) second. The others had the opposite assignments. Each of these two groups was again divided, with half assigned to control (without tape) first and intervention (with tape) second. The others again had the opposite assignments. The study design flowchart is presented in the accompanying figure. As the researchers were actively involved in the acquisition of data, there was no blinding as to the assignments.

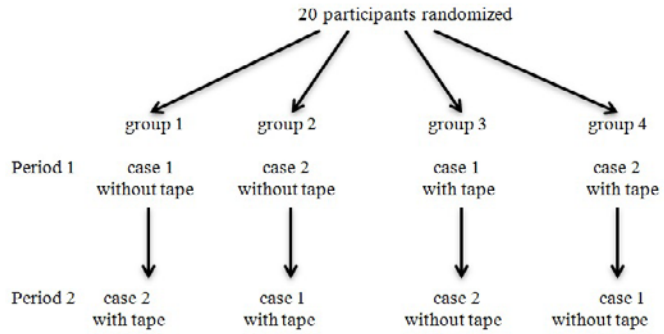

Figure. Design of the two-period, two-treatment crossover trial; "intervention" denoted use of the length-based tape.

Institutional Review Board Approval

This study received approval from the Community Medical Centers/UCSF Fresno Institutional Review Board.

Intervention/Treatments

When given an intervention (with tape) case, the Parkmedics used the length-based tape to determine the doses of the appropriate medications to be given in the scenario. During the control (without tape) scenarios, the Parkmedics used standard methods of determining the medication dose. These methods include, but are not limited to, asking the simulated parent for the weight of the patient; estimating the patient's weight; looking up the weight or age-based medication dose in a protocol or other reference; or calling the simulated base hospital for dosing. If estimating the patient's weight, the Parkmedic would also need to calculate the appropriate weight-based dose for each medication.

Outcome Measures

This study had two primary outcome measures: accuracy of drug dose using the length-based tape compared with the accuracy of the dose using standard methods of dose acquisition; and the time it took to determine the dose of each drug using the length-based tape compared with time to determination of dosing using the standard methods of dose acquisition. We defined a dosing error for each drug as being a >25% deviation from the correct weight-based dose for each drug; this is consistent with other studies of medication dosing errors in pediatric patients, where acceptable error percentages range from 10-25%.[17-19]

Study Protocol

Each Parkmedic participated in two simulated emergent prehospital pediatric scenarios. In each scenario, it was appropriate to give two medications. Scenario 1 was a 9 pound/4kg infant with febrile seizure requiring both midazolam and acetaminophen. Scenario 2 was a 22 pound/10kg toddler with anaphylaxis requiring both epinephrine and diphenhydramine. Mannequins were used as simulated patients and were selected for appropriate size

(length) for use with the tape. The subjects were oriented to the scenarios including simulated access to base hospital; use of protocols; simulated access to the patients' parents during all scenarios; and access to the length-based tape during the intervention scenarios. They were asked to voice out loud the moment they decided a medication should be given and similarly voice out loud the dose to be given as soon as the dose was determined. The scenarios began with each proctor reading a basic description of the clinical situation. History, vital signs, physical exam findings, and response to treatment were all voiced by the proctors as appropriate throughout the scenario. The timer for each medication was started at the moment the decision to give the appropriate medication was indicated and stopped when the dose was decided. The time and dose were recorded for each medication in each case.

Analytical Methods

We used Microsoft Excel 2007 (Microsoft Inc., Redmond, WA) for data collection and statistical analysis. Fisher's exact test was used to compare the drug dose data, and we used the t-test for independent samples to interpret the time data.

RESULTS

Dose Error

Twenty Parkmedics participated in a total of 40 scenarios and delivered medication 78 times. (One provider did not give acetaminophen during their control case, and another provider did not give diphenhydramine during their control case; these omissions were not included in the statistical analysis as dosing errors.) See Table 2a and 2b for all results. We defined a medication dose error as a greater than 25% deviation from the appropriate weight-based dose, with the exception of epinephrine. For true weight-based dosing, the correct epinephrine dose for a 10kg patient would be 0.1mg; however, on the tape the correct dose is 0.3mg, so both doses were accepted as correct. (See dosing in NPS protocol in discussion section.) Acceptable dose ranges for each medication are listed in Table 1.

Acetaminophen doses were 45mg (11.25mg/kg), 60mg (15mg/kg), 61mg (15.25mg/kg) and a single outlier of 135mg (33.75mg/kg) that occurred in the control group and was considered the only error for acetaminophen administration. Midazolam doses were 0.4mg (0.1mg/kg) and 0.5mg (0.125mg/kg) with a single outlier of 1.5mg (0.375mg/kg) that occurred in the control group and was considered the only error for midazolam administration. Diphenhydramine doses were 10mg (1mg/kg) and 12mg (1.2mg/kg) for all but two cases; the two errors were doses of 22mg (2.2mg/kg) and 1mg (0.1mg/kg), both in the control group, which were considered the only errors for diphenhydramine administration. Epinephrine was given in 0.1mg (0.01mg/kg), 0.2mg (0.02mg/kg) and 0.3mg (0.03mg/kg) doses with one outlier of 1mg (0.1mg/kg), which was in the control group and considered the only error for epinephrine. Overall, there were five errors in the control group and no errors in the intervention group (p=0.024) (Table 3a).

Time to Determination of Dose

The mean time to determination of acetaminophen dose in the intervention (with tape) group was shorter at 28.6s (12-90s) than the 50.6s (24-90s) in the control group (p=0.036). The mean time to determination of midazolam dosing in the intervention (with tape) group was shorter at 8.6s (5-18s) than the 27s (10-58s) in the control group (p=0.005). There was no difference between the groups in time required to determine the dose for epinephrine (intervention group: 23.3s [1-50s] vs. control group: 22.9s [7-56s], p=0.96). The mean time to determination of diphenhydramine dose was shorter in the intervention group (13s [2-28s]) than in the control group (37.6s [19-65s]) (p=0.0005) (Table 3b).

DISCUSSION AND LIMITATIONS

Weight Based Dosing and Acceptable Error

As stated above, for the drugs in our study we defined a medication dose error as a greater than 25% deviation from the appropriate weight-based dose. We consulted with our hospital pharmacist; performed a literature search using the search words "pediatric drug error range,""pediatric drug error percent,""acceptable pediatric drug dose range," and "pediatric drug dosing;" and calculated percent error from the Broselow® Tape, all in an attempt to determine a literature-based acceptable error for pediatric medication dosing. Using the numbers for epinephrine and lorazepam from the Broselow® Tape at the Purple (10-12kg) zone and accepting the known variance from child to child with respect to the weight/length proportion, a potential 20% variance in dosing is within the tolerance recommended by the tape. We concur with this range and although there is little literature to support the

Table 1. Accepted dosage ranges in study examining use of pediatric emergency resuscitation tape by National Park EMTs.

Drug	Accepted dose range (mg)
Midazolam	0.3-0.6
Acetaminophen	45-75
Epinephrine	0.1-0.3
Diphenhydramine	7.5-12.5

EMT, emergency medical technician

Table 2a. Case one - febrile seizure. Dose and time for each medication in each group.

Treatment	Medication	Dose (mg)	Time (s)	Medication	Dose (mg)	Time (s)
Intervention	Acetaminophen	60	15	Midazolam	0.5	5
Intervention	Acetaminophen	45	16	Midazolam	0.5	10
Intervention	Acetaminophen	60	12	Midazolam	0.5	5
Intervention	Acetaminophen	60	25	Midazolam	0.5	18
Intervention	Acetaminophen	60	90	Midazolam	0.4	14
Intervention	Acetaminophen	60	23	Midazolam	0.5	5
Intervention	Acetaminophen	45	16	Midazolam	0.5	8
Intervention	Acetaminophen	45	22	Midazolam	0.5	6
Intervention	Acetaminophen	60	27	Midazolam	0.5	7
Intervention	Acetaminophen	60	40	Midazolam	0.5	5
Control	Acetaminophen	60	90	Midazolam	0.4	10
Control	Acetaminophen	60	40	Midazolam	0.4	16
Control	Acetaminophen	60	55	Midazolam	0.4	58
Control	Acetaminophen	60	63	Midazolam	0.4	30
Control	Acetaminophen	60	44	Midazolam	0.4	16
Control	Acetaminophen	135	49	Midazolam	1.5	40
Control	Acetaminophen	60	52	Midazolam	0.4	27
Control	Acetaminophen	60	24	Midazolam	0.4	24
Control	Acetaminophen	61	38	Midazolam	0.4	14
Control	Acetaminophen	not given	not given	Midazolam	0.4	35

Table 2b. Case two - anaphylaxis. Dose and time for each medication in each group.

Treatment	Medication	Dose (mg)	Time (s)	Medication	Dose (mg)	Time (s)
Intervention	Epinephrine	0.3	27	Diphenhydramine	10	10
Intervention	Epinephrine	0.3	39	Diphenhydramine	10	4
Intervention	Epinephrine	0.1	1	Diphenhydramine	10	20
Intervention	Epinephrine	0.3	15	Diphenhydramine	10	12
Intervention	Epinephrine	0.3	5	Diphenhydramine	10	2
Intervention	Epinephrine	0.3	30	Diphenhydramine	10	14
Intervention	Epinephrine	0.3	50	Diphenhydramine	10	15
Intervention	Epinephrine	0.1	49	Diphenhydramine	10	23
Intervention	Epinephrine	0.3	15	Diphenhydramine	10	2
Intervention	Epinephrine	0.1	2	Diphenhydramine	10	28
Control	Epinephrine	0.1	28	Diphenhydramine	10	19
Control	Epinephrine	1	56	Diphenhydramine	10	16
Control	Epinephrine	0.1	27	Diphenhydramine	22	35
Control	Epinephrine	0.2	15	Diphenhydramine	10	65
Control	Epinephrine	0.2	30	Diphenhydramine	1	51
Control	Epinephrine	0.1	25	Diphenhydramine	10	35
Control	Epinephrine	0.1	10	Diphenhydramine	10	46
Control	Epinephrine	0.2	21	Diphenhydramine	10	28
Control	Epinephrine	0.1	7	Diphenhydramine	12	43
Control	Epinephrine	0.1	10	Diphenhydramine	not given	not given

Table 3a. Dose error in each group.

	Number of dosing errors
Control group	
Acetaminophen	1
Midazolam	1
Epinephrine	1
Diphenhydramine	2
Intervention group	
Acetaminophen	0
Midazolam	0
Epinephrine	0
Diphenhydramine	0

Table 3b. Time-to-medication delivery in each group.

	Control group	Intervention group	p-value
Acetaminophen	50.6	28.6	0.036
Midazolam	27	8.6	0.005
Epinephrine	22.9	23.3	0.96
Diphenhydramine	37.6	13	<0.005

safety of tolerating higher dosing errors, anecdotally and from previous high-dose epinephrine use–common and pediatric advanced life support recommended until relatively recently–we believe that a 25% range for dosing error is reasonably safe. This is for a single dose administration and cumulative doses would, of course, carry additional risks. Lastly, we emphasize the importance of error reduction in all medication dosing, but simultaneously recognize that with lifesaving therapies, some overdosing is likely preferable to underdosing, and that, conversely, underdosing would be preferable with so-called comfort medications.

This study adds to the body of literature demonstrating that a pediatric length-based tape can reduce medication dosing errors, decrease time to administration and potentially improve overall safety in pediatric resuscitation. Additionally, this study shows that NPS Parkmedics can safely use this tool in the prehospital setting.

There were no medication dosing errors in the intervention (tape) group; all five errors occurred in the control (no tape) group. This is a statistically significant difference. The errors were spread across the different variables, with two errors in case 1 and three errors in case 2, and at least one error for each drug. They were also distributed across periods of the study, with three errors occurring during the subjects' first scenario and two errors during the second scenario. This suggests that learning bias was minimized. The clinical relevance of the dosing errors is somewhat less obvious, however; it is not clear that the medication errors made would have led to adverse clinical consequences. Perhaps the most clinically relevant errors were the 10x overdosing of epinephrine (this dose is too high for even an adult patient) and the 10x underdosing of Benadryl. (This low a dose is unlikely to have its intended clinical effect.) A dose of epinephrine this high would almost certainly lead to significant tachycardia and hypertension in a 10kg child, if not to more serious unintended effects. There were no such errors in the group using the pediatric resuscitation tape. Underdosing both epinephrine and versed are also likely to be clinically significant, since at low doses they are unlikely to achieve their intended therapeutic effect. We did not observe significant underdosing of these medications in this study; but the overall increased accuracy with the pediatric emergency resuscitation tape suggests that this type of error would be minimized as well with widespread use of such a resuscitation tape.

In evaluating time-to-medication dosing, there was a significant difference for all of the drugs except epinephrine. There are several factors that may explain this. First, during the course it was emphasized that epinephrine is a truly lifesaving medication and the students were expected to memorize epinephrine dosing for all patients; the same was not true for the other medications used in this study. In addition, the protocols for the NPS are written such that the same dose of epinephrine is acceptable across a wide range of patient weights; the rationale behind this is that giving a higher dose of a lifesaving medication is likely to be better than a delay to administration due to difficulty in calculating the correct dose. This combination of factors probably explains the uniformity of time-to-epinephrine dosing. For the other medications, however, it appears that use of the length-based tape resulted in faster determination of medication dosing. Rapid medication dosing is most important in critically ill patients and for potentially lifesaving medications, which were emphasized in this study. While there is no guarantee that faster determination of drug dosing would result in faster drug administration, these two factors are likely positively correlated. If it is true that faster determination of drug dosing leads to faster drug administration, this would be clinically significant for some drugs such as epinephrine and midazolam.

This study was subject to several limitations. First, the study has a small sample size. All students in the Parkmedic course were invited to participate, and 20 of them did (out of 24 students in the class). Participation was not required, and participation in the study had no bearing on class standing. Second, the study used a crossover design. Learning bias is always a potential problem in crossover studies (that is, performance in period 2 scenarios is improved by things learned during period 1 participation). We attempted to minimize learning bias in the study design, with randomization of both the case encountered first, as well as the intervention (with tape) versus control assignments. In this design, any learning carried over into the second period would affect both the control and intervention groups equally. In addition, the two cases differed in patient age and clinical

presentation, thus minimizing the amount of learning that could be carried over into the second period. Third, the study was carried out using simulated scenarios and mannequins instead of real patients or live simulated patients. There is some loss of fidelity in any simulated scenario, but this should have affected all participants and both cases equally, thus minimizing any bias.

CONCLUSION

This study demonstrates that NPS Parkmedics can use a novel length-based pediatric emergency resuscitation tape, which was associated with a significantly lower number of dosing errors and faster time to determination of medication dosing in simulated pediatric emergencies. Further research is needed to investigate its impact in a clinical setting.

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Sensitivity of a Clinical Decision Rule and Early Computed Tomography in Aneurysmal Subarachnoid Hemorrhage

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Introduction: Application of a clinical decision rule for subarachnoid hemorrhage, in combination with cranial computed tomography (CT) performed within six hours of ictus (early cranial CT), may be able to reasonably exclude a diagnosis of aneurysmal subarachnoid hemorrhage (aSAH). This study's objective was to examine the sensitivity of both early cranial CT and a previously validated clinical decision rule among emergency department (ED) patients with aSAH and a normal mental status.

Methods: Patients were evaluated in the 21 EDs of an integrated health delivery system between January 2007 and June 2013. We identified by chart review a retrospective cohort of patients diagnosed with aSAH in the setting of a normal mental status and performance of early cranial CT. Variables comprising the SAH clinical decision rule (age ≥40, presence of neck pain or stiffness, headache onset with exertion, loss of consciousness at headache onset) were abstracted from the chart and assessed for inter-rater reliability.

Results: One hundred fifty-five patients with aSAH met study inclusion criteria. The sensitivity of early cranial CT was 95.5% (95% CI [90.9-98.2]). The sensitivity of the SAH clinical decision rule was also 95.5% (95% CI [90.9-98.2]). Since all false negative cases for each diagnostic modality were mutually independent, the combined use of both early cranial CT and the clinical decision rule improved sensitivity to 100% (95% CI [97.6-100.0]).

Conclusion: Neither early cranial CT nor the SAH clinical decision rule demonstrated ideal sensitivity for aSAH in this retrospective cohort. However, the combination of both strategies might optimize sensitivity for this life-threatening disease. [West J Emerg Med. 2015;16(5):671-676.]

INTRODUCTION

Background

Approximately 80% of non-traumatic cases of subarachnoid hemorrhage are attributable to ruptured cerebral aneurysms, for which delays in definitive aneurysm treatment can increase the risk of disability or death.[1,2] While the vast majority of aneurysmal subarachnoid hemorrhage (aSAH) cases are identified by cranial computed tomography (CT), the sensitivity of CT diminishes with time such that lumbar puncture is recommended as the definitive test to exclude a diagnosis of "CT-negative" SAH. While two large studies have reported that early cranial CT (i.e. performed within six hours of headache onset) may be up to 100% sensitive for SAH among patients presenting with a normal mental status,[3-6] a prior study by our research group demonstrated imperfect sensitivity of this definition of early cranial CT in the non-academic emergency department (ED) setting.[7] Accordingly, we proposed that sequential application of a validated SAH clinical decision rule

(absence of all the following: age ≥40, neck pain or stiffness, headache onset with exertion, loss of consciousness at headache onset) in such a clinical scenario might further reduce the posterior probability of CT-negative SAH to an acceptable level of risk.[8-10]

Goals of this investigation

We sought to further examine the potential incremental gain in sensitivity when applying a previously validated SAH clinical decision rule to a cohort of patients diagnosed with aSAH after presenting to the ED with normal mental status and undergoing early cranial CT.

METHODS

Study Population

We screened electronic health records of patients treated within the Kaiser Permanente Northern California (KPNC) integrated healthcare delivery system between January 2007 and June 2013 for case inclusion if they had an ED or hospital encounter with an associated International Statistical Classification of Diseases and Related Health Problems, ninth edition (ICD-9) diagnosis code of SAH (430). Emergency care within KPNC is provided through 21 non-academic medical center-based EDs, serving a population of over 3.3 million Kaiser Foundation Health Plan (KFHP) members. This study was part of a larger project examining outcomes following misdiagnosis of aSAH. Patients were electronically excluded if they had an ICD-9 coded diagnosis of head or neck trauma within 24 hours of the index encounter, lacked continuous KFHP membership within the two weeks preceding diagnosis, were under 18 years of age or had a prior diagnosis of SAH between 2002 and 2006. Data on age, sex and race were electronically collected. We then manually reviewed charts for the following inclusion criteria: initial diagnosis at a KPNC ED, Hunt-Hess clinical grade of 1 or 2 at the time of ED presentation, non-contrast cranial CT imaging within six hours of headache onset, either evidence of SAH on non-contrast cranial CT or greater than five red blood cells per microliter on cerebrospinal fluid analysis, and angiographic evidence of cerebral aneurysm thought to be consistent with the clinical presentation and pattern of hemorrhage visualized on imaging, if applicable. The study was approved by the Kaiser Foundation Research Institute Institutional Review Board with a waiver of the requirement for informed consent.

Methods and Measurements

Two investigators (DGM and MVK) conducted a structured explicit chart review and abstraction of records using a standardized paper form as part of a larger study examining outcomes following misdiagnosis of aSAH.[11] Abstractors confirmed the inclusion criteria and the final radiologist interpretation of the initial cranial CT, the location and size of the culprit aneurysm and documentation of the presence or absence of the following variables: neck pain or stiffness, loss of consciousness, physical exertion at the time of headache onset, need for external ventricular drainage and treatment of vasospasm during hospitalization. A best modified Rankin Scale (mRS) score at one year was assigned by reviewing neurosurgical, rehabilitation services and primary care clinical notes following hospital discharge, if applicable, using previously validated methodology.[12] We considered a mRS score ≤2 a favorable neurologic outcome. Both abstractors reviewed 20% of the sample to establish the inter-rater reliability of the following variables with an estimated error margin less than 20%: early cranial CT (inclusion criteria), Hunt-Hess grade at ED presentation and the clinical decision rule.[13] All CT examinations were performed without contrast using multi-slice cine technology (16 slice or higher). Either general radiologists or neuroradiologists made the final interpretation of CT images.

Outcomes and Analysis

The primary outcome of interest was the combined sensitivity of early cranial CT and the SAH clinical decision rule (a negative result for the latter being defined as absence of all four clinical criteria). Secondary outcomes were the independent sensitivities of early cranial CT and the SAH clinical decision rule. Missing variables from the SAH clinical decision rule were imputed as being absent to provide the most conservative estimate of sensitivity. We calculated binomial confidence intervals (CI) using the Clopper-Pearson (exact) method. All statistical analyses were performed using STATA v 13.0 (College Station, TX).

RESULTS

Characteristics of study subjects

We identified 155 patients following application of exclusion and inclusion criteria (Figure). The median age was 55 years and 79% were female. Hunt-Hess grade was 2 in 95% of patients, though none of these had notation of a cranial nerve deficit upon initial ED evaluation. The most common aneurysm location was the anterior communicating artery (30%), followed by the posterior communicating artery (21%). Eighty percent of patients had a favorable neurologic outcome one year from initial hospitalization. Summary statistics of the study population are provided in Table 1.

Main results

Early cranial CT was reported as positive for SAH in 148 patients, yielding an estimated sensitivity of 95.5% (95% CI [90.9-98.2]). The SAH clinical decision rule was likewise positive in 148 patients with the same estimated sensitivity (95.5%, 95% CI [90.0-98.2]). Since the false negative cases for early cranial CT were mutually independent from the false negative cases by the SAH clinical decision rule, the combined estimated sensitivity for application of both early cranial CT and the SAH clinical decision rule was 100% (95% CI [97.6-100.0]). Seven patients (4.5%) underwent lumbar puncture, all

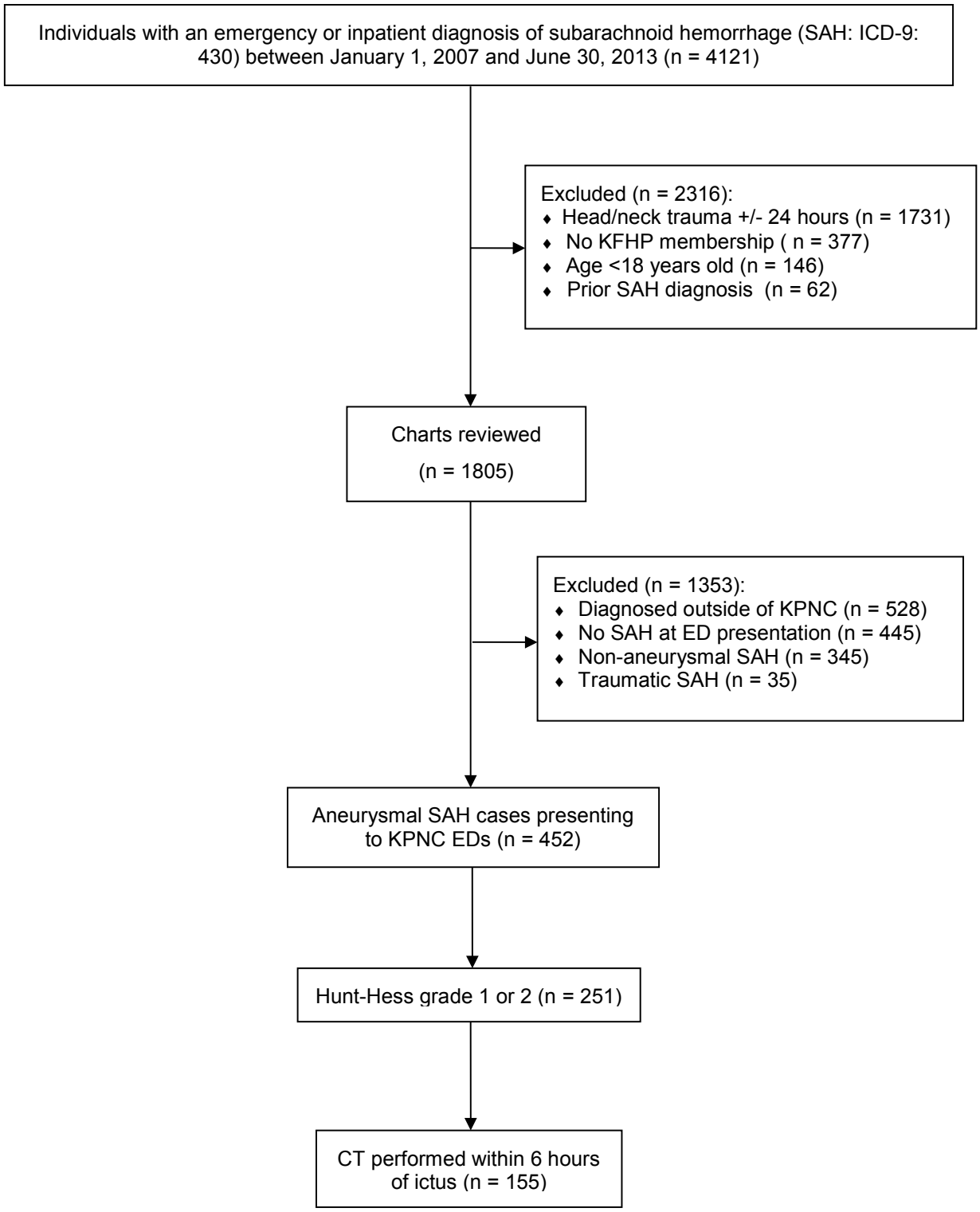

Figure. Aneurysmal subarachnoid hemorrhage cohort assembly.
CT, computed tomography; *ED,* emergency department; *ICD-9,* International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM); *KFHP*, Kaiser Foundation Health Plan; *KPNC*, Kaiser Permanente Northern California; *SAH*, subarachnoid hemorrhage

of whom had negative early cranial CT interpretations. Pertinent details for false negative cases of early cranial CT and the SAH decision rule are provided in Tables 2 and 3, respectively.

The inter-rater agreement for electronic health record abstraction was 100% for early cranial CT, 87% for Hunt-Hess grade (1 versus 2) and 100% for a negative result on the overall SAH clinical decision rule (71% for neck pain or stiffness in isolation).

Table 1. Patient characteristics and outcomes (n=155).

Variable	Value
Age (median, years)	55
Female (%)	79
Race (%)	
Caucasian	42
Black	17
Asian	23
Hispanic	2
Unknown/other	16
Hunt-Hess grade (%)	
1	5
2	95
Neck pain (%)	
Yes	45
Unknown	10
Loss of consciousness (%)	
Yes	14
Unknown	1
Headache onset with exertion (%)	
Yes	15
Unknown	16
Aneurysm location (%)	
ACOM	30
PCOM	21
MCA	15
ACA	6
ICA	8
PICA	5
Basilar	5
Other*	7
Unknown	3
Inpatient treatments (%, n)	
Vasospasm requiring intervention	21 (33/151)
Hydrocephalus requiring EVD	26 (40/154)
Neurologic outcome by one year (%, n)	
Alive	85 (132/155)
mRS ≤2	80 (122/152)

ACOM, anterior communicating artery; *PCOM*, posterior communicating artery; *MCA*, middle cerebral artery; *ACA*, anterior cerebral artery; *ICA,* internal carotid artery; *PICA*, posterior inferior cerebellar artery; *EVD*, external ventricular drainage; *mRS*, modified Rankin scale. *Other locations (n) included the vertebral artery (5), superior cerebellar artery (3), pericallosal artery (3), anterior choriodal artery (3), ophthalmic artery (2) and the superior hypophyseal artery (1).

DISCUSSION

The goal of this study was to help clinicians further refine and understand current testing strategies for aSAH, specifically by highlighting the potential gain in sensitivity obtained with the "post-hoc" application of a SAH clinical decision rule following early cranial CT. While we recognize that this was not the original derivation or validation setting of the SAH clinical decision rule, we feel our study demonstrates that such an approach can potentially help inform shared decision-making between clinicians and patients when faced with uncertainty over the absolute sensitivity of early cranial CT, especially in the face of non-low pretest probability.

This testing strategy is similar in concept to performing a serum d-dimer assay to reliably exclude a lower extremity deep vein thrombosis in a patient with a high pre-test probability for disease but a negative lower extremity ultrasound examination; only the combined sensitivities of the two tests offer a low enough post-test probability to forgo further testing.[14] Additionally, although early cranial CT failed to detect aSAH in seven out of 155 cases (4.5%) in our retrospective cohort, this is only a point estimate and is specific to our practice setting. The findings of 100% sensitivity in the prospective Perry et al.[4] cohort and the retrospective Backes et al.[3] study rightfully prompt consideration of using early CT alone to rule out aSAH in those particular practice settings.

Important contextual differences between our study and prior reports involve both spectrum bias and radiologist staffing practices. Perry et al.[4] enrolled patients with acute headaches reaching maximal intensity within one hour. Backes et al.[3] retrospectively identified patients presenting to a SAH referral center with a 50% incidence of SAH among patients undergoing early cranial CT (as opposed to 13% in the Perry et al. study). Thus it is possible that our study cohort includes patients with less severe presentations of aSAH who may be less likely to manifest positive CT findings on early cranial CT. Likewise, radiology staffing at a tertiary neurosurgical referral center as in Backes et al.[3] is not representative of the vast majority of EDs. While the Perry et al.[4] study setting was similar to ours in that radiographic studies were interpreted by a mix of neuroradiologists and general radiologists who routinely interpreted cranial CTs, several of the medical centers participating in that study had active radiology residency training programs with over-reading of studies by faculty in the daytime, making it difficult to extrapolate that level of scrutiny to practicing radiologists in a non-academic hospital setting. Of note, one early cranial CT in that series was initially misinterpreted as being negative by a radiology trainee, and was only retrospectively re-interpreted as positive when a magnetic resonance angiogram performed several days later revealed an aneurysm. This example highlights the potential for introducing

Table 2. Imaging and laboratory details for the seven false negative cranial computed tomography studies.

Age	CT scanner	CT slice thickness	CSF RBCs/ microliter**	Xanthochromia	Angiography results
≥90	unavailable	5mm	280000	Yes	5mm ACOM aneurysm
76	GE lightspeed VCT (64 slice)	5mm	517500	No	4mm right PCOM aneurysm
67	GE lightspeed VCT (64 slice)	5mm	408000	No	6mm left PCOM aneurysm
45	GE lightspeed VCT (64 slice)	5 mm	190000	No	4mm left ICA aneurysm
53	GE lightspeed Pro 16 (16 slice)	5mm	49750	No	2mm right PCOM aneurysm
50	GE lightspeed VCT (64 slice)	1.25mm	9960	No	10mm ACOM aneurysm
70	GE lightspeed VCT (64 slice)	5mm	55000	Yes	2mm right vertebral artery

Seven patients presenting with aneurysmal SAH had cranial CT studies performed within six hours of headache onset that were initially reported as negative for evidence of subarachnoid hemorrhage. Diagnosis of SAH was made by lumbar puncture in each case. Details of the CT technology used as well as the results of diagnostic lumbar punctures and formal cerebral angiography are presented for each case.
**CSF RBC counts were the lowest values reported in cases where multiple tubes were analyzed.
GE, General Electric; *VCT,* volume computed tomography; *CT*, computed tomography; *ACOM*, anterior communicating artery; *CSF*, cerebrospinal fluid; *RBC,* red blood cell; *ICA*, internal carotid artery; *PCOM*, posterior communicating artery; *SAH*, subarachnoid hemorrhage

Table 3. Imaging and clinical details for the seven patients with false negative clinical decision rules.

Age	Neck pain or stiffness	Onset with exertion	Loss of consciousness	CT results	Angiography findings
32	No	Unknown	No	Positive	5mm right ACA aneurysm
39	No	No	No	Positive	6mm left MCA aneurysm
27	No	No	No	Positive	7mm left ACOM aneurysm
32	No	Unknown	No	Positive	6mm right PCOM aneurysm
39	Unknown	No	No	Positive	ACOM aneurysm (unknown size/location)
25	No	No	No	Positive	2mm right ICA aneurysm
29	Unknown	No	No	Positive	Right MCA aneurysm (unknown size)

Seven patients presenting with aneurysmal SAH had false negative results using the clinical decision rule (age >40, presence of neck pain or stiffness, headache onset with exertion, loss of consciousness at headache onset) for subarachnoid hemorrhage. Diagnosis of SAH was made by computed tomography in each case. Details of the decision rule elements and formal cerebral angiography are presented for each case.
ACA, anterior cerebral artery; *ACOM*, anterior communicating artery; *CT*, computed tomography; *ICA*, internal carotid artery; *MCA*, middle cerebral artery; *PCOM*, posterior communicating artery; *SAH*, subarachnoid hemorrhage

hindsight bias by using final written radiology reports as the gold standard for CT interpretations, an issue for all studies on this topic to date.

Finally, it is notable that all of the patients with false negative cranial CT studies met the age criteria of the SAH clinical decision rule. It is thus possible that a post-imaging rule could be further refined for improved specificity and ease of applicability.

LIMITATIONS

Given the retrospective nature of the study, appropriate characterization of early cranial CT is only as accurate as the available documentation. While the inter-rater agreement for abstraction of this dichotomous variable was 100%, we cannot exclude errors in reporting the actual time of headache onset such that some patients may have been both included and excluded inappropriately. However, such errors in reporting can occur in prospective observational studies as well, and thus is a more general limitation of using historical factors as part of any decision rule.

The completeness of our case identification was also limited by the accuracy of the diagnostic coding from hospital and ED encounters. However, we searched databases specific for diagnostic codes assigned during treatment within KPNC as well as those used to track services billed for outside of KPNC, thus making it unlikely that we failed to capture cases of aSAH that were transferred to a non-KPNC hospital. Regardless, it seems improbable that we failed to capture enough cases of aSAH to appreciably alter our results; for example, to raise the sensitivity point estimate for detection of aSAH by early cranial CT to 99.0%, we would require an additional 545 cases of aSAH, all with positive early cranial CT findings (693/700=0.99).

Given that we conservatively imputed missing variables for the SAH decision rule as being absent, it is also possible that the SAH clinical decision rule may have performed better than reported if missing variables were in fact present. However, recent prospective and retrospective validations of

the same SAH clinical decision rule also revealed suboptimal sensitivities at 98.5% and 96.6%, respectively.[8,15] Additionally, we cannot comment on the specificity of the SAH clinical decision rule when applied following early cranial CT, given the case-only cohort design of our study. It is possible that such an approach would not reduce overall testing rates from current practice, although individual clinicians may be differentially influenced given variable testing thresholds.[16]

Finally, we did not include potentially missed cases of aSAH who may have undergone early cranial CT imaging with no confirmatory (LP) or subsequent testing, only to later present with evidence of aneurysm rupture. Inclusion of such cases in this cohort would bias towards a lower sensitivity of early cranial CT since it is impossible to be certain that evidence of SAH would have been otherwise detected (i.e., by lumbar puncture) at the initial evaluation.

CONCLUSION

In summary, we found the sensitivity of early cranial CT for aSAH to be 95.5% among patients presenting to non-academic EDs in an integrated healthcare system. Application of a SAH clinical decision rule in addition to early cranial CT improved sensitivity to 100% (95% CI [97.6-100.0]). Prospective decision rule refinement and validation of this approach is warranted.

Author contribution statement: DGM, MVK, DRV and DWB conceived the study and obtained research funding. DGM and NU refined participant and variable selection. DGM and MVK undertook chart abstraction and managed the data, including quality control. DGM drafted the manuscript, and all authors contributed substantially to its revision. DGM takes responsibility for the paper as a whole.

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Triple Rule Out versus CT Angiogram Plus Stress Test for Evaluation of Chest Pain in the Emergency Department

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Introduction: Undifferentiated chest pain in the emergency department (ED) is a diagnostic challenge. One approach includes a dedicated chest computed tomography (CT) for pulmonary embolism or dissection followed by a cardiac stress test (TRAD). An alternative strategy is a coronary CT angiogram with concurrent chest CT (Triple Rule Out, TRO). The objective of this study was to describe the ED patient course and short-term safety for these evaluation methods.

Methods: This was a retrospective observational study of adult patients presenting to a large, community ED for acute chest pain who had non-diagnostic electrocardiograms (ECGs) and normal biomarkers. We collected demographics, ED length of stay, hospital costs, and estimated radiation exposures. We evaluated 30-day return visits for major adverse cardiac events.

Results: A total of 829 patients underwent TRAD, and 642 patients had TRO. Patients undergoing TRO tended to be younger (mean 52.3 vs 56.5 years) and were more likely to be male (42.4% vs. 30.4%). TRO patients tended to have a shorter ED length of stay (mean 14.45 vs. 21.86 hours), to incur less cost (median $449.83 vs. $1147.70), and to be exposed to less radiation (median 7.18 vs. 16.6mSv). No patient in either group had a related 30-day revisit.

Conclusion: Use of TRO is feasible for assessment of chest pain in the ED. Both TRAD and TRO safely evaluated patients. Prospective studies investigating this diagnostic strategy are needed to further assess this approach to ED chest pain evaluation. [West J Emerg Med. 2015;16(5):677-682.]

INTRODUCTION

Chest pain is one of the most common reasons people seek medical attention in the emergency department (ED). Evaluation of non-specific chest pain often requires testing for different life-threatening clinical entities, such as aortic dissection, pulmonary embolism, or acute coronary syndrome (ACS). Several clinical and non-invasive stratification tools have been explored to avert missed cardiovascular emergency diagnoses.[1-11] Still, with an aging population and a dramatic increase in the number of ED visits overall, the frequency of this vexing presentation will only increase.[12-16]

Chest pain and observation units have evolved for further risk stratification of low and intermediate risk patients.[17-19] These units typically use supplemental objective testing to exclude ACS, as well as other life-threatening emergencies. Testing strategies include chest computed tomography (CT) with varying protocols for aortic dissection and pulmonary or coronary angiography, as well as stress testing, either alone or more typically using myocardial perfusion imaging (MPI) or stress echocardiography. While

these observation units are safe and effective while reducing cost and length of stay, there is no direct evidence that this strategy reduces adverse cardiac events.[20-22]

CT coronary angiography has recently been implemented as a diagnostic tool in low-risk patients for coronary artery disease.[23-25] A variant of this method, CT coronary angiography with triple rule out protocol (triple rule out, TRO), has been used to evaluate the presence of coronary artery disease, as well as pulmonary embolism and aortic dissection.[26,27] This test, however, draws controversy, in part because of concerns regarding the technique used and the performance characteristics of this test.[28-30] Critics argue that the pre-test probability for each of these three causes of chest pain is never equal enough to warrant TRO protocol.[31] Yet, typically two etiologies (most commonly ACS and pulmonary embolism) are often considered plausible, and providers not infrequently apply a serial approach to evaluation, including first a chest CT pulmonary embolism protocol and then subsequent provocative testing (TRAD), often graded exercise stress with MPI.[32] While TRO has been demonstrated as safe and effective as a diagnostic strategy for ACS, no literature exists to compare the safety and effectiveness of these two approaches.[33]

For these reasons, we reviewed the ED course and 30-day outcome for patients with undifferentiated chest pain evaluated with TRO compared to patients who received TRAD. We hypothesized that both methodologies would be safe and effective for ED patients.

METHODS

Study Setting & Population

Our study was performed in a single academic community hospital with 1,066 inpatient beds and 115,000 annual ED visits. It was approved by our institutional review board as an expedited review with a waiver of informed consent.

This was a retrospective observational cohort study whereby the testing strategy was at the discretion of the treating physician and thus no pre-test probability assessment is available. We collected demographics and process data from the electronic medical record, including age, gender, body mass indexes, total and ED length of stay (hours), and short-term revisit details. Data abstraction was conducted electronically by our experienced outcomes research director (LQ).

All adult patients (age≥18), evaluated initially in the ED for chest pain between February 2009 and January 2012, were considered for inclusion if they had one of two testing strategies: 1) Coronary CTA-TRO protocol or 2) dedicated Chest CT and provocative testing for ischemic cardiac disease (TRAD). We excluded patients who had abnormal biomarkers, abnormal ECGs, a single imaging study to evaluate for the cause of chest pain, an initial abnormal chest CT, or a high suspicion of ACS warranting admission to the hospital.

Testing strategy was almost exclusively chosen by the ED physician alone. Both TRO and stress testing were available seven days per week during business hours, with the exception of stress echocardiography, which was not available on weekends. Patients who presented late in the day required transfer to the ED observation unit until evaluation could be completed. In these cases, the treating ED physician still determined the testing strategy to be carried out in observation, with rare changes to individual plans based on patient factors (i.e. inability to beta block sufficiently) rather than consultant input. Ultimately ED providers made decisions regarding further testing, discharge, or admission from the observation unit.

Measurements & Outcomes

Total hospital costs (dollars) include direct and variable patient care costs, but did not include physician professional fees. We calculated total cost using Sunrise ESPI software. Radiation doses (mSv) were estimated by radiation physicists in both nuclear medicine and imaging, based on average radiation dosing for each study and patient body mass index.[34] TRO protocol used a triphasic injection, with 100mL of contrast at 5mL/sec, then an additional 30mL at 3mL/sec to maintain pulmonary artery opacification, followed by a standard saline injection. TRO images were acquired in a caudal-cranial fashion.

Our measure of safety was revisit for major adverse cardiac event (MACE), including death, acute myocardial infarction, and revascularization, or venous thromboembolic disease within 30 days of the initial admission. All patients were reviewed for 30-day revisits to our health system, and revisit details were manually reviewed by two independent study authors, blinded to testing strategy, to identify whether revisits met adverse event criteria or were unrelated to the index visit.

Data Analysis

Data are presented as means and standard deviations if normally distributed, or medians and inter-quartile ranges if non-normal. No statistical inferences were made. We used the software JMP 9.0.2 (SAS Inc., Cary, NC) to calculate descriptive statistics.

RESULTS

This study investigated two populations (Figure): 829 patients who were evaluated using TRAD and 642 patients who were evaluated using TRO.

Demographics by group are presented in Table 1 and radiation estimates based on body mass index are shown in Table 2. TRO patients were younger (mean 52.3 versus 56.5 years); had lower body mass index (mean 29.4 versus 31.8); and were more likely to be male (42.4% versus 30.4%). TRO patients also incurred less cost (median $449.83 versus $1147.70) and less radiation exposure (median 7.18mSv versus 16.6mSv). For the TRO cohort, eight patients were found to have pulmonary embolism, three were found to have

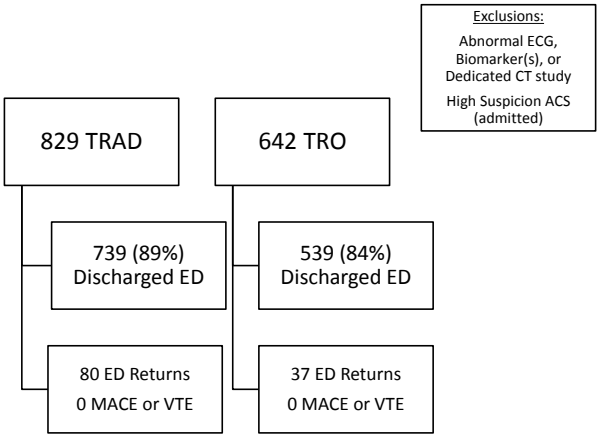

Figure. Patient summary diagram.
ECG, electrocardiogram; *CT*, computed tomography; *ACS*, acute coronary syndrome; *TRAD*, traditional group; *TRO*, triple rule out group; *ED*, emergency department; *MACE*, major adverse cardiac event; *VTE*, venous thromboembolism

Table 1. Summary demographics by study group.

Demographic	TRAD N=829	TRO N=642
Age (years)	56.5 (SD 14.61)	52.3 (SD 12.04)
Gender (male)	252 (30%)	272 (42%)
Body mass index	31.8 (SD 8.04)	29.4 (SD 6.23)
Length of stay (hours) in ED	21.86 (SD 6.14)	14.45 (SD 7.54)

TRAD, traditional group; *TRO,* triple rule out group; *ED*, emergency department

Table 2. Radiation estimates (mSv) based on body mass index.

Body mass index	Myocardial perfusion imaging	CT chest
BMI<30	12.1mSv±1.2	4.5mSv
BMI 30-45	12.1mSv±1.2	8.2mSv
BMI>45	16mSv±1.6	13mSv

CT, computed tomography; *BMI*, body mass index

aortic dissection, and 539 (84.0%) were discharged home. Within 30 days, 37 (6.6%) of those patients revisited the ED but none was related to MACE or venous thromboembolism. For patients discharged from the ED, TRO patients had a shorter length of stay (mean 14.45 vs 21.86 hours).

The vast majority of TRAD had stress testing that included MPI (N=707, 85.3%), while 71 (8.6%) underwent stress echocardiography and 51 (6.2%) underwent other risk stratification modalities, including treadmill stress testing alone, stress positron emission tomography. Seven hundred thirty-nine (89%) patients were discharged home from the ED. Within 30 days, 80 (10.5%) of those patients revisited the ED but none was related to MACE or venous thromboembolic disease.

DISCUSSION

Patients evaluated with TRO tended to have a shorter ED length of stay, fewer hospital costs, and less exposure to radiation than traditional testing. No patient in the TRO or traditional cohort that was discharged from the hospital had a short-term adverse event, identifying that both methods are effective at safely ruling out short-term events. Given the low rate of life-threatening chest pain diagnoses and high rate of patient discharge from the ED, our study population represents a low risk group of patients.

Limited literature exists evaluating the performance characteristics of TRO as a mono-testing strategy for emergency patients. In one study by Madder et al,[28] TRO was compared to a large cohort of ED and elective patients to evaluate its ability to detect coronary disease. TRO had similar performance characteristics to dedicated coronary CT angiography, and no patient returned for missed ACS. The control group of this study was not an ED cohort, however, and the results of this study do not directly address the evaluation of the ED patient with undifferentiated chest pain. Rogers et al[29] prospectively evaluated TRO compared to dedicated chest CT protocol for patients in the ED presenting with acute, undifferentiated chest pain. They found no difference in total hospital length of stay, radiation exposure, or cost between groups, although their definition of length of stay included total hospital time and ED time. A lack of sample size (total N=59) likely contributed to the lower, yet non-statistically significant, rates of MACE, on-going clinical symptoms, and revisits in the TRO group at follow up. Importantly, Rogers et al did not evaluate specifically for coronary artery disease in the dedicated chest CT arm. Finally, Takakuwa and Halpern[35] investigated the use of TRO in low-to-moderate risk ED patients with symptoms and history concerning for ACS. They used TRO to evaluate for coronary artery disease versus alternative diagnoses to explain each patient's presentation. Ultimately 11% of their study population had a clinically important alternative diagnosis and 76% of patients with no to mild coronary disease required no further testing.

A recent meta-analysis looking at TRO compared to other diagnostic modalities for nontraumatic chest pain included 11 studies and concluded that TRO is highly accurate for coronary artery disease but associated with increased radiation exposure.[33] In contrast to our investigation, the studies included in Ayaram et al did not exclusively enroll ED patients and did not evaluate all patients for undifferentiated chest pain with a non-invasive strategy. While their analysis adds to the literature on TRO, it did not address the clinical utility of TRO compared to other currently used diagnostic strategies for emergency patients. Despite its broad review of the available literature, it cannot be used in isolation to draw conclusions on the usefulness of TRO in the ED.

As technology changes, so does our ability to image with less radiation, less contrast volume, and less beta blockade.

New imaging techniques have allowed for the improved safety profile of TRO protocols while obtaining adequate quality.[36-40] In the future, prospective and randomized study of TRO vs TRAD is needed in the evaluation of undifferentiated chest pain patients in the ED. Furthermore, prospective study with actual radiation dose measurements and longer follow-up periods for MACE would be useful.

LIMITATIONS

Limitations of this study include its short follow-up period and potential to have missed revisits, adverse events, or deaths not presenting to our own institution. A short follow-up period was chosen since the alternative to admission or ED observation for further risk stratification is short-term outpatient testing. Given the similar safety profiles between the TRO and TRAD groups, it seems our patient population was sufficiently low risk, such that further outpatient testing may have been reasonable.[41]

Because of this study's retrospective design, we have little information regarding physician testing strategy other than clinician judgment led to testing for more for more than one etiology of chest pain in these patients. Furthermore, we have little information regarding baseline characteristics of the two groups, and as such, we cannot directly compare groups further. However, since there is no previous literature comparing TRO to a TRAD strategy in ED patients with undifferentiated chest pain, this study represents a necessary pilot investigation.

Our institution frequently uses MPI to increase diagnostic accuracy for ACS[41] but has increasingly used CT coronary angiography when coronary artery disease is the leading diagnostic concern. Institutions that use stress testing alone or in combination with echocardiography would be expected to identify lower radiation exposure compared to their traditional testing but would still be limited by image quality and operator skillfulness.

Finally, our length-of-stay data may be biased by the fact that not all diagnostic tests were available 24 hours a day or seven days a week, and observation overnight was sometimes required to obtain further objective testing. At our institution, neither TRO nor TRAD was available after 7 p.m. and stress echocardiography was not available on weekends. While the difference in availability of specific choices in provocative testing may influence the length-of-stay advantage of TRO, less than 10% of the TRAD cohort received stress echocardiography implying that influence was minimal. While resource availability for chest pain rule-out pathways at all times would be ideal, this is not necessarily feasible in all institutions.[42]

CONCLUSION

Undifferentiated chest pain evaluation by TRO in the ED appears to be a feasible, safe, and effective modality for excluding life-threatening causes of chest pain for low risk patients in the ED. Prospective studies evaluating the clinical utility of this diagnostic strategy are needed to further assess this approach to ED chest pain evaluation.

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Comparing an Unstructured Risk Stratification to Published Guidelines in Acute Coronary Syndromes

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Introduction: Guidelines are designed to encompass the needs of the majority of patients with a particular condition. The American Heart Association (AHA) in conjunction with the American College of Cardiology (ACC) and the American College of Emergency Physicians (ACEP) developed risk stratification guidelines to aid physicians with accurate and efficient diagnosis and management of patients with acute coronary syndrome (ACS). While useful in a primary care setting, in the unique environment of an emergency department (ED), the feasibility of incorporating guidelines into clinical workflow remains in question. We aim to compare emergency physicians' (EP) clinical risk stratification ability to AHA/ACC/ACEP guidelines for ACS, and assessed each for accuracy in predicting ACS.

Methods: We conducted a prospective observational cohort study in an urban teaching hospital ED. All patients presenting to the ED with chest pain who were evaluated for ACS had two risk stratification scores assigned: one by the treating physician based on clinical evaluation and the other by the AHA/ACC/ACEP guideline aforementioned. The patient's ACS risk stratification classified by the EP was compared to AHA/ACC/ACEP guidelines. Patients were contacted at 30 days following the index ED visit to determine all cause mortality, unscheduled hospital/ED revisits, and objective cardiac testing performed.

Results: We enrolled 641 patients presenting for evaluation by 21 different EPs. There was a difference between the physician's clinical assessment used in the ED, and the AHA/ACC/ACEP task force guidelines. EPs were more likely to assess patients as low risk (40%), while AHA/ACC/ACEP guidelines were more likely to classify patients as intermediate (45%) or high (45%) risk. Of the 119 (19%) patients deemed high risk by EP evaluation, 38 (32%) were diagnosed with ACS. AHA/ACC/ACEP guidelines classified only 57 (9%) patients low risk with 56 (98%) of those patients diagnosed with no ACS.

Conclusion: In the ED, physicians are more efficient at correctly placing patients with underlying ACS into a high-risk category. A small percentage of patients were considered low risk when applying AHA/ACC/ACEP guidelines, which demonstrates how clinical insight is often required to make an efficient assessment of cardiac risk and established criteria may be overly conservative when applied to an acute care population. [West J Emerg Med. 2015;16(5):683-689.]

INTRODUCTION

Chest pain is the second most frequent complaint among patients presenting to the ED and is associated with the leadin g cause of death in the United States, coronary artery disease (CAD).[1] It is estimated that about 117 million ED visits are made annually in the U.S., with just over 5% of those visits due to a primary complaint of chest pain.[2] Approximately one third of the patients presenting with chest pain are diagnosed with acute coronary syndrome (ACS).[1]

ACS includes acute myocardial infarction (AMI) and unstable angina (UA). Acute MI is further differentiated by 12-lead-electrocardiogram (ECG) into two categories: non-ST-elevation myocardial infarction (NSTEMI) and ST-elevation myocardial infarction (STEMI). STEMI patients have ST elevations of ≥1mm in two or more consecutive leads on ECG findings. Patients with suspected UA or NSTEMI are identified by practice guidelines, clinical suspicion, patient risk factors, and cardiac enzyme determination.[4,5] While patients with myocardial necrosis are identified by elevated cardiac enzymes, those ACS patients without evidence of myocardial necrosis remain difficult to identify because there is no true standard for the diagnosis of UA.[6]

The American Heart Association (AHA) in conjunction with the American College of Cardiology (ACC) and the American College of Emergency Physicians (ACEP) devised risk stratification guidelines to assist physicians with accurate and efficient diagnosis and management of patients with UA and NSTEMI.[7] These guidelines suggest that a physician's initial evaluation of a chest pain patient should verify the 'likelihood that signs and symptoms represent an ACS secondary to CAD.' This AHA/ACC/ACEP algorithm is considered the gold standard for risk stratifying a patient with suspected ACS secondary to CAD (Table 1). The guidelines established four categories to evaluate a potential cardiac patient: patient history, physical examination, ECG and cardiac markers. Each category contains specific criteria, which then determine a patient's ACS risk as low, intermediate, or high.[7-9]

Theoretically, physicians can base their risk stratification on the AHA/ACC/ACEP guidelines. It is important to note that these guidelines simply provide a framework for the clinician to approach patients with suspected ACS. They are typically not used as a decision tool in clinical practice. Restraints on time, space, and resources in the ED compete with the need to efficiently and accurately diagnose a patient. We hypothesized that in the ED setting, providers are more likely to rely on their clinical experience when risk stratifying a patient for ACS. The objective of our study was to compare the point of care, unstructured ACS risk stratification value assigned by EPs to the score deduced from AHA/ACC/ACEP guidelines for ACS secondary to CAD. Our goal was to ascertain whether the practicing physician or the AHA/ACC/ACEP guidelines were more accurate in predicting a patient's ultimate diagnosis of ACS.

METHODS

Study Design

This prospective observational cohort study analyzed the patient's risk stratification for ACS as determined by an EP and by AHA/ACC/ACEP guidelines. All EPs evaluating patients with possible ACS calculated each patient's risk for ACS. Using published AHA/ACC/ACEP guidelines, an independent observer determined a patient's likelihood for ACS.

Study Setting and Population

The setting for this study was the main ED of an urban, academic hospital with an annual census of approximately 90,000 ED visits per year. All patients ≥35 years of age presenting with a chief complaint of chest pain, and undergoing evaluation for ACS (indicated by cardiac-biomarker testing ordered) were prospectively enrolled. We defined exclusion criteria as patients who had a STEMI or new left bundle branch block (LBBB), left against medical advice (AMA), were sent to the ED by their primary physician or cardiologist for direct admission, or in cases where the EP played no role in patient disposition. Also excluded from enrollment were patients with unknown physician risk stratification or missing results from any cardiac testing. All patients were contacted at 48 hours and 30 days following the index ED visit to determine all cause mortality, unscheduled hospital/ED revisits, and objective cardiac testing performed.

Informed consent was not necessary because the scoring system has been incorporated as part of our electronic medical record and is our current standard of care. The information technology department integrated TIMI scoring and EP evaluation of patient ACS risk to auto populate ACS-related chief complaint notes (i.e. chest pain, and potential MI) as a mandatory field. A total of 641 patients were enrolled.

Study Protocol

The treating EP evaluated all patients, and determined the diagnostic approach. EPs were required to document whether they suspected the patient to be at high, intermediate, or low likelihood for ACS, based on ECG findings, patient history, physical exam findings, and cardiac biomarkers. Two independent physicians reviewed patient charts using established AHA/ACC/ACEP guidelines and all available clinical data to identify the presence of UA, NSTEMI, as well as cardiac and non-cardiac death. These results are found in table 3.

Outcome Measures

A standard database was used to record patient demographics, medical history, physical exam findings, cardiac biomarker values, objective cardiac testing, unstructured ACS risk stratification rating assigned by EP, likelihood of ACS by AHA/ACC/ACEP guidelines risk, final cardiology impression, 48-hour and 30-day follow-up information.

Table 1. AHA/ACC/ACEP risk stratification for ACS.

	High likelihood	Intermediate likelihood	Low likelihood
Feature	Any of the following	Absence of high-likelihood features and presence of any of the following:	Absence of high- or intermediate-likelihood features but may have:
History	Chest or left arm pain or discomfort as chief symptom reproducing prior documented angina Known history of CAD, including MI	Chest or left arm pain or discomfort as chief symptom Age >70 years Male sex Diabetes mellitus	Probable ischemic symptoms in absence of any of the intermediate likelihood characteristics Recent cocaine use
Examination	Transient MR murmur, hypotension, diaphoresis, pulmonary edema, or rales	Extracardiac vascular disease	Chest discomfort reprduced by palpation
ECG	New, or presumably new, transient ST-segment deviation (≥0.1 mV) or T-wave inversion in multiple precordial leads	Fixed Q waves ST depression 0.05 to 0.1mV or T-wave inversion >0.1mV	T-wave flattening or inversion <0.1mV in leads with dominant R waves or normal ECG
Cardiac markers	Elevated cardiac TnI, TnT, or CK-MB	Normal	Normal

AHA, American Heart Association, *ACC*, American College of Cardiology; *ACEP,* American College of Emergency Physicians; *ACS,* acute coronary syndrome; *CAD*, coronary artery disease; *ECG,* electrocardiogram; *CK-MB*, MB fraction of creatine kinase; *MI*, myocardial infarction; *MR*, mitral regurgitation; *TnI*, troponin; *TnT*, troponin T
Reproduced from Anderson et al.[12]

Our measures were the point-of-care ACS risk assessment by the EP, AHA/ACC/ACEP guidelines score, and the patient's final diagnosis (scored as either ACS or no ACS).

Data Analysis

We abstracted data for the study using double data entry for error checking. All charts were adjudicated by two EM resident physicians, using all available clinical data according to previously published AHA/ACC/ACEP guidelines to classify patients with regard to ACS diagnosis. In cases where the adjudication and diagnosis assigned by the treating physician were discordant, the medical records were reviewed by a panel comprised of a board-certified cardiologist and two board-certified EPs for consensus.

Electronic chart review included analysis of ED notes, index visit and hospital revisits, and cardiac test results including ECG, exercise stress test, pharmacologic stress test, myocardial perfusion and cardiac catheterization.

A diagnosis of ACS was noted if cardiac biomarkers were elevated due to myocardial injury (typical rise and fall of serial cardiac biomarkers), an ischemic defect was found by myocardial perfusion, a new or more narrowed stenosis of the coronary arteries was found upon catheterization per the cardiologist's official report, revascularization was indicated, or if a diagnosis of ACS was documented in the patient's discharge instructions.

Patient follow up at 48 hours included a phone call and review of inpatient charts. At 30 days the enrolled patient received up to three phone calls to connect with patient or caregiver. In addition, we reviewed all medical records through 30 days to identify any hospital revisits, significant cardiac events, and diagnostic cardiac testing.

RESULTS

We identified 701 patients treated by 21 EPs who were eligible for the study. Sixty patients did not have an assessment of risk completed by the treating physician, leaving 641 patients in the study cohort. Overall, there was little concordance between the EP's unstructured assessment used in clinical practice and the guidelines put forth by the AHA/ACC/ACEP task force. Physicians were more likely to assess a patient at low risk than the task force guidelines (40% vs 9%). While AHA/ACC/ACEP guidelines were more likely to classify patients as intermediate (45%) or high (45%) risk. Table 2 demonstrates the risk stratification of all 641 patients by AHA/ACC/ACEP guidelines and physician assessment. A comparison between the patient's final ACS diagnosis and the relation to risk assessment value is provided in Table 3.

When considering the patient's ACS diagnosis and its relation to the risk assessment value (Table 3), AHA/ACC/

Table 2. AHA/ACC/ACEP guidelines versus emergency physician (EP) risk stratification for ACS.

Total N=641	Low	Intermediate	High
AHA/ACC/ACEP	57 (9%)	290 (45%)	294 (45%)
EP	257 (40%)	265 (41%)	119 (19%)

AHA, American Heart Association; *ACC*, American College of Cardiology; *ACEP*, American College of Emergency Physicians; *ACS*, Acute Coronary Syndrome

ACEP guidelines proved better at identifying low-risk patients who did not have ACS (only 2% had ACS vs. 8% for EPs), while EPs proved better predictors of high-risk patients who in fact had ACS (68% had no ACS vs 87% for AHA/ACC/ACEP guidelines). Of all enrolled patients, 119 (17%) were determined by the EP to be at high risk for ACS; 38 (32%) of the 119 high-risk patients were diagnosed with ACS. The AHA/ACC/ACEP guidelines classified 294 (45%) patients high risk, with 74 (25%) of those patients diagnosed with ACS. AHA/ACC/ACEP guidelines classified only 57 (9%) patients low risk, with 56 (98%) of those patients diagnosed with no ACS. In contrast, physicians classified 257 (40%) of the sample as low risk for ACS, of whom 20 (8%) actually had ACS. Chi-square test of independence identified a difference in physician and AHA/ACC/ACEP scores, and their relation to ACS diagnosis ($p \leq 0.05$). Graphical representation of the physician risk assessment and guideline classification stratified by final diagnosis is shown in Figure 1. The receiver operating characteristic curves showing the performance for either the EP clinical impression or the AHA/ACC/ACEP scores for identifying patients with underlying ACS are shown in Figure 2.

Within 48 hours, 67% of patients discharged to home received follow-up phone calls. At 30 days, follow up on 86% of patients was obtained by phone, EMR check for return visits, contacting PMD (if known), or mail.

DISCUSSION

The prevalence of patients presenting to the ED with chest pain of cardiac origin results in many non-cardiovascular specialists evaluating and managing this patient population. Although the majority of patients presenting to the ED with chest pain do not have a life-threatening condition, the EP needs to efficiently and accurately differentiate between those patients requiring urgent treatment and those who will not warrant hospital admission.[13] AHA/ACC/ACEP guidelines may prove worthwhile for use in a primary care setting, but our study reveals these guidelines may not be as valuable a tool for use in the ED.

Our study shows that in the ED, physicians are more adept at correctly placing patients with underlying ACS into a high-risk category. AHA/ACC/ACEP guidelines place a greater number of patients into the high-risk category than physicians (294 (45%) vs 119 (19%)), but fewer of these patients have underlying ACS (25% vs 32%). Furthermore, only a small percentage of patients (57/641 (9%)) were

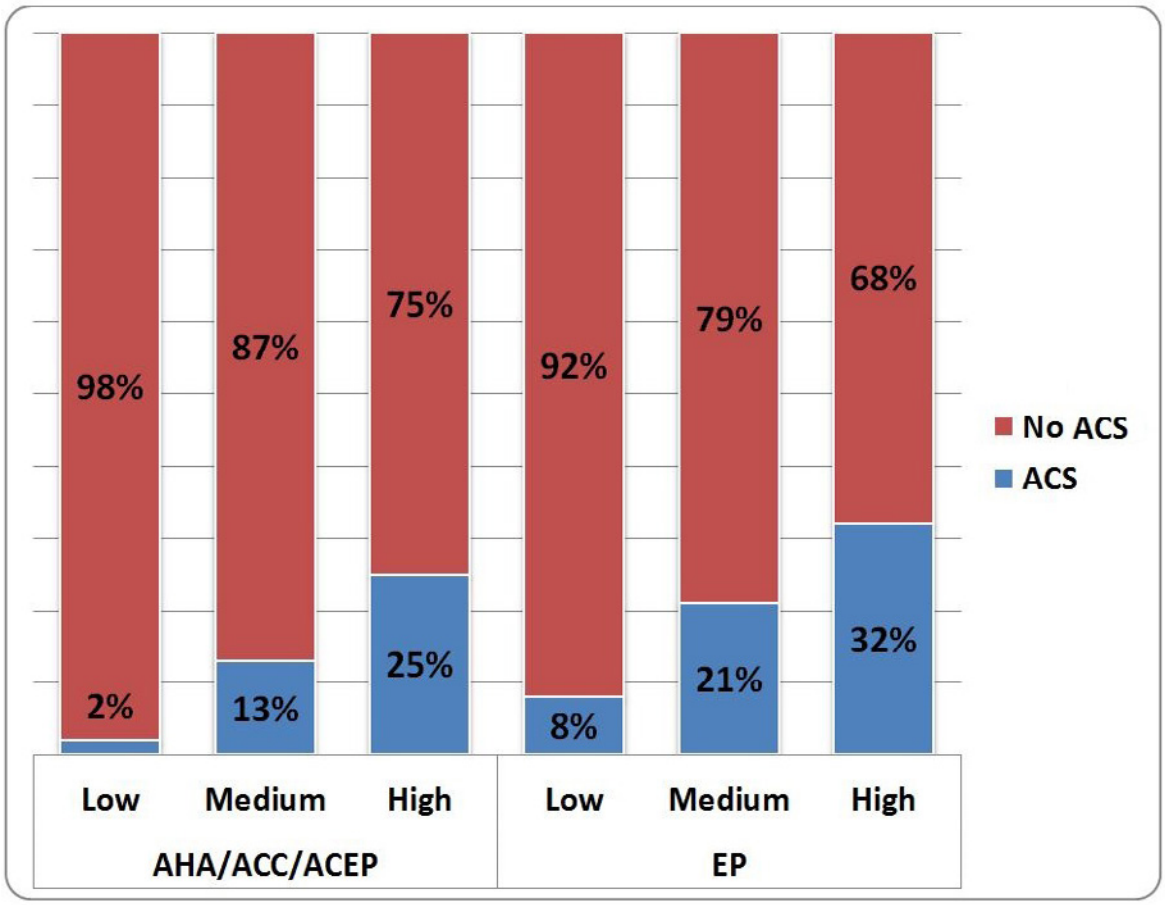

Figure 1. Patient's risk assessment value versus final ACS diagnosis.
AHA, American Heart Association; *ACC*, American College of Cardiology; *ACEP*, American College of Emergency Physicians; *ACS*, Acute Coronary Syndrome; *EP*, emergency physicians

Table 3. Comparison of ACS positive diagnosis by EP and AHA/ACC/ACEP guidelines.

	EP			
	Low	Medium	High	Total
AHA/ACC/ACEP				
Low	0	1	0	1/57
Medium	13	23	2	38/290
High	7	31	36	74/294
Total	20/257	55/265	38/119	-

AHA, American Heart Association; *ACC*, American College of Cardiology; *ACEP*, American College of Emergency Physicians; *ACS*, acute coronary syndrome; *EP*, emergency physicians

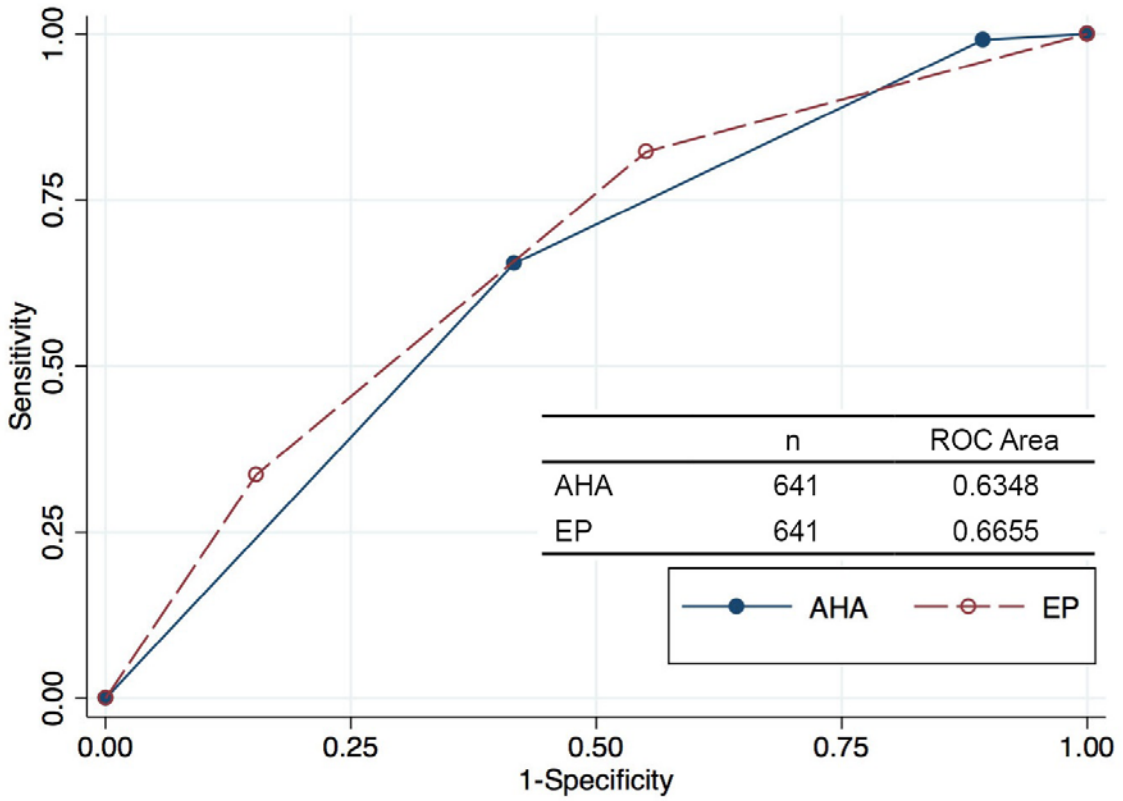

Figure 2. Receiver operating characteristic curve comparing AHA/ACC/ACEP to emergency physician risk stratification. *AHA*, American Heart Association; *ACC*, American College of Cardiology; *ACEP*, American College of Emergency Physicians; *EP*, emergency physicians; *ROC*, receiver operating characteristic

assessed as low risk by task force guidelines. The task force guidelines' predilection to assess patients as low risk may be useful in primary care where the clinical decision is whether a patient should undergo further cardiac testing. However, in the ED the decision point is not whether a patient should undergo cardiac testing, but if that testing should be done as an inpatient or outpatient. In the primary care setting, it is more useful to have a broader net since the consequence of a missed diagnosis of ACS would be an undiagnosed cardiac condition. In our cohort, all patients had serial cardiac biomarkers to assess for an acute ischemic event (unstable angina would still be ACS with negative biomarkers). Misclassification of a patient with underlying ACS into a low-risk category would be the difference between inpatient and outpatient cardiac testing. In either case, cardiac testing is recommended at time of disposition. In contrast, the use of AHA/ACC/ACEP guidelines to guide clinical decision-making would have quadrupled the use of inpatient hospital resources at our institution. A plausible explanation for this observed trend is that AHA/ACC/ACEP guidelines require only one criterion to be met for a patient to be grouped into a higher risk assessment category, whereas the physician considers multiple factors when assessing a patient for ACS. AHA/ACC/ACEP guidelines were developed for a national population that is approximately 72% Caucasian; in the urban teaching hospital where this study was conducted, our

study population was far more racially diverse with 40% Black, 30% White, 24% Hispanic, and 6% Asian. This may have contributed to a difference in application of guidelines in the study population.

The impact of clinical insight when assessing cardiac risk is demonstrated by the comparison between EP and AHA/ACC/ACEP guidelines and ACS final diagnosis. The results show that EPs correctly assigned 7% more patients with ACS to the appropriate high-risk category than the AHA/ACC/ACEP guidelines. The AHA/ACC/ACEP guideline correctly assigned 6% more patients without ACS to the appropriate low-risk category (Table 3).

As ED crowding continues to be an obstacle for hospitals and EPs, it is crucial to develop a better method to evaluate chest pain patients. If the AHA/ACC/ACEP guidelines are the criterion reference for risk stratifying a patient with chest pain in the ED, the possibility of further hampering patient flow needs to be considered.

LIMITATIONS

Our study has a few notable limitations. First, the study took place at one clinical center. This limits the ability to generalize findings to other clinical centers as they may have different staffing, patient demographics, and technology/instruments available for use. As an urban teaching hospital, our study may show different trends than rural or non-teaching facilities.

We made attempts to conduct 48-hour and 30-day follow up of all patients by chart review, and three attempts were made by phone. Through these methods of follow up we were not able to account for patients who sought care at another hospital, provided an incorrect phone number, or whom we were unable to reach.

A final limitation to our study was the lack of verification that the diagnosis of ACS was a primary event. This information could skew data, as patients who have had more than one event are likely to present differently than someone experiencing chest pain for the first time, and this presentation would likely influence a physician's ACS risk assessment.

CONCLUSION

In the ED, more so than anywhere else in medicine, the need to efficiently and accurately diagnose a patient comes into direct conflict with limitations on time, space, and resources. Our study suggests that physicians were more efficient at placing patients with underlying ACS correctly into a high-risk category. At the lower end of the scale, clinicians using an unstructured risk assessment translated this efficiency into a much broader group classified as low risk than would have been recommended by existing AHA/ACC/ACEP guidelines. Although the guidelines would have classified just one patient with underlying ACS as low risk in this cohort, it would have done so at the cost of a four-fold increase in the number of patients requiring more ED and hospital resources. The guidelines meant to inform clinicians when evaluating patients with suspected ACS may be overly conservative when applied to the ED in an era of crowding.

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Interposed Abdominal Compression CPR for an Out-of-Hospital Cardiac Arrest Victim Failing Traditional CPR

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Interposed abdominal compression cardiopulmonary resuscitation (IAC-CPR) is an alternative technique to traditional cardiopulmonary resuscitation (CPR) that can improve perfusion and lead to restoration of circulation in patients with chest wall deformity either acquired through vigorous CPR or co-morbidity such as chronic obstructive pulmonary disease. We report a case of out-of-hospital cardiac arrest where IAC-CPR allowed for restoration of spontaneous circulation and eventual full neurologic recovery when traditional CPR was failing to generate adequate pulses with chest compression alone. [West J Emerg Med. 2015;16(5):690-692.]

CASE REPORT

While chest compression cardiopulmonary resuscitation (CPR) is the primary resuscitation technique, it is not the only technique that can be applied, and in some cases it may fail to provide adequate perfusion pressure to restore circulation. We report on the use of interposed abdominal compression CPR (IAC-CPR) in an out-of-hospital cardiac arrest victim.

A 79-year-old female with history of chronic obstructive pulmonary disease (COPD), chronic renal failure, dialysis dependence, diabetes mellitus, and hypertension who was being treated for a respiratory infection with Levaquin for one day, awoke in the early morning with an ill feeling. A few minutes later she had a witnessed cardiac arrest, emergency medical services (EMS) was immediately notified, and bystander CPR was initiated. Upon paramedic arrival, she had an agonal rhythm and was pulseless. Paramedics initiated advanced cardiac life support, while standard CPR was continued. She was intubated, given two rounds of epinephrine, and transported to the emergency department (ED). Upon arrival after more than 20 minutes from her arrest, her rhythm was asystole, she remained apneic, and pupils were equal and reactive. The position of her endotracheal tube, placed in the pre-hospital setting, was confirmed and an orogastric tube was passed, with suction applied. She had a right anterior-chest dialysis catheter, which was used to deliver two ampules of 8.4% $NaHCO_3$, two ampules of CaCl, and 40 units of vasopressin. There were no interruptions of the chest compressions from EMS handoff or during procedures. During the secondary assessment it was noted that the pulsations with chest compression were nearly undetectable despite what appeared to be adequate compression depth and rate. The intermittent pulse checks that occurred over the ensuing nine minutes were with pulseless electrical activity. The physician took over chest compressions and noted the severe chest wall deformity and lack of chest-recoil. Following that discovery, we initiated IAC-CPR, and her pulses with chest compression significantly improved. The rate of abdominal compression was matched 1:1 to chest compressions at about 100 chest compressions per minute. Her rhythm changed to ventricular fibrillation, and she underwent defibrillation with 200J (biphasic), with restoration of spontaneous circulation at 16 minutes after ED arrival. Her neurologic assessment remained unresponsive but with equal reactive pupils. Her electrocardiogram was interpreted as sinus rhythm with a ventricular rate of 56, right bundle branch block, without any ST-segment elevations. Chest radiograph demonstrated good position of supportive devices and bilateral lower lobe infiltrates were noted.

Initial laboratory studies revealed normal potassium, elevated troponin I (6.63), creatinine 4.2, and arterial blood gas demonstrated pH 7.24, pCO_2 42, pO_2 111, HCO_3 18, 94% saturation, and base excess of -9. A bedside limited

echocardiography revealed global hypokinesis and absence of a pericardial effusion. She was hypotensive, treated with norepinephrine, and placed on a continuous bicarbonate infusion. Empiric intravenous antibiotics were given.

She was admitted to the intensive care unit. Later that morning, she underwent stenting of a subtotal occlusion of the proximal left anterior descending artery. The following day the patient was responsive and was extubated on hospital day two, with complete neurologic recovery with complaints of chest discomfort but no abdominal pain.

DISCUSSION

Most emergency physicians are unfamiliar with IAC-CPR even though it was described in previous editions of Roberts and Hedges Clinical Procedures in Emergency Medicine. In this case, standard chest compression CPR alone was not effective, and without changing our strategy the patient would not have likely achieved adequate perfusion to allow restoration of spontaneous circulation. Viewing the chest wall integrity as dynamic and changing during resuscitation efforts, assessment of the adequacy of pulses and other markers of perfusion were key to determining that alternative resuscitation strategies were necessary.

This technique requires three providers, one to provide bag-valve mask respirations, one for the chest wall and another for the abdomen. The synchronization of the abdominal compressions is challenging but merely requires a counter pulsation for every chest compression with a slightly caudal and deep compression at the mid-abdomen 5cm above the umbilicus. The International Liaison Committee on Resuscitation (ILCOR) supports the use of IAC-CPR in hospital when sufficiently trained personnel are available.[1] Our case differs from published recommendations since there are no studies of using this technique as a rescue strategy from failed traditional methods.

There are many possible mechanisms that may explain the efficacy of IAC-CPR. Sack et al.[2] offered two of these mechanisms. The first postulates that by compressing the abdominal aorta, the aortic diastolic blood pressure is improved, and this may lead to retrograde flow to the coronary arteries and brain. The second involves "priming of the thoracic pump," which states that global increases in intrathoracic pressure are equally transmitted to the heart, lung, and pulmonary vessels, such that the intrathoracic blood pool is advanced with each compression.[3] Lastly, by compressing the abdomen, we are likely increasing venous return and improving stroke volumes.[4] Ultimately, this technique is aimed at improving coronary perfusion pressure (CPP), which has been demonstrated to be essential to establish return of spontaneous circulation (ROSC) when either maximal CPP>15mmHg or peak diastolic CPP>12mmHg is achieved.[5-7]

IAC-CPR has been shown in animal models and human clinical studies to increase several hemodynamic factors and improve survival outcomes. In canine and porcine models, it has been shown to increase cerebral perfusion,[8-9] cardiac output,[8,10] carotid artery perfusion,[11-12] coronary artery perfusion pressure,[11,13] systolic and diastolic arterial pressure,[10,13] and oxygen delivery.[8] In human studies, it has been demonstrated to increase cardiac output,[4,14-15] systolic and diastolic arterial pressures,[14-15] and to improve clinical outcomes such as ROSC,[2,16-17] 24-hour survival,[2,16] survival to discharge,[2,17] and six-month survival.[17] The studies demonstrating improved clinical outcomes involved in-hospital cardiac arrest, in contrast to outcomes involved with out-of-hospital cardiac arrest, which were not significantly changed by this method. McDonald[18] found no increase in systolic arterial pressure, and Mateer et al.,[19] found no change in survival outcome. Sack[20] postulated that this may be due to decreased vascular tone associated with prolonged cardiac arrest.

A previously stated concern with the addition of abdominal compressions during CPR is abdominal organ injury. IAC-CPR has been shown through several clinical studies not to cause any major abdominal injury.[2,4,14-17,19] However, it is worth noting that there are inherent limitations with diagnosing an abdominal injury after IAC-CPR. In these clinical studies, only a small percentage of the deceased patients underwent an autopsy, and in the surviving patients without abdominal symptoms, an evaluation of potential acute injury was often not undertaken. There may be increased risk of aspiration, which could be mitigated by intubation and orogastric tube placement.

This technique is by no means novel and as Sack suggested, "it is an evolution, not a revolution" in the treatment of cardiac arrest.[20] This technique may be of particular benefit in patients who have abnormal chest wall mechanics, either through co-morbidity such as COPD or through the acquired chest wall deformity associated with prolonged compressions. Clinical consideration of the dynamic changes in chest wall movement may be beneficial during the course of resuscitation to consider modifying strategies of resuscitation. In this case one would expect the change in compliance of the chest wall would afford a more direct compression of the heart, improving systolic function; however, the poor diastolic response likely muted any benefit.

Since 2005, ILCOR has stressed improved quality and rate of chest compressions; and despite a 2003 meta-analysis demonstrating improved ROSC for IAC-CPR,[21] there have been no large follow-up studies comparing these techniques. Ultimately the question may not be whether IAC-CPR should replace traditional CPR but rather that knowledge and practice of this technique may improve outcomes in concert with traditional methods. We need improved measures of perfusion during CPR to inform us when alternative techniques may actually improve physiological thresholds that can restore spontaneous circulation or support using external bypass devices.

Chest recoil is important regardless of the resuscitative

technique. Sometimes a clinician is faced with circumstances that the literature has not addressed, such as how to resuscitate a person with no chest recoil. In those instances, having knowledge of alternative techniques may suffice to achieve the desired outcome. We feel this case illustrates a technique worth remembering.

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Injuries Following Segway Personal Transporter Accidents: Case Report and Review of the Literature

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The Segway® self-balancing personal transporter has been used as a means of transport for sightseeing tourists, military, police and emergency medical personnel. Only recently have reports been published about serious injuries that have been sustained while operating this device. This case describes a 67-year-old male who sustained an oblique fracture of the shaft of the femur while using the Segway® for transportation around his community. We also present a review of the literature. [West J Emerg Med. 2015;16(5):693-695.]

INTRODUCTION

In 2001, Dean Kamen developed a self-balancing, zero emissions personal transportation vehicle, known as the Segway® Personal Transporter (PT).[1] The Segway's® top speed is 12.5mph and was deemed safe for operation on urban pedestrian areas by the Centre for Electric Vehicle Experimentation in Quebec in 2006.[1,2] However, several reports have been published that showed serious injuries to the "gliders" who operate these devices.[3-6] This report adds to the growing literature of serious injury associated with the Segway® Personal Transporter.

CASE REPORT

A 67-year-old male presented to the emergency department with right leg pain after a fall from his Segway®. The patient reported that he used the personal transporter as his main means of transportation around the community and that evening had several alcoholic drinks and attempted to drive home. En route, he subsequently fell from the Segway® and injured his right leg. Past medical history was significant for diabetes and coronary artery disease.

Physical exam revealed a temperature of 36.6, pulse of 72 beats per minute, respirations of 14 and a blood pressure of 176/94mmHg. The patient's Glasgow coma scale was 15 and he did not appear to have an alcohol smell on his breath. The only outward signs of trauma were located on his right lower extremity. A gross deformity was noted over the mid thigh with the entire lower extremity held in flexion and external rotation. Peripheral pulses were present in the extremity and no parasthesia was noted.

Radiograph of the right femur demonstrated an oblique fracture of the proximal shaft of the femur with severe displacement and angulation (Figure). Alcohol level was 0.024% and the remainder of the trauma studies were negative. The patient was subsequently admitted to the trauma service and underwent operative fixation the next day. He was discharged to a rehab facility five days post injury.

DISCUSSION

The U.S. Consumer Product Safety Commission is tasked in the United States with compiling data in the National Electronic Injury Surveillance System on injuries related to consumer products. Despite two separate recalls issued by the commission on the Segway® Personal Transporter, only 33 injuries were noted in the National Electronic Injury Surveillance System (NEISS) cases when searched with the key term "Segway"® from the year 2009 to 2013.[7] Few injuries were identified because the National Electronic Injury Surveillance System does not have a specific code for this means of transportation but includes it with Scooters/Skateboards-powered under the code 5042.

When compared to published data from case reports and case series, none of the NEISS match the published literature. Most likely, the scarcity of literature is related to the under-reporting of the true number of accidents while using personal transporters. This is evidenced by the lack of an International Classification of Diseases 10 code as well as only a handful of reported cases.

After a review of Medline, we found four separate

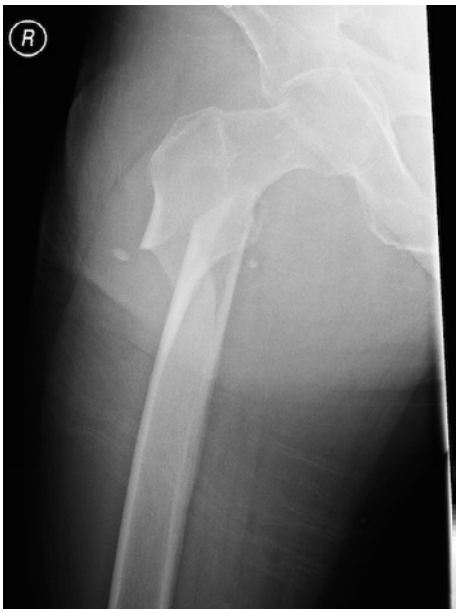

Figure. Oblique fracture of the proximal shaft of the femur with severe displacement and angulation.

publications that noted significant injuries in relation to the Segway® Personal Transporter (Table 1). Of those reviewed, 16 patients required hospital admission due to significant traumatic injuries and seven were placed in an intensive care setting. Further examination showed that much like our patient, 81% of patients had a fracture with 38% occurring in the lower extremity. Although fractures are common, this classically differs from skateboard and scooter injuries in which the majority occur in the upper extremity.

More alarmingly, however, is the age of those sustaining injuries. Based upon reported data in the literature and from the NEISS, the average age of those injured is 46.07 years old (Table 2) on a personal transporter. Also, 44% of those reported injuries on personal transporters had significant head trauma that required an intensive care admission. It is difficult to ascertain the reason for this trend but could be related to personal transporters being used more by tourists as compared to other modes of transportation.

No deaths caused by Segway® use could be found in the published medical literature or within the NEISS over the time

Table 1. Compiled data from all published reports on traumatic Segway® injuries requiring admission (n=16).

Age	Injuries	Admission
72	Multiple brain contusions, radial head fracture, subarachnoid hemorrhage, subdural hematoma, comminuted nasal bone fracture, mandibular fracture	ICU
57	Subarachnoid hemorrhage	ICU
61	Elbow laceration, pneumothorax, rib fracture	
40	Comminuted intra-articular fracture of the tibial plateau with impaction, comminuted intra-articular fracture of the proximal fibula, partial tear of the Achilles tendon.	
62	Comminuted fracture of the proximal humerus, inferiorly displaced comminuted fracture of the right orbital floor, displaced comminuted fracture of the anterior medial and lateral maxillary sinus walls, subarachnoid hemorrhage	ICU
52	Closed head injury without loss of consciousness	ICU
25	Trimalleolar fracture	
45	Displaced fractures of the superior pubic ramus and inferior pubic ramus	
33	Non-displaced fracture of the anterior column of the left acetabulum, non-displaced fracture of the left inferior pubic ramus	
73	Mandibular fractures, comminuted and displaced fractures of the anterolateral and posterolateral walls of the left maxillary sinus, displaced fracture of the zygomatic arch, fracture of the left orbital floor, comminuted fracture of the lateral wall of the left orbit, angulated fracture of the left nasal bone, fracture of the lateral pterygoid plate.	
73	Comminuted transverse fracture of the left anterior column of the acetabular cup with femoral head displacement	
59	Femoral neck fracture	
58	Right pneumothorax, second, third and eighth rib fracture, right pulmonary contusion, right acetabular fracture, respiratory failure	ICU
55	Open distal fibula fracture	
57	Subarachnoid hemorrhage, Intraparenchymal contusion	ICU
55	Respiratory failure, right subdural hematoma, and basilar skull fracture	ICU

ICU, intensive care unit

Table 2. Compiled data from the National Electronic Injury Surveillance System on all Segway® injuries from 2009 through 2013. (n=33).

Age	Diagnosis
72	Tib/fib fracture
12	Fractured elbow
56	Right shoulder contusion
62	Left shoulder sprain
51	Intertrochanteric hip fracture
74	Abrasions
35	Humeral fracture
59	Fibular fracture
48	Wrist fracture
56	Pubic ramus fracture
12	Concussion
20	Abrasions
87	Nasal fracture
61	Radial head fracture, wrist fracture
45	Shoulder fracture
65	Leg hematoma
61	Closed head injury
13	Neck pain
86	Sprained knee
55	Sprained ankle
56	Fibular fracture
37	Lip laceration
59	Hand fracture
67	Wrist fracture
55	Elbow fracture
54	Hand laceration
22	Knee abrasions
43	Laceration
46	Back contusion
63	Ankle fracture
56	Facial laceration
86	Concussion
75	Abrasions

period selected. Ironically, however, a subsequent owner of the Segway® company perished after his personal transporter rolled off a 30-foot cliff and into the water in the United Kingdom.[8]

CONCLUSION

Based upon a literature review, injuries from the Segway® Personal Transporter are likely under-reported but those that are reported are significant in nature. Emergency physicians and the Consumer Product Safety Commission should continue to monitor the number of injuries that present in the United States, and further studies regarding the personal transporter's safety should be undertaken.

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Invasive Mechanical Ventilation in California Over 2000-2009: Implications for Emergency Medicine

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Introduction: Patients who require invasive mechanical ventilation (IMV) often represent a sequence of care between the emergency department (ED) and intensive care unit (ICU). Despite being the most populous state, little information exists to define patterns of IMV use within the state of California.

Methods: We examined data from the masked Patient Discharge Database of California's Office of Statewide Health Planning and Development from 2000-2009. Adult patients who received IMV during their stay were identified using the International Classification of Diseases 9th Revision and Clinical Modification procedure codes (96.70, 96.71, 96.72). Patients were divided into age strata (18-34yr, 35-64yr, and >65yr). Using descriptive statistics and regression analyses, for IMV discharges during the study period, we quantified the number of ED vs. non-ED based admissions; changes in patient characteristics and clinical outcome; evaluated the marginal costs for IMV; determined predictors for prolonged acute mechanical ventilation (PAMV, i.e. IMV>96hr); and projected the number of IMV discharges and ED-based admissions by year 2020.

Results: There were 696,634 IMV discharges available for analysis. From 2000–2009, IMV discharges increased by 2.8%/year: n=60,933 (293/100,000 persons) in 2000 to n=79,868 (328/100,000 persons) in 2009. While ED-based admissions grew by 3.8%/year, non-ED-based admissions remained stable (0%). During 2000-2009, fastest growth was noted for 1) the 35–64 year age strata; 2) Hispanics; 3) patients with non-Medicare public insurance; and 4) patients requiring PAMV. Average total patient cost-adjusted charges per hospital discharge increased by 29% from 2000 (from $42,528 to $60,215 in 2014 dollars) along with increases in the number of patients discharged to home and skilled nursing facilities. Higher marginal costs were noted for younger patients (ages 18-34yr), non-whites, and publicly insured patients. Some of the strongest predictors for PAMV were age 35-64 years (OR=1.12; 95% CI [1.09-1.14], p<0.05); non-Whites; and non-Medicare public insurance. Our models suggest that by 2020, IMV discharges will grow to n=153,153 (377 IMV discharges/100,000 persons) with 99,095 admitted through the ED.

Conclusion: Based on sustained growth over the past decade, by the year 2020, we project a further increase to 153,153 IMV discharges with 99,095 admitted through the ED. Given limited ICU bed capacities, ongoing increases in the number and type of IMV patients have the potential to adversely affect California EDs that often admit patients to ICUs. [West J Emerg Med. 2015;16(5):696-706.]

INTRODUCTION

Management of patients requiring invasive mechanical ventilation (IMV) often represents a sequence of care starting with the pre-hospital period, extending to emergency department (ED) management and peaking with intensive care unit (ICU) admission and treatment i.e., the "critical care cascade."[1] For patients who require IMV, initial presentation to ED may involve medical stabilization with a trial of non-IMV.[2] The patient who fails initial management may then require emergent intubation, mechanical ventilation, and eventual transfer to the ICU.[2] Studies have already documented an increase in ICU admissions from the ED over the past decade on a national level.[3,4]

For the estimated 800,000 adult patients who require IMV annually in the United States (U.S.), acute respiratory failure remains one of the most common indications.[5] Increasing age, the presence of co-morbidities (i.e., chronic obstructive pulmonary disease, congestive heart failure, asthma), and acuity of illness are all independent predictors of the need for IMV in patients with acute respiratory failure.[6,7] Although IMV can be a life-saving intervention, it is associated with major costs estimated at $27 billion annually in the U.S. alone.[5] Aggravating this problem is the fact that while patients who require prolonged acute mechanical ventilation (PAMV; defined as IMV≥96 hr) make up less than 10% of the adult IMV patient population, they can account for two-thirds of all annual hospital costs associated with IMV.[5,8] The incidence, duration, and costs associated with IMV in the U.S. are only expected to increase substantially over the next several decades as the U.S. population ages and the co-morbidity burden of patients with acute respiratory failure rises.[5,9-11]

Despite being the most populous state (38 million) in the nation little information exists to define patterns of IMV use within the state of California.[12,13] California employs substantial data documenting capabilities allowing for analysis of state-level variation in healthcare. Furthermore, with data already indicating an increasing utilization of critical care services within California EDs for the past decade, population-based analyses of IMV usage within the state may be useful to identify future policy priorities.[14] The objectives of this study were to 1) identify the number of ED vs. non-ED based admissions, demographic patterns, outcomes, and marginal costs of patients who underwent IMV; 2) determine risk factors for prolonged IMV; and 3) predict future IMV usage in the state of California.

METHODS

Study Design And Principal Data Source

Given this study is an analysis of publicly available data and de-identified data are used, the study was deemed exempt by our university-affiliated institutional review board. We examined retrospective data from the masked Patient Discharge Database (PDD) obtained from California's Office of Statewide Health Planning and Development (OSHPD) for the period 2000-2009. For the past three decades, OSHPD has mandated that all California hospitals collect and report detailed information on all patients whose hospital stay is >1 day. The masked PDD contains information on all patient discharges from non-federal, acute-care hospitals, with standardized, random masking of key demographic variables to prevent linkages of patients across discharges. For example, across the age strata used within our sample, OSHPD masks data at the same frequency, i.e. 6-8%.

For this analysis, we used PDD variables from the following categories: OSHPD-hospital identification number; the county and zip code of each hospital; year of admission; patients' age in years upon admission; admission source; gender; race/ethnicity; expected principal source of payment (i.e., plan code number); principal procedure code fields (including the principal procedure, and up to 24 additional procedures); hospital charges and discharge disposition (i.e., for both medical and surgical patients to home, skilled nursing facility, etc). OSHPD closely monitors the quality of its data reporting with low levels (<0.1%) of missing data for the variables used for this study. In addition, data extracts are released yearly only after screening by automated reporting software and correction by individual facilities. OSHPD's data standardization has enabled population level and hospital quality of care analyses such as system-level health disparities in California EDs.[15,16]

Study Population

After identifying discharges with hospital stay >1 day from 2000-2009, our initial sample consisted of 39,537,980 patient discharges (Figure 1). Our objective was to identify only those patients who underwent IMV at any point during their hospital stay for the study period. To accomplish this, we initially screened all patients with the International Classification of Diseases 9th Revision and Clinical Modification (ICD-9-CM) procedure codes 96.70 (mechanical ventilation, unspecified), 96.71 (mechanical ventilation for <96 hours), or 96.72 (mechanical ventilation for ≥96 hours) in their discharge records, resulting in an initial sample of 1,067,585 discharges. Professional coders, not physicians, create the ICD-9 codes; audits have shown these data to be very accurate.[17] We then excluded records with age<18, masked age, gender, insurance type, or unspecified duration of mechanical ventilation (n=3,740), leaving us with a final sample of n=696,634 discharges for analysis.

Data Collection

Patients were initially divided into three broad age strata based upon their age at the time of admission: 18-34yr, 35-64yr, and ≥65yr. We identified the number of IMV patients who were admitted through the ED. Patients were classified by gender (male vs. female), and race/ethnicity (White, Hispanic, Black, Asian, other, or unknown). Insurance was categorized as public (Medicare vs. non-Medicare public:

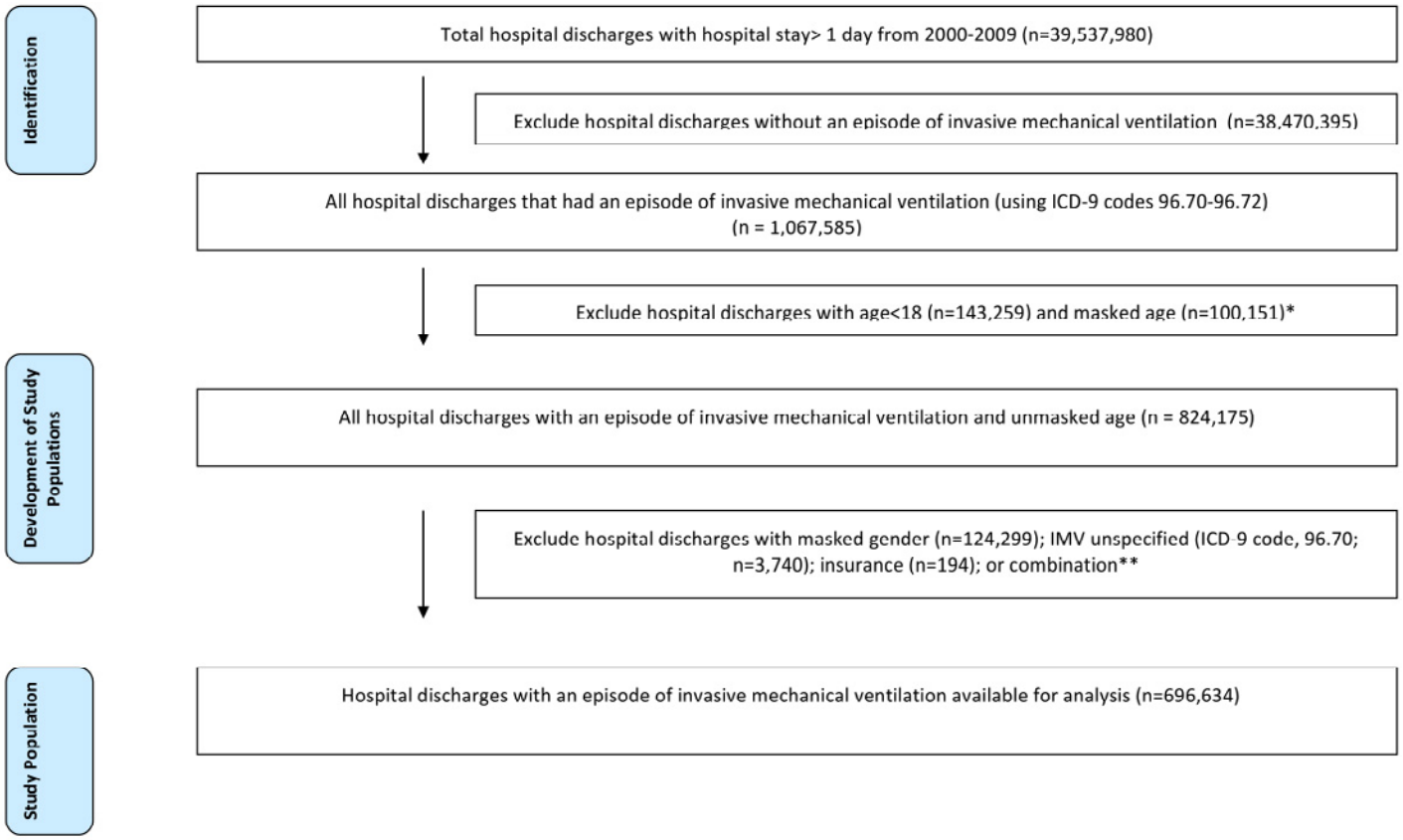

Figure 1. Selection of study population.
IMV, invasive mechanical ventilation; *ICD-9,* International Classification of Diseases 9th Revision
*Number of IMV unspecified discharges (n=569).
**Some patients with IMV unspecified (ICD-9 code:96.70) also had missing gender or some combination of those three variables (IMV time, gender, and insurance).

Medi-Cal [California's Medicaid program], county indigent programs), private, or other (worker's compensation, self-pay, and other payer). To account for differences in the distribution of patients' co-morbidities, we constructed a Charlson illness severity index (using the Charlson-Deyo-Quan method) for each patient using all discharge diagnosis codes.[18] We aggregated patients' illness severity scores into levels (0 to 3+) on the basis of sample distribution; higher scores represented a greater severity of illness. To identify surgical admissions, principal procedure codes for each discharge were merged with Healthcare Cost and Utilization Project (HCUP) identifiers to distinguish surgical procedures.[19] HCUP classifies ICD-9 procedure codes as minor diagnostic, minor therapeutic, major diagnostic, and major therapeutic; major diagnostic and therapeutic codes refer to procedures routinely conducted in the OR. Major diagnostic and therapeutic ICD-9 codes were selected to identify operating room surgical procedures. For the set of patients who were not admitted through the ED, we quantified the number of surgical vs. medical patients.

Hospitals were classified by urban vs. rural geographic location using rural-urban commuting area (RUCA) code linked to each hospital's zip code. The RUCA codes use data from U.S. census tracts on measures of population density, urbanization, and daily commuting to classify zip codes. We used the most recent RUCA codes (2006 ZIP Version 2.0 last updated 11/13/07), based on 2000 US Census data. We used the following codes: Urban: 1.0, 1.1, 2.0, 2.1, 3.0, 4.1, 5.1, 7.1, 8.1, 10.1; Rural: 4.0, 4.2, 5.0, 5.2, 6.0, 6.1, 7.0, 7.2, 7.3, 7.4, 8.0, 8.2, 8.3, 8.4, 9.0, 9.1, 9.2, 10.0, 10.2, 10.3, 10.4, 10.5, 10.6.

Outcomes

Outcomes of interest included death, discharge status (home, acute care hospital, other care hospital, or skilled nursing facility), lengths of stay and total hospital costs. We estimated total costs by adjusting hospital charges using available cost-to-charge ratios from Centers for Medicaid and Medicare Impact files. All costs were also adjusted to 2014 dollars using the Consumer Price Index and to reflect stays more than one year in length.

Statistical Analyses

For years 2000-2009, we used data collected by the California Department of Finance to calculate a California

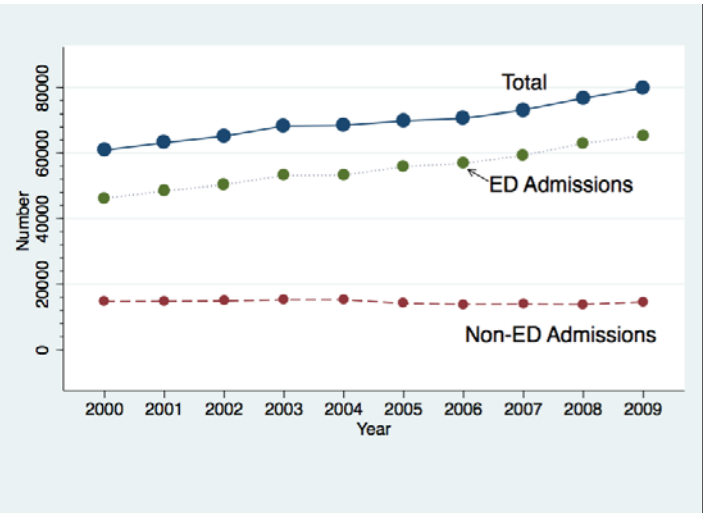

Figure 2. Invasive mechanical ventilation (IMV) discharges in California from 2000–2009.
ED, emergency department

population growth rate relative to all hospitalizations in the population from 2009. This value was then applied to counts of discharges in year 2000.

We aggregated patient and hospital characteristics, and clinical outcomes using descriptive statistics and t-tests, analysis of variance, or chi square tests as appropriate. Initial comparisons for patient characteristics were also based on unadjusted logistic regressions. First, we conducted an ordinary least squares linear regression analysis with robust standard errors to evaluate marginal costs for IMV. Marginal costs for IMV are defined as the average incremental cost of mechanical ventilation per discharge. All independent factors were used for model development and were forced into the model: age strata, gender, race/ethnicity, insurance, co-morbidity burden, surgery, and hospital geographic location. Second, we conducted a multivariate logistic regression analysis that predicted PAMV (i.e. IMV≥96 hr) using the same independent factors included in our marginal cost model. Third, based on average growth rates of IMV from 2000-2009, we projected rates of IMV discharges and ED-based admissions for the year 2020 using linear regression. A p-value≤0.05 was considered statistically significant (two-sided tests). We used SAS software, version 9.2 (SAS Institute Inc., Cary, NC) for the statistical analyses and Stata 12.1 (Stata Corporation, College Station, TX, USA) for figures.

RESULTS

Demographic Patterns And Outcomes Of IMV

From 2000-2009 (n=696,634 IMV discharges), we noted an absolute increase from n=60,933 IMV discharges (293 IMV discharges/100,000 persons) in year 2000 to n=79,868 (328 IMV discharges/100,000 persons) in year 2009 (average yearly growth rate=+2.8%) (Figure 2). IMV discharges originating from the ED also increased in parallel fashion from n=46,258 in 2000 to n=65,321 in 2009: a 3.8% annual growth rate (Figure 2). Non-ED admissions had a 0% growth rate (n=14,675 in 2000 to n=14,547 in 2009). For ED-based admissions during the study interval, the largest increase was noted in medical patients (from n=32,722 to 46,173), not surgical patients (from 13,516 to 19,144).

Table 1 summarizes the characteristics of the overall study population, and for years 2000 and 2009. The following growth rates are reported as average yearly rates and are absolute (not population adjusted). Overall, our study population primarily was older (≥65 year strata; 54.9%); almost equally divided between female and male; primarily White (58.3%); receiving Medicare insurance (55.4%); over one third of patients had three or more co-morbidities; with a medical admission (65.1%); urban (95.5%); and with a mechanical ventilation time <96 hours. During 2000-2009, fastest growth was noted for 1) the 35–64 year age strata (+4.7%/year) vs. the ≥65 year strata (+1.2%/year); p<0.01; 2) Hispanics:(+6.8%/year) vs. Whites (+ 1.0%/year); p<0.01; and 3) non-Medicare patients with public insurance vs. Medicare patients (+2.5%/year); p<0.01. The proportion of patients requiring PAMV (i.e. IMV>96hr) also increased fastest over time (+3.8%/year), with increases noted for all age strata vs. IMV<96hr (+ 2.3%/year); p<0.01.

Clinical outcomes and total hospital costs are shown in Table 2. For the entire study population, approximately one third died in hospital. We noted increases upon hospital discharge in the number of patients who were discharged to home (2000:13/1,000 IMV discharges to 2009:17/1,000 IMV discharges) and transferred to skilled nursing facilities (2000:10/1,000 IMV discharges to 2009:16/1,000 IMV discharges). While the average hospital length of stay (LOS) was 14d for all patients receiving IMV, hospital LOS increased over the study period, especially for survivors (0.6d). Decedents had an average hospital LOS of 11.2d, which did not decrease over time. From 2000-2009, average total patient cost-adjusted charges per hospital discharge with an IMV episode increased by 29% from 2000 (from $42,528 to $60,215 in 2014 dollars) with increases noted for both survivors and decedents. PAMV patients had an approximately three-fold difference in average costs overall and for 2000 and 2009. Table 3 shows that higher marginal costs for IMV were noted for patients who were younger (both age 18-34 years and 35-64 strata), male and non-White, had non-Medicare public insurance, had a higher co-morbidity burden, a surgical admission, and those hospitalized in urban hospitals. Marginal costs increased progressively each year with an approximate four-fold difference between 2000 and 2009 ($3,590 to $16,898 in 2014 dollars; p<0.05).

Risk Factors For Prolonged Acute Mechanical Ventilation

Factors associated with an increased probability of PAMV are provided in Table 4. The strongest predictors for PAMV were: age 35-64yr (OR=1.12; 95% CI [1.09-1.14], p<0.01); non-Whites: Hispanic (OR=1.08; 95% CI [1.07-1.10],

Table 1. Demographic and clinical characteristics of invasive mechanical ventilation (IMV) discharges in California, 2000-2009.

Characteristic	All patients from 2000-2009 (n=696,634)[#]	2000*	2009*
Age strata			
18-34 (yrs)	47,371 (6.8)	4	6
35-64 (yrs)	266,114 (38.2)	19	32
≥65 (yrs)	382,452 (54.9)	33	42
Gender,			
Female, reference	328,115 (47.1)	27	37
Male	368,519 (52.9)	29	43[a]
Race/ethnicity			
White, reference	406,138 (58.3)	36	43
Hispanic	100,315 (14.4)	7	13[a]
Black	57,124 (8.2)	4	7[a]
Asian	39,012 (5.6)	3	5[a]
Other	11,843 (1.7)	1	2[a]
Unknown	82,203 (11.8)	6	10[a]
Type of insurance			
Medicare, reference	385,935 (55.4)	32	44
Non-Medicare public	138,630 (19.9)	10	17[a]
Private	133,057 (19.1)	12	15[a]
Other	39,012 (5.6)	3	5[a]
Charlson co-morbidity index			
0, reference	101,709 (14.6)	8	11
1-2	345,530 (49.6)	30	38 [a]
3+	249,395 (35.8)	17	31 [a]
Surgery			
No, reference	453,509 (65.1)	36	53
Yes	243,125 (34.9)	20	27[a]
Urban vs. rural			
Urban, reference	665,285 (95.5)	53	77
Rural	20,899 (3)	2	2
Unknown	10,450 (1.5)	1	1
Mechanical ventilation time			
<96 hours, reference	413,801 (59.4)	35	47[a]
≥96 hours	282,833 (40.6)	21	33

[#]Displayed as count (column percent).
*Displayed as number of patients per 1,000 IMV discharges. All counts for the year 2000 are population adjusted relative to all 2009 hospitalizations in the California population.
[a]P-values<0.01 based on logistic regression models comparing 2009 discharges with 2000, for all discharges and within each age group.

p<0.01), Black (OR=1.12; 95% CI [1.10-1.14], p<0.01) and Asian (OR=1.22; 95% CI [1.19-1.24], p<0.01); non-Medicare public insurance (OR=1.18; 95% CI [1.18-1.16-1.20]; p<0.01); increasing co-morbidity burden; surgical admission; an urban hospitalization, and by the end of the study period.

Projected IMV Use

By 2020, our models suggest that IMV utilization would increase to 153,153 IMV discharges (377 IMV discharges/100,000 persons) of which 99,095 would be admitted through the ED.

DISCUSSION

In this population level study of IMV use in California, based on sustained growth over the past decade, by the year 2020, we project a further increase to 153,153 IMV discharges

Table 2. Outcomes of patients who received mechanical ventilation in California, 2000-2009.

Characteristic	2000-2009	2000	2009
Discharge status			
Home	151,866 (21.6)#	13*	17*
Acute care hospital	54,337 (7.8)#	5*	6*
Other care hospital	39,708 (5.7)#	3*	5*
Skilled nursing facilities	130,271(18.7)#	10*	16*
In-hospital death	246,068 (35.4)#	20*	27*
Other	67,573 (9.7)#	5*	9*
Unknown	6,270 (0.9)#	0*	1*
Days of stay, mean			
All patients	14.1	13.4	13.9
Survivors	15.7	14.8	15.4
Decedents	11.2	10.9	10.8
Total cost** average cost per patient			
All patients	54,931	42,528	60,215
Survivors	58,566	44,800	64,122
Decedents	48,311	38,595	52,482
Total cost** average cost per patient by mechanical ventilation time			
<96 hours	27,708	21,575	31,002
≥96 hours	82,105	66,018	88,001

#Displayed as absolute counts (column percent)
*Displayed as number of patients per 1,000 IMV discharges. All counts for the year 2000 are population adjusted relative to all 2009 hospitalizations.
**Total costs were estimated by adjusting hospital charges using available cost-to-charge ratios. All costs were also adjusted to 2014 dollars using the Consumer Price Index and to reflect stays more than one year in length.

(377 IMV discharges/100,000 persons) with 99,095 admitted through the ED. During the study interval, fastest IMV growth rates were observed in patients who were admitted through the ED, and in middle-aged and Hispanic cohorts. While more IMV patients were discharged to home and skilled nursing facilities, there were tendencies towards prolonged mechanical ventilation and longer hospitalizations. Our study is one of the first to document patterns of IMV usage in California while using a longitudinal approach with cost analyses. Since patients who require IMV often represent a sequence of care between the ED and ICU, if changes in the volume and type of IMV patients are sustained for the near future, these factors, along with a limited ICU bed capacity, have the potential to create substantial, additional strains on California EDs.[1,2,4,14]

Demographic Patterns of IMV

The dramatic increase in the overall number of IMV-discharges and related costs in California over the past decade may be attributed to multiple factors, including California's population growth, increasing use of critical care resources, and advances in the management of coexisting conditions during this period.[5,9,10] From 2000-2009, California's population grew by 10% from roughly 34 million to 37 million.[20] Demographic projections also suggest that older patients (≥65yr) will increase from 10% of California's population in 2000 to 20% by 2020, a growth rate similar to the U.S. overall.[21] In response to both population growth and healthcare financing changes, hospitals throughout California implemented cost-cutting strategies by moving procedures to outpatient settings and the creation of more ICU beds (with numbers stabilizing in the late 2000s).[22,23] The net effect has been to have sicker patients in hospitals with more consumption of ICU beds. We noted an overall increase in the percentage of patients with the highest co-morbidity burden (i.e. Charlson index of 3) over the study period.

Simultaneously, average total costs for IMV patients in California increased by 42% over the 10-year study period, more than double the growth rate of California's gross domestic product (GDP) (19%) and the U.S. GDP (16%) during this same period.[24] Increasing costs for an IMV-discharge were noted for the overall study population, across all age groups, and for both survivors and decedents. While

Table 3. Marginal cost per invasive mechanical ventilation discharge in California, 2000-2009.

Characteristic	Marginal cost
Age group†	
18-34	Reference
35-64	-1,280‡
≥65	-8,820‡
Gender†	
Female	Reference
Male	2,743‡
Race/ethnicity†	
White	Reference
Hispanic	417
Black	10,560‡
Asian	3,104‡
Other	-118
Unknown	8,026‡
Insurance†	
Medicare	Reference
Other public	17,248‡
Private	-5,355‡
Other	-5,913‡
Charlson comorbidity index†	
0	Reference
1-2	8,349‡
≥3	14,537‡
Surgery†	
No	Reference
Yes	60,443‡
Urban/rural†	
Urban	Reference
Rural	-13,662‡
Unknown	10,536‡
Discharge year†	
2000	Reference
2001	3,590‡
2002	8,694‡
2003	11,904‡
2004	13,936‡
2005	13,085‡
2006	14,983‡
2007	14,668‡
2008	16,898‡
2009	

Intercept=$12,885.

*Total costs were estimated by adjusting hospital charges with available cost-to-charge ratios. All costs were adjusted to 2014 dollars; we used the Consumer Price Index to reflect stays that spanned more than one year.

†P-value significant at 0.05 for overall F-test.

‡P-value significant at 0.05 for contrast with reference group from multivariate linear regression model with robust standard errors.

potential reasons for this growth in costs include worsening co-morbidity burdens for critically ill patients, other reasons might be advances in critical care medicine promoting survivorship (i.e. automatic weaning strategies) and the less prominent role of palliative care at the time.[25,26]

Although older patients (≥65 years) still accounted for the majority of patients overall receiving IMV in CA from 2000-2009, IMV use grew fastest during the same time period for younger age groups, particularly those age 35-64 years (from 19 to 32 discharges/1,000 or a growth rate of +4.7%/year). In our multivariate analysis of marginal costs, our models also showed highest marginal costs for IMV among those aged 35-64 years and 18-34 years. Our regional findings differ from national level data predicting that greatest growth rates in mechanical ventilation will occur in older patients as the "baby boomer" generation begins to pass age 65 in the U.S.[5] We speculate that the observed age-related patterns in IMV usage in this study may represent a shift towards less aggressive treatments for older patients at the end of life, together with a growing acuity of younger patients due to an increasing co-morbidity burden and a potential lack of access to healthcare in California.[27,28]

IMV use also increased faster for all non-White ethnic minorities, especially Hispanics and Blacks. Increased marginal costs for an IMV episode were indeed found for Hispanic and Black patients. One potential explanation may be the dramatic increase in population growth for all ethnic minorities in California. Hispanics represent the fastest growing segment of the state's population due in large part to immigration; in addition, immigrant populations in California tend to be ethnic minorities, younger, clustered in urban areas, and lack private insurance.[15,28] The growth of IMV in ethnic minorities is consistent with our data documenting an increase in IMV in younger age strata, in urban hospitals, and those with non-Medicare public (i.e. Medi-Cal) insurance.

Growth and Risk Factors For PAMV

The observed regional level growth rates for PAMV in our study are similar to previously predicted national growth rates

Table 4. Risk factors for prolonged acute mechanical ventilation in California, 2000-2009.

Characteristic	Odds ratio (95% CI)
Age group	
18-34	Reference
35-64	1.12 (1.09, 1.14)†
≥65 years	1.03 (1.00, 1.05)‡
Gender	
Female	Reference
Male	1.05 (1.04, 1.06)†
Race/ethnicity	
White	Reference
Hispanic	1.08 (1.07, 1.10)†
Black	1.12 (1.10, 1.14)†
Asian	1.22 (1.19, 1.24)†
Other	1.10 (1.06, 1.14)†
Unknown	1.13 (1.11, 1.15)†
Type of insurance	
Medicare	Reference
Other public	1.18 (1.16, 1.20)†
Private	0.87 (0.86, 0.88)†
Other	0.71 (0.70, 0.73)†
Charlson comorbidity index	
0	Reference
1-2	1.58 (1.55, 1.60)†
3+	1.99 (1.96, 2.03)†
Surgery	
No	Reference
Yes	2.08 (2.06, 2.10)†
Urban/rural	
Urban	Reference
Rural	0.62 (0.60, 0.64)†
Unknown	0.85 (0.82, 0.89)†
Discharge year	
2000	Reference
2001	1.03 (1.00, 1.05)‡
2002	1.05 (1.02, 1.07)†
2003	1.07 (1.05, 1.10)†
2004	1.09 (1.06, 1.11)†
2005	1.11 (1.08, 1.13)†
2006	1.12 (1.10, 1.15)†
2007	1.14 (1.11, 1.16)†
2008	1.14 (1.11, 1.16)†
2009	1.11 (1.09, 1.14)†

Prolonged acute mechanical ventilation (PAMV): invasive mechanical ventilation (IMV) ≥96 hours (n=282,664); Reference group is IMV<96 hours (n=413,970)]
†P-value<0.01 ‡P-values<0.05

for PAMV.[8,29] Our models showed an increased odds of PAMV for the end of the study period relative to the start (2009: OR: 1.14, 95% CI=1.09-1.14, p<0.01). Increasing rates of PAMV likely reflect both improvements in critical care as well as an increase in the co-morbidity burden of patients over time.[30] We found that IMV patients with three or more co-morbidities were nearly twice as likely as those with a Charlson index of zero to require prolonged mechanical ventilation. In addition, data indicate that critically ill patients who have received a prolonged course of IMV are more likely to suffer additional iatrogenic complications; have longer hospital lengths of stay; have higher in-hospital and one-year post-discharge mortality rates; and a higher incidence of long-term physical and cognitive disability, leading to a higher proportion of these patients being discharged from the hospital to a skilled nursing facility.[31] We noted an increase in the hospital LOS for all IMV patients and the proportion of patients discharged to skilled nursing facilities.

The age strata 35-64 years had higher odds of prolonged mechanical ventilation in this study than older IMV patients. Potential explanations include a trend towards earlier transitions to comfort care measures and an earlier withdrawal of life support in high acuity elderly patients over time.[32] In addition, all ethnic minorities had higher odds of prolonged mechanical ventilation compared with Whites. Based on the similarity in results on overall IMV usage (i.e., increase in IMV over the study period for ethnic minorities, urban hospitals, and those lacking private insurance), further research is necessary to identify whether factors such as co-morbidity burden or healthcare access may be also contributing to an increased risk of PAMV for these vulnerable populations.[33]

Policy Implications

If trends continue for an increasing number of IMV episodes, for rising admissions through EDs, and for growing IMV utilization by younger patients, ethnic minorities, and those requiring PAMV, then all of these factors will place an enormous stress on California EDs.[34] Asplin's widely used input-throughput-output conceptual model for ED patient flow can be helpful in identifying where these trends may most affect California EDs.[35] Briefly, this model suggests that EDs operate within the context of a greater hospital milieu with input describing elements such as safety-net care affecting demand for ED care; throughput defining operations within

the ED such as boarding of inpatients; and output identifying variables such as inpatient bed occupancy rates affecting transfer and discharge of patients. Based on Asplin's model, we suggest two immediate impacts by IMV patients on ED care processes.

First, an increased number of IMV episodes and a relatively fixed ICU bed capacity in California may create higher ICU bed occupancy rates. In turn, higher ICU bed occupancy rates along with a growing number of ED-based admissions for IMV patients can affect ED output and increase ED boarding times. Because of potential hospital-mandated nurse-patient 1:1 staffing ratios for IMV patients, crucial nursing resources may be unavailable to process and manage less acute patients further aggravating ER crowding and waiting times.[14] As IMV patients experience increased ER boarding times, emergency physicians (EP) may also be called upon to manage a larger proportion of mechanically ventilated patients for longer intervals.[22,36,37] However, data indicate that EPs may be less comfortable managing ventilator settings and monitoring progression to acute lung injury for IMV patients.[36] Extended LOS for IMV patients in ED settings have also been associated with poorer outcomes.[2,37]

Second, with ongoing growth in IMV episodes by younger patients, ethnic minorities, and those with non-Medicare public insurance, Asplin's model suggests additional, large increases in demand for care in EDs that serve these patient populations. Data indicate that California EDs as a whole already serve a large proportion of minority and Medicaid populations for safety net care.[15] According to the Agency for Healthcare Research and Quality, ethnic minorities are more likely to be near or below the poverty line than Whites, are less likely to have health insurance, and are 20-60% more likely to experience significant barriers in their access to quality healthcare.[33] As a result, ethnic minorities tend to have a greater co-morbidity burden and experience significant delays in receiving timely, high quality healthcare, resulting in a higher average acuity for minority patients at the time of hospital and ED admission.[15] Our data showed that the largest increase in ED-based admissions was in medical not surgical patients. ED crowding may be intensified by the influx of patient presenting with acute respiratory failure; reports already indicate that high ED crowding is associated with increased inpatient mortality.[38]

LIMITATIONS

Our study has several potential limitations. First, we used administrative data to examine patient discharges with IMV usage, and coding errors could have occurred. We also lacked clinical details on patient management with consequent inability to look at complications and events after discharge. However, both IMV and PAMV coding have been noted to have very good inter-rater reliability.[18] In addition, our goal was to generate a descriptive analysis of patterns for IMV and to inform policy discussions. Second, our analysis was restricted to California, potentially limiting generalizability to other parts of the U.S. or other countries. Nevertheless, we examined decade-long patterns from the most populated state, and compared discharges for many hospitals over different age strata. While our results may not be immediately generalizable to the U.S. as a whole, our methods give a framework for other states to use when looking at their states data and future needs. Third, future studies are necessary to better estimate marginal costs for IMV using more homogeneous subgroups of patients (i.e., by disease) and better account for post-discharge care for these patients. Finally, our study used the masked PDD, so we were unable to account for correlations for repeat admissions for the same patient. We excluded about 224,000 patients (25% of our initial sample) for masked age and masked gender. However, we were able to use a substantially large sample from a systematically de-identified dataset. The large OSHPD database also provides the ability to perform a population-level analysis that includes patients in multiple types of ED and hospital settings (e.g. tertiary, academic, community settings).

CONCLUSION

Based on sustained growth over the past decade, by the year 2020, we project a further increase to 153,153 IMV discharges with 99,095 admitted through the ED. Given our projections for a steady, substantial growth of IMV discharges within California over the next five years along with potential ED-based admissions, our main findings suggest the need for healthcare management strategies that target younger patients, ethnic minorities, and patients requiring prolonged mechanical ventilation. While longer-term goals include improved outcomes for these vulnerable patients and reducing healthcare-related expenditures, short-term policy priorities would involve modeling the impact of increased number of IMV patients on California EDs.[8,39] More research is needed to confirm our main findings with additional lines of research to determine necessary levels of ED staffing, strategies to decrease ER boarding times, and to quantify resource allocation for safety net EDs.

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Patient Admission Preferences and Perceptions

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Introduction: Understanding patient perceptions and preferences of hospital care is important to improve patients' hospitalization experiences and satisfaction. The objective of this study was to investigate patient preferences and perceptions of hospital care, specifically differences between intensive care unit (ICU) and hospital floor admissions.

Methods: This was a cross-sectional survey of emergency department (ED) patients who were presented with a hypothetical scenario of a patient with mild traumatic brain injury (TBI). We surveyed their preferences and perceptions of hospital care related to this scenario. A closed-ended questionnaire provided quantitative data on patient preferences and perceptions of hospital care and an open-ended questionnaire evaluated factors that may not have been captured with the closed-ended questionnaire.

Results: Out of 302 study patients, the ability for family and friends to visit (83%), nurse availability (80%), and physician availability (79%) were the factors most commonly rated "very important," while the cost of hospitalization (62%) and length of hospitalization (59%) were the factors least commonly rated "very important." When asked to choose between the ICU and the floor if they were the patient in the scenario, 33 patients (10.9%) choose the ICU, 133 chose the floor (44.0%), and 136 (45.0%) had no preference.

Conclusion: Based on a hypothetical scenario of mild TBI, the majority of patients preferred admission to the floor or had no preference compared to admission to the ICU. Humanistic factors such as the availability of doctors and nurses and the ability to interact with family appear to have a greater priority than systematic factors of hospitalization, such as length and cost of hospitalization or length of time in the ED waiting for an in-patient bed. [West J Emerg Med 2015;16(5):707-714.]

INTRODUCTION

The Institute of Medicine emphasizes that "desired outcomes" are a composite of patient and clinical goals so that care is patient-centered -- respectful of and responsive to individual patient preferences, needs, and values.[1] Quality measurements and improvement efforts often focus on clinical processes and outcomes of care, such as hospital complications, time to intervention, and risk-adjusted mortality. These measures, however, do not capture other outcomes that are important to patients and their caregivers.

Patients' experiences during hospitalization are an important aspect of delivering quality care. The Centers of Medicare and Medicaid Services have prioritized this aspect of care by including measurements of patient hospitalization experiences as part of hospital reimbursement.[2]

A significant factor impacting patients' experiences during

hospitalization is the type of hospital unit (most commonly the intensive care unit [ICU], a telemetry floor, or a general floor) to which they are admitted. Numerous differences exist between the ICU and the hospital floors, all of which may impact patients' experiences during hospitalization. For example, a higher frequency of vital sign measurements in the ICU compared to the floor may facilitate more frequent data on patient status but may also impact a patient's privacy and ability to sleep.

For patients who clearly benefit from ICU care (i.e., those who are severely ill and/or unstable), admission to the floor is not a viable option as the clinical outcome benefits strongly favor the ICU.[3-6] However, many patients are admitted to the ICU primarily for observation and are at low risk for requiring a critical care intervention such as mechanical ventilation or vasopressor infusion.[7] For these patients, the clinical outcome benefits of ICU admission are much less evident, and other patient-centered outcomes such as their experiences during hospitalization should be considered.

Understanding patient perceptions and preferences of hospital care is important to improve patients' hospitalization experiences and satisfaction. The objective of this study was to conduct a patient survey based on a hypothetical scenario of mild traumatic brain injury (TBI) to investigate patient preferences and perceptions of hospital care, specifically differences between ICU and hospital floor admissions.

METHODS

Study Design

This was a cross-sectional survey of emergency department (ED) patients conducted at a Level I trauma center. Patients were presented a hypothetical scenario of a patient with mild TBI and were surveyed about preferences and perceptions of hospital care related to this scenario. This study was approved by the study site's institutional review board. The study was anonymous (no patient identifiers were collected) and all patients gave verbal consent to participate in the study.

Study Setting and Population

The study population consisted of a convenience sample of ED patients surveyed between December 2012 and March 2013. Adult (18 years and older) ED patients in the ED waiting room who spoke English as their primary language were eligible. Excluded patients included those presenting to the ED for psychiatric evaluation, prisoners or those who were in custody, intoxicated patients, patients with a history of dementia or altered level of consciousness, and pregnant patients. Patients were enrolled seven days a week from 5 a.m. to midnight.

Survey Development

We developed two separate questionnaires for the study: one consisted of closed-ended questions to provide quantitative data on patient preferences and perceptions of hospital care, and the second consisted of three open-ended questions to evaluate factors or themes that may not have been captured with the closed-ended questionnaire (see Appendix). The questionnaires used the general framework of the Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS) survey, which measures hospitalized patients' perspectives on different hospital experience topics such as nurse and doctor communication, responsiveness of hospital staff, and quietness of hospital environment.[2] The HCAHPS survey is the first national, standardized, publicly reported survey of patients' perspectives of hospital care and was developed through a rigorous and multi-faceted scientific process including a public call for measures, literature review, cognitive interviews, consumer focus groups, stakeholder input, a three-state pilot test, extensive psychometric analyses, consumer testing, and numerous small-scale field tests.

Both questionnaires were drafted by two of the study authors (CW and DN) and revised based on input from all of the study authors. The questionnaires were then administered to 10 patients who provided feedback on question style, wording, and content (cognitive testing) and 10 separate patients who provided feedback on the logistical aspects of administering the questionnaires, including screening, determination of inclusion and exclusion criteria, question order, and the overall length of the questionnaires (pilot testing). We refined the questionnaires after each stage of testing.

Closed-ended Questionnaire Protocol

The closed-ended questionnaire was administered to 302 eligible patients. We considered this sample size adequate to generate sufficiently narrow confidence intervals (CIs). The questionnaire included background questions, a clinical scenario, and multiple choice questions. Background questions evaluated relevant patient characteristics including self-reported general health, race, ethnicity, education level, insurance status, and prior experiences with ED and in-hospital care. Patients then read a clinical scenario where they suffered a TBI with a small intracranial hemorrhage diagnosed on head computed tomography (Figure). This particular clinical scenario involving TBI was chosen because we previously demonstrated that many low-risk patients with TBI and intracranial hemorrhage likely do not require ICU admission and wide variability of ICU admission practices exists across trauma centers.[8-11]

Multiple choice questions addressed patient preferences and perceptions of hospital care in the context of the clinical scenario. Patient preference questions (10 questions) evaluated the importance (five-point scale; very important to not important at all) of specific hospitalization factors including access to family and friends, access to treating doctor or nurse, cost, ED and hospital length of stay, privacy, and ability to sleep. Patients were also asked choose the most important hospitalization factor and their preference of admission location (ICU, floor, or no preference). Perception-of-care questions (14 questions) addressed perceived

"Earlier this morning you slip on a wet sidewalk and hit the back of your head. You have a small cut to the back of your head so you go to the emergency room to get the cut sutured. Your doctor in the emergency room also gets a CT scan of your brain and tells you that you have a small bleed in your brain. She tells you that less than 1% of these bleeds will require brain surgery but still would like to admit you to the hospital for 2 days for "observation" to make sure that the brain bleeding does not get worse. You have a small headache but otherwise feel fine."

Figure. Hypothetical clinical scenario.
CT, computed tomography

differences between ICU and floor admission along the same hospitalization factors. Questions and answer choices were read aloud to the patient by trained research associates while the patient marked answers on a paper questionnaire.

Open-ended Questionnaire Protocol

The open-ended questionnaire was administered until theme saturation was reached (30 patients). Sampling was conducted the same way as with the closed-ended questionnaire and consisted of the same patient background questions and clinical scenario provided in the closed-ended questionnaire. Patients were not asked the closed-ended questions because they may have influenced responses to the open-ended questions. The three open-ended questions were:

- "If you were the patient in the scenario, would you prefer to be in the ICU or the floor? Why?"
- "How do you think hospitalization in the ICU versus on the floor differ?"
- "If you had to be admitted to the hospital, what factors are important to you?"

Survey questions were read aloud to the patient and their verbal responses were audio-recorded and transcribed.

Analysis

We conducted data formatting and recoding of variables using STATA 11.0 statistical software (STATA Corp, College Station, TX). The study population was described using descriptive statistics. We reported normal data with means and standard deviations and proportions were presented with 95% CIs.

For the open-ended questionnaire, transcriptions were uploaded into ATLAS.ti (Belin, Germany), a qualitative data analysis software program. Transcripts were reviewed by two authors (DN and JM) who independently generated an exhaustive list of items representing emergent themes and factors regarding patient preferences, perceived differences between the ICU and the floor, and hospitalization factors important to patients. This exhaustive list was narrowed to generate a summative list of themes and factors. We developed coding criteria and systematically applied them to the formatted transcripts by "tagging" elements within the transcripts. "Tagged" elements were quantitatively assessed to identify predominant factors and common themes. We then chose from the transcripts specific quotes that best represented these factors and themes.

RESULTS

Characteristics of Study Subjects

A total of 332 patients were enrolled in the study; 302 patients completed the closed-ended questionnaire and 30 patients completed the open-ended questionnaire. There were 143 males (44%) and the mean age was 44.3 years (SD 14.9 years). Two-hundred seventy three of 317 patients (86%) responded that they had some form of insurance and 210 of 317 (66%) patients said they were previously admitted to a hospital. See Table 1 for complete patient characteristics.

Main Results

Importance of Hospitalization Factors

On the closed-ended questionnaire, the ability for family and friends to visit (83%), nurse availability (80%), and physician availability (79%) were the factors with the highest response of "very important," while the cost of hospitalization (62%) and length of hospitalization (59%) received the lowest response (Table 2 and eTable 1). When asked to choose which of the eight factors is the most important during hospitalization, 54% choose physician availability followed by the ability for family and friends to visit (14%) (Table 2).

The open-ended questionnaire revealed six summative categories of important hospitalization factors. This list outlines these categories with representative patient quotations.

1. Availability to family and friends
   "One of the most important things to me would be being able to visit my family."
   "My wife can see me when she wants to."
2. Competency of doctors and nurses
   "Quality of the physicians, nurses, nursing staff."
   "Just pleasant people and that everyone knows what they are doing."
3. Communication and kindness of doctors and nurses
   "Treat me as if you were to treat your parents."
   "Good communication between staff, especially during shift change."
4. Privacy and comfort
   "A single room -- quiet and privacy."
   "I wouldn't want to share a room. I think privacy is important when you're a patient and I know on the floor you don't get that option."

5. Responsiveness of doctors and nurses
   "Getting seen quick and fixed quick."
   "For the doctors to take care of what needs to be taken care of."
6. System efficiency and coordination of care
   "To have everything done as quickly as possible so I can go home as quickly as possible."
   "Get me back on my feet and get me home, get out of the way for other patients who need the spot."

Table 1. Patient characteristics, n=332.

Characteristic	n, %
Age, mean (standard deviation)	44.3 (15.0)
Male	143/329, 43.5%
Race	
American Indian or Alaska Native	10/325, 3.1%
Asian	11/325, 3.4%
Black or African American	60/325, 18.5%
Native Hawaiian or Pacific Islander	8/325, 2.5%
White	175/325, 53.9%
Other	61/325, 18.8%
Hispanic/Latino	64/322, 19.9%
Education	
No high school	40/325, 12.3%
High school	72/325, 22.2%
Some college	101/325, 31.1%
2 year college degree	44/325, 13.5%
4 year college	47/325, 14.5%
Graduate degree	21/325, 6.5%
Health insurance	
No insurance	39/317, 12.3%
County insurance	14/317, 4.4%
Medi-Cal	57/317, 18.0%
Medicare	54/317, 17.0%
Health maintenance organization	70/317, 22.1%
Preferred provider organization	53/317, 16.7%
Other	25/317, 7.9%
Don't know	5/317, 1.6%
Emergency severity index	
1 (Highest acuity: life or limb threatening)	0/311, 0%
2 (High risk situation)	97/311, 31.2%
3 (Multiple resources anticipated)	174/311, 56.0%
4 (One resource anticipated)	35/311, 11.3%
5 (No resources anticipated)	5/311, 1.6%
Seen on weekend	61/329, 18.5%
Seen at night (7 pm to 7 am)	57/326, 17.5%
Arrival mode	
Emergency medical services	16/329, 4.9%
Private car	194/329, 59.0%
Walk-in	110/329, 33.4%
Unknown	9/329, 2.7%
Prior emergency department visit	252/317, 79.5%
Prior hospital admission	210/317, 66.3%
Prior intensive care unit admission	91/315, 28.9%
Self-reported general health	
Excellent	12/326, 3.7%
Very good	84/326, 25.8%
Good	107/326, 32.8%
Fair	77/326, 23.6%
Poor	46/326, 14.1%

Patient Preferences

We asked patients to choose between the ICU and the floor if they were the patient in the scenario. Thirty-three patients (10.9%) chose the ICU, 133 (44.0%) chose the floor, and 136 (45.0%) had no preference.

The open-ended questionnaire provided additional information for each of these choices.

1. Prefer the ICU
   "ICU since you get better care."
   "ICU… because there is a possibility of surgery. I would like to be watched very good."
   "ICU… because a bleed in the brain is pretty serious and the brain is a very vital organ."
2. Prefer the floor
   "The floor would be fine… If I just have a headache and there is nothing that seems to be critical at the time then I think the floor would be fine unless something changed."
   "I guess I could go to the floor, my gut tells me that the floor would be faster. Faster in terms of getting in/out of the hospital."
   "Just the floor, I don't need the ICU because I know the difference between the floor and ICU, and I wouldn't really qualify for the ICU and I don't need one to one nursing care especially if it's only for observation."
   "For a small bleed, floor. The ICU is meant for people who need intensive care. A small bleed isn't intensive."
   "Probably the floor… if I wasn't immediately dying I don't see a reason to go to the ICU if it's just to be observed and watched."
   "Well I wouldn't want to be in the ICU, because it doesn't sound like I'm that sick, that's space that could keep somebody else."

Table 2. Importance of hospitalization factors, n=302.

Factor	Responded as "very important" [a], n (%)	Responded as "most important" [b], n (%)
Family and friends can visit	251/302 (83.1)	42/296 (14.2)
Nurse availability	242/302 (80.1)	26/296 (8.8)
Physician availability	238/302 (78.8)	159/296 (53.7)
Privacy	220/302 (72.9)	8/296 (2.7)
Ability to sleep well at night	212/302 (70.2)	15/296 (5.1)
Length of time in the emergency department	207/302 (68.5)	18/296 (6.1)
Cost of hospitalization	187/302 (61.9)	22/296 (7.4)
Length of hospitalization	177/302 (58.8)	6/296 (2.0)

[a]see eTable 1 for complete breakdown of responses.
[b]six patients had missing responses.

Table 3. Perceptions of care, n=302.

Where do you think…	ICU n (%)	Floor n (%)	No difference n (%)
... you will receive overall better care?[a]	153 (51.0)	27 (9.0)	120 (40.0)
… your family and friends will have an easier time visiting you?[b]	21 (7.1)	191 (64.1)	86 (28.9)
... you will receive more attention and care from your doctors?[c]	201 (67.2)	20 (6.7)	76 (26.1)
... you will receive more attention and care from your nurses?[c]	174 (58.2)	32 (10.7)	93 (31.1)
... it costs more per day?[b]	253 (84.9)	6 (2.0)	39 (13.1)
... a bed will become available earlier from the ER?[d]	60 (20.2)	161 (54.2)	76 (25.6)
... you will stay longer in the hospital?[d]	110 (37.0)	107 (36.0)	80 (26.9)
... you will have more privacy?[c]	157 (52.5)	71 (23.8)	71 (23.8)
... you will get better sleep?[b]	103 (34.6)	72 (24.2)	123 (41.3)

ICU, intensive care unit; *ER*, emergency room
[a] two missing responses.
[b] four missing responses.
[c] three missing responses.
[d] five missing responses.

Perceptions of Care

We asked specific questions on the closed-ended questionnaire aimed at evaluating the perceived differences in admission to the ICU and the floor (Table 3).

The open-ended questionnaire revealed three summative categories of differences between admission locations. This list outlines these categories with representative patient quotations.

1. ICU is more closely monitored/more responsiveness
   "The only thing I would guess is better more people available to you for more immediate responses in the ICU."
   "The ICU they give you a lot more attention, they are watching you, it feels like constantly and they treat you a lot better in the ICU than they do on the floor at this hospital."
2. There are more nurses and doctors on the ICU
   "More practitioners in the ICU than the floor."
   "Your treatment is like one nurse for every two patients."
3. No differences between the ICU and the floor
   "I don't think there is very much of a difference… if you are hospitalized in the ICU, you're in a bed just like you are on the floor and doctors come around and they see everybody in your unit or wherever you're at and they spend time with you… it's the same amount of time, you're getting the same treatment as anybody one else, but in intensive care they do get a little more people who are watching them 24/7 but the doctors are not doing any more for them than they are doing for you on the floor."

We asked patients to estimate the daily charge for the ICU and the floor. The median estimate for the ICU was $2000 (IQR $1000 to $5000) and the floor was $1000 (IQR $500 to $3000). When asked if they would be willing to pay more for an ICU, 76/298 (26%) responded "yes" and would pay a median of $500 (IQR $200 to $2000) more. Seventy-nine (26.9%) patients strongly agreed that doctors should consider bed availability when making admission decisions, while 37 (12.5%) of patients strongly agreed that doctors should consider cost (eTable 2).

DISCUSSION

To our knowledge, this is the first study to evaluate patient perceptions and preferences regarding hospital admission location. We distributed closed- and open-ended questionnaires to ED patients to investigate patient preferences and perceptions of hospital care, specifically differences between ICU and hospital floor admissions. The questions referred to a hypothetical scenario of mild TBI and were based on hospitalization factors from the validated HCAHPS survey. The overall objective of the closed-ended questionnaire was to quantitatively evaluate any general trends in responses, while the open-ended questionnaire aimed to capture a more personal level of responses and identify any themes that may have been missed by the closed-ended questionnaire.

There were a number of interesting results from the survey. It was surprising that the majority of patients, given the hypothetical clinical scenario, preferred to be admitted to the floor (44%) or had no preference regarding admission location (45%), while only 11% preferred admission to the ICU. This was despite 51% of patients responding that admission to the ICU would result in overall better care (9% felt the admission to floor would result in better care and 40% responded no difference). These results challenge the notion that patients generally prefer more "intensive care" and suggest that hospitalization factors other than direct clinical care may influence patients' overall preference on admission location.

Our results also suggest that patient-centered factors of hospitalization, such as physician and nurse availability and the ability for family and friends to visit, were consistently more important to patients than systemic/logistical factors of hospitalization, such as length and cost of hospitalization or length of time in the ED waiting for an in-patient bed. Future initiatives to improve patients' hospitalization experiences should consider emphasizing improving patient-centered factors over logistical factors of hospitalization. Patient-centered initiatives, such as more liberal visitation hours[12-13] or including families during rounds[14-15], also may be easier to implement than improving systemic/logistical factors of hospitalization such as decreasing ED waiting time.[16]

Regarding patients' perceptions of hospitalization, patients thought admission to the ICU compared to admission to the floor, would result in more attention from doctors and nurses, have more privacy, be more expensive, be more difficult for family and friends to visit, and have longer waiting times for an in-patient bed in the ED. However, a substantial proportion of patients felt there was no difference between the ICU and the floor when asked about various factors of hospitalization. It is important to differentiate between patient perceptions of care and experiences of care. Prior studies have shown that perceptions of care may not be accurate of actual care[17] and may influence patient satisfaction more than actual experiences.[18] Future work may be directed towards evaluating the relationships between patient perceptions, experiences, and satisfaction of hospitalization.[19]

Patients are admitted to the ICU for observation for a wide-range of clinical conditions despite being at low risk for requiring critical care interventions.[7] Prior studies demonstrated limited clinical benefit of ICU admission for low-risk patients with drug overdoses,[20] post-carotid endarterectomy,[21] angioedema,[22] gastrointestinal hemorrhage,[23] and traumatic intracranial hemorrhage.[8-9, 11] Given the limited clinical benefit in these low-risk patients, other factors such as patient preferences, cost, and resource availability should be considered. Appropriate utilization of ICU resources, which is costly (one-third of acute hospital charges) and limited (8% of hospital beds),[24] is important in the era of escalating healthcare costs.[25]

Traditionally, admission decisions are unilateral – decisions are made by the clinician with minimal input from patients and/or their caregivers. However, while frequently not categorized as such, the decision to admit patients to the ICU or hospital floor is an intervention with risks and potential benefits to the patient and their caregivers. In addition, these decisions impact the healthcare system as a whole and indirectly impact other patients through the use of limited resources. Shared decision-making should be considered in situations where an intervention is not considered "standard" (defined as "virtual unanimity among patients about the overall desirability…of the outcomes").[26] The role of shared decision-making in decisions regarding level of care during hospital admission is unclear. Patients and their caregivers may not comprehend the nuances between the ICU or the floor or they may not want to participate in the decision-making process.[27] Also, the addition of patient input may lead to disagreements with physicians and patients with unclear methods of resolution. However, as we move to a delivery-of-care model that is more patient-centered with increasing implementation of shared decision-making, a better understanding of patient perceptions and preferences of care will be of greater importance.

Limitations

These results should be interpreted in the context of several limitations. Our results are based on a cross-sectional survey of ED patients. We sampled stable, low-acuity ED patients who could be conveniently queried in the ED waiting room from a single-center and thus their responses may not be generalizable to the ED population as a whole. In addition, participants who agreed to participate in the survey may be different from those who refused. Patient responses were based on a specific clinical scenario of a patient with mild TBI. Results may differ if the clinical scenario were different or if we surveyed patients currently experiencing the clinical scenario. Quotations were categorized into common themes; however, some quotations may be categorized into more than one theme. Sixty-eight percent and 30% of patients were previously admitted to the hospital and the ICU respectively. Thus, many subjects have limited prior personal experience with understanding the

differences between the ICU and the floor.

Conclusion

Based on a hypothetical scenario of mild TBI, the majority of patients preferred admission to the floor or had no preference compared to admission to the ICU. Humanistic factors such as availability of doctors and nurses and the ability to interact with family appear to have a greater priority than systematic factors of hospitalization.

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Evaluation of Social Media Use by Emergency Medicine Residents and Faculty

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Introduction: Clinicians and residency programs are increasing their use of social media (SM) websites for educational and promotional uses, yet little is known about the use of these sites by residents and faculty. The objective of the study is to assess patterns of SM use for personal and professional purposes among emergency medicine (EM) residents and faculty.

Methods: In this multi-site study, an 18-question survey was sent by e-mail to the residents and faculty in 14 EM programs and to the Council of Emergency Medicine Residency Directors (CORD) listserv via the online tool SurveyMonkey™. We compiled descriptive statistics, including assessment with the chi-square test or Fisher's exact test. StatsDirect software (v 2.8.0, StatsDirect, Cheshire, UK) was used for all analyses.

Results: We received 1,314 responses: 63% of respondents were male, 40% were <30 years of age, 39% were between the ages 31 and 40, and 21% were older than 40. The study group consisted of 772 residents and 542 faculty members (15% were program directors, 21% were assistant or associate PDs, 45% were core faculty, and 19% held other faculty positions. Forty-four percent of respondents completed residency more than 10 years ago. Residents used SM markedly more than faculty for social interactions with family and friends (83% vs 65% [p<0.0001]), entertainment (61% vs 47% [p<0.0001]), and videos (42% vs 23% [p=0.0006]). Residents used Facebook™ and YouTube™ more often than faculty (86% vs 67% [p<0.001]; 53% vs 46% [p=0.01]), whereas residents used Twitter™ (19% vs 26% [p=0.005]) and LinkedIn™ (15% vs 32% [p<0.0001]) less than faculty. Overall, residents used SM sites more than faculty, notably in daily use (30% vs 24% [p<0.001]). For professional use, residents were most interested in its use for open positions/hiring (30% vs 18% [p<0.0001]) and videos (33% vs 26% [p=0.005]) and less interested than faculty with award postings (22% vs 33% [p<0.0001]) or publications (30% vs 38% [p=0.0007]).

Conclusion: EM residents and faculty have different patterns and interests in the personal and professional uses of social media. Awareness of these utilization patterns could benefit future educational endeavors. [West J Emerg Med. 2015;16(5):715-720.]

INTRODUCTION

The term social media (SM) describes interactive digital platforms that are used to share information and ideas. Emergency medicine (EM) practitioners and educators use SM as tools to share medical education and healthcare applications.[1-5]

Residency programs are using SM increasingly for recruiting, communication, and education.[1-6]Many programs report higher learner satisfaction, improved peer collaboration, increased communication, and benefits of asynchronous learning opportunities.[7-17] This growing integration of SM into medical education has led some to believe that SM constitute the cornerstone platform for the future of medical education (http://bit.ly/NxV0RJ).

Despite their potential benefits, SM pose substantial potential legal, ethical, personal, and professional risks.[18-24] Disclosures of private health information and breaches of professionalism issues leading to termination have been reported.[2-20;25-27] In recognition of these potential risks, many hospitals and institutions have instituted policies around posting content that could have professional ramifications. In addition, residency programs have been advised to provide education regarding SM use.[28]

Despite the potential benefits and risks of SM use in EM graduate medical education, little is known about the personal and professional usage patterns of residents and the faculty of residency programs. Understanding how these physicians use SM might enhance how education is delivered and could help optimize SM use in graduate medical education. Therefore, we undertook a study that compared the personal and professional use of various SM applications by residents and faculty in EM residencies in the United States. We hypothesized that residents use SM for personal intent more than faculty members and that faculty members would be more likely to use SM for professional purposes.

METHODS

This multi-site study was based on a voluntary, anonymous 18-question survey distributed by email in May 2013 via the online tool SurveyMonkey™. The recipients were residents and faculty whose contact information was available in the Council of Emergency Medicine Residency Directors (CORD) listserv. The members of CORD, a national EM education organization, are leaders in allopathic and osteopathic EM residencies. This study was administered by CORD's Social Media Task Force, consisting of 14 geographically diverse educational leaders, each associated with an accredited EM residency program. The study protocol was approved by the institutional review board of the Carolinas Health Care System.

We included residents in the survey if they were enrolled in one of the 14 EM programs with a leader on the CORD SM Task Force. The number of contacts at the 14 institutions totaled 432 residents. Our goal was a 70% response rate (approximately 302 resident respondents). Additionally, residents outside this core group of 14 institutions were included if a faculty member from another institution forwarded the survey to them; the proportion from each resident group is unknown. We sent follow-up emails two and four weeks after the initial survey distribution in an attempt to increase the participation rate.

The faculty component of the study consisted of residency program directors (PDs), assistant and associate program directors (APDs), core faculty members, and others with access to the CORD listserv. A link to the survey was sent to these faculty members via the CORD listserv. We also sent follow-up emails at two weeks and four weeks in an attempt to increase the participation rate.

Sample survey questions are presented in Appendix A. Specific measures included the use of SM by residents, knowledge of institutional policies regarding SM, and a comparison of SM use by residents and faculty members.

The data are summarized as counts and percentages. Between-group comparisons were performed with the chi-square or Fisher's exact test. The analysis was performed using StatsDirect Version 2.8.0 (StatsDirect Ltd).

RESULTS

We received 1,314 responses. The participants' demographics are summarized in Table 1. The faculty respondents' geographic distribution was as follows: Northeast, 32%; South, 31%; Midwest, 27%; and West, 8%.The residents had a similar geographic distribution: Northeast, 33%; South, 33%; Midwest, 24%; and West, 8% ($p<0.58$).

Residents used social networking sites more frequently for personal use than did faculty members. The highest frequencies of use were associated with "multiple times per day" and "daily" (Table 2). For overall personal use, 12.3% of the combined group of residents and faculty stated that they don't use any social networking sites and 11.5% of the group reported that they use networking sites "infrequently enough to forget my password." The barriers most frequently cited were privacy concerns (84.1%), professional boundary concerns (72.2%), lack of time (51.4%), and sites being blocked (32.7%).

Residents reported using SM markedly more than faculty for social interaction with family and friends, entertainment, and videos (Table 3). Residents used Facebook™ and YouTube™ more often than faculty, whereas faculty members used Twitter™ and LinkedIn™ more often than the residents. Overall, residents use SM sites more than faculty, notably in the daily use category (Table 4).

We then assessed interest in the use of SM for professional purposes. After combining the resident and faculty groups, we found that 28.7% had a "very high" or "high" level of interest, 30% were neutral in their interest, and 41.3% had a "low" or "very low" interest. Residents and faculty members had similar levels of "very high" or "high" interest (28% vs 30%) and "low" or "very low" interest (39%

Table 1. Demographics.

Total responses	1,314
Residents	772 (59%)
Faculty	542 (41%)
Program directors	81/542 (15%)
Assistant or associate program directors	114/542 (21%)
Core faculty	244/542 (45%)
Other faculty	103 (19%)
Sex: Male	828 (63%)
Age <30 years	526 (40%)
Age 31–40 years	512 (39%)
Age >40 years	276 (21%)
Faculty completed residency >10 years ago	578 (44%)

Table 2. Frequency of personal use of social media networking sites by faculty and residents.

How often do you use social networking sites?	Residents (n=742)*	Faculty (n=496)*	p
Daily	221 (30%)	118 (24%)	0.001
Infrequently enough to forget my password	49 (7%)	94 (19%)	
Monthly	42 (6%)	32 (6%)	
Multiple times a day	231 (31%)	112 (23%)	
Several times a week	129 (17%)	69 (14%)	
Weekly	70 (9%)	71 (14%)	

*46 faculty members and 30 residents did not answer this question.

Table 3. Reasons for personal use of social media.

	Residents (n=772)	Faculty (n=542)	p
News	334 (43.3%)	218 (40.2%)*	0.27
Entertainment	469 (60.8)	256 (47.2)	<0.0001
Videos	321 (41.6)	175 (23.3)	0.0006
Research	121 (15.7)	71 (13.1)	0.19
Events	220 (28.5)	120 (22.1)	0.01
Networking	370 (47.9)	225 (41.5)	0.02
Social (family/friends)	643 (83.3)	351 (64.8)	<0.0001

Table 4. Use of specific social media sites.

	Residents (n=772)	Faculty (n=542)	p
Facebook™	661 (85.6%)	364 (67.2%)	<0.0001
Twitter™	147 (19.0)	138 (25.5)	0.005
LinkedIn™	119 (15.4)	173 (31.9)	<0.0001
YouTube™	408 (52.8)	248 (45.8)	0.01
Ning™	1 (0.1)	2 (0.4)	0.57
Blogs	166 (21.5)	120 (22.1)	0.78

Table 5. Level of interest in using social media in residency environment.

	Residents (n=762)	Faculty (n=529)	p
Very high	87 (11.4%)	58 (11.0%)	<0.001
High	124 (16.3%)	102 (19.3%)	
Neutral	254 (33.3%)	133 (25.1%)	
Low	154 (20.2%)	85 (16.1%)	
Very low	143 (18.8%)	151 (28.5%)	

vs 44.6%) for the use of SM in a residency environment (Table 5). Residents were most interested in professional SM use for open positions/hiring (30% vs 18% [p<0.0001]) and videos (33% vs 26% [p=0.005]) and were less interested than faculty with award postings (22% vs 33% [p<0.0001]) and publications (30% vs 38% [p=0.0007]) (Table 6).

One fourth of the respondents said their program has an official SM policy in place, and 15% reported they did not have such a policy. Eighteen percent reported being covered under hospital, corporate, or institutional policy, and 37% did not know if a policy had been enacted. Less than half (40.3%) of the respondents said their residency programs had a SM page/site, and 28.8% of respondents were not sure about the existence of a site. Of those reporting a SM page/site, 30% said the site manager or administrator was a resident, 27% reported that this role was filled by the PD or an APD, 19% said that a faculty member other than the PD or an APD administered the site, and 14.7% reported that program coordinator filled this responsibility.

DISCUSSION

The results of our survey indicate that, for personal use, EM residents are more likely to use SM than are EM faculty members. The frequency of use of specific SM modalities varied between the two groups of respondents. For professional purposes, residents and faculty had highly varied levels of interest in the use of SM in a residency environment.

Given the expanding presence of SM in graduate medical education, understanding utilization patterns is essential to integrating them into educational programs. SM have the potential to facilitate didactic learning, capture feedback from learners, and enhance educational discussions, but if educators and learners are familiar with different SM tools, program developers face major challenges. We suggest that each residency program should explore its faculty and residents' use patterns before implementing a new SM-based curriculum. For example, our survey study revealed that faculty members use Twitter™ more commonly than do residents; so, before a Twitter™-based curriculum is deployed, residents and faculty members should be educated about the site to maximize participation and satisfaction. Residents and faculty members should be made aware of institutional policies regarding the use of social media. Before launching an educational program that includes the use of SM, program administrators should talk with information technology personnel and hospital administrators to ensure appropriate access to the educational resources (e.g., Facebook™, Twitter™, and YouTube™). A third of the physicians who responded to our survey reported being blocked from sites of interest by hospital networks. The elimination of technology barriers is essential to the successful use of SM in residency education.

We were surprised that 41% of our study group expressed "low" or "very low" interest in using SM for professional purposes. The highest levels of interest in this category were associated with obtaining information about the residency program, viewing articles for discussion during Journal Club, and retrieving publications (Table 6). This information could provide a starting point from which to launch programs based on SM in a residency program. Additionally, SM can be used to address Milestones 15, 18, 19, 20, and 21, which cover medical knowledge, technology, practice-based performance improvement, professional values, and accountability, respectively.[29-30]

LIMITATIONS

Limitations of this study include the unavoidable limitations inherent to the collection of self-reported information via a survey. Our initial intent was to reach out to only 14 residencies; the study group expanded beyond that focus when the survey was distributed more broadly by faculty members on the CORD listserv. Thus, we received more responses than we anticipated (772 instead of 302), and we were not able to tally the number of programs and residents that actually received the survey (i.e., our response rate is unknown). The faculty response rate is also unknown, because the total number of individuals on the CORD listserv is unknown and our emails could have been forwarded to faculty not on the listserv. CORD membership includes nearly all EM residency PDs and APDs; therefore, 542 faculty responses represents a large proportion of residency leaders. Finally, respondents could have responded more than once, as the survey was anonymous.

CONCLUSION

Emergency medicine residents and faculty members are different in their patterns regarding the use of social media

Table 6. Information of interest to residents and faculty when using social media.

	Residents (n=772)	Faculty (n=542)	p
Current providers	108 (14.0%)	96 (17.7%)	0.07
New providers	103 (13.3)	83 (15.3)	0.31
Open positions/hiring	231 (29.9)	99 (18.3)	<0.0001
Residency program	416 (53.9)	302 (55.7)	0.51
Services, departmental	103 (13.3)	88 (16.2)	0.14
Awards	172 (22.3)	176 (32.5)	<0.0001
Publications	235 (30.4)	204 (37.6)	0.0007
Research	220 (28.5)	180 (33.2)	0.07
Articles/journal club	330 (42.7)	226 (41.7)	0.7
Videos	255 (33.0)	140 (25.8)	0.005

for personal purposes and in their interest in using social media for professional purposes. Awareness of these varied utilization patterns may benefit future educational endeavors.

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Effectiveness of a 40-minute Ophthalmologic Examination Teaching Session on Medical Student Learning

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Introduction: Emergency physicians are among the few specialists besides ophthalmologists who commonly perform ophthalmologic examinations using the slit lamp and other instruments. However, most medical schools in the United States do not require an ophthalmology rotation upon completion. Teaching procedural skills to medical students can be challenging due to limited resources and instructor availability. Our study assesses the effectiveness of a 40-minute hands-on teaching session on ophthalmologic examination for medical students using only two instructors and low-cost equipment.

Methods: We performed an interventional study using a convenience sample of subjects. Pre- and post-workshop questionnaires on students' confidence in performing ophthalmologic examination were administered. We used a paired t-test and Wilcoxon rank test to analyze the data.

Results: Of the 30 participants in the study, the mean age was 25 and the majority were first-year medical students. The students' confidence in performing every portion of the ophthalmologic exam increased significantly after the teaching session. We found that the average confidence level before the teaching session were below 2 on a 1-5 Likert scale (1 being the least confident). Confidence levels in using the slit lamp had the highest improvement among the skills taught (2.17 95% CI [1.84-2.49]). Students reported the least improvement in their confidence in assessing extraocular movements (0.73, 95% CI [0.30-1.71]) and examining pupillary function (0.73, 95% CI [0.42-1.04]). We observed the biggest difference in median confidence level in the use of the tonometer (4 with a p-value of <0.05).

Conclusion: A 40-minute structured hands-on training session can significantly improve students' confidence levels in ophthalmologic skills. [West J Emerg Med. 2015;16(5):721-726.]

INTRODUCTION

Teaching procedural skills continues to be a major challenge in medical student education. Procedural skill requires knowledge, familiarity with the instrument, and hand-eye coordination. Despite advances in medical education and the availability of various methods for teaching procedural skills, a 2009 survey reported that recent medical school graduates felt a lack of self-confidence in their ability to perform common procedures upon entering residency training.[4] Conversely, procedural training in medical school is associated with higher self-reported competency with common medical procedures upon entering residency training. Therefore, it is highly desirable to provide medical students with more opportunities to learn hands-on procedural skills.[4]

The ophthalmologic examination, although indispensable in the emergency department (ED), has been less emphasized in medical education.[5] Most of the medical schools in the U.S. do not require a rotation in ophthalmology or formal ophthalmologic training for medical students.[5] One study reported that the slit lamp is one of 12 procedures that even emergency medicine (EM) residents felt they were under-prepared to perform.[6] EM physicians are among the few specialists who commonly perform ophthalmologic examinations using the slit lamp, tonometry, and ophthalmoscope. To remedy the lack of procedural training in ophthalmological procedures, we created a 40-minute structured hands-on skills teaching session for medical students interested in EM. The session required two instructors, low-cost simulated globes, two tonometers and a portable slit lamp. We then examined whether this teaching session showed benefit to a medical student's confidence in performing ophthalmologic examination.

METHODS

Data collection

We conducted this cross-sectional study of a convenience sample of 30 medical students at the 2012 Emergency Medicine Interest Group Symposium. The 40-minute teaching session was delivered to 10 medical students at a time. The participants were asked to complete a pre- and post-workshop questionnaire to assess their confidence level with the instruments. We then tabulated the results of the pre- and post-workshop questionnaires in Excel (Microsoft, Redmond, WA) (Figure 1).

Year in Medical School _____

Age _____

Please circle the equipment you have worked with before:

Slit Lamp Tonometer Fluorescein Stain

	Circle the appropriate number				
	Disagree				Ag
I feel comfortable checking a patient's visual acuity	1	2	3	4	5
I feel comfortable testing a patient's pupil function	1	2	3	4	5
I feel comfortable testing a patient's extraocular movements	1	2	3	4	5
I feel comfortable using a tonometer	1	2	3	4	5
I know how to calibrate a tonometer	1	2	3	4	5
I feel comfortable using the slit lamp for the eye exam	1	2	3	4	5
I can move the slit lamp left/right and up and down to exam the eye	1	2	3	4	5
I can change the light filters	1	2	3	4	5
I can adjust the width and height of the light beam	1	2	3	4	5
I can confidently examine the external eye	1	2	3	4	5
I can confidently examine the cornea	1	2	3	4	5
I can confidently examine the anterior chamber for cells of flare	1	2	3	4	5
I know how to perform the fluorescein exam	1	2	3	4	5

For the fluorescein exam, what color should the light filter be?
a. Red
b. Cobalt Blue
c. Green

For the fluorescein exam, what is a positive finding?
a. Fluorescent green uptake on the cornea
b. Blue streaks on the eyelid
c. White spots on the cornea

A tonometer measures:
a. Visual acuity
b. Intraocular pressure
c. Pupil function

How many times should you touch the tonometer tip to the patient's cornea?
a. Once
b. Three times
c. Until the tonometer makes a loud beep

Figure 1. Emergency medicine interest group symposium: ophthalmology workshop questionnaire.

Teaching session

The participants rotated through stations focused on slit lamp, tonometer, and the ophthalmoscope. Students spent 12 minutes at each station and two minutes completing the pre- and post-workshop questionnaires. There were instructors at the slit lamp and tonometry stations. At the ophthalmoscope station, the students were given the opportunity to practice their fundoscopic skills, with an instructor available for questions. We used one portable slit lamp, two tonometers and four ophthalmoscopes.

Slit Lamp

At the slit lamp station (Keeler PSL, Keeler Ophthalmic Instruments, Broomall, PA), participants used a portable slit lamp to inspect the external eye structures (eyelids, cornea, iris, etc.) and the anterior chamber of their peers' eyes (Figure 2). After each participant had an opportunity to use the slit lamp, they applied fluorescein stain using paper, and re-examined each other's eyes. Anesthesia drops were not applied. With only one slit lamp available for use, the remaining students reviewed a slide presentation on other ophthalmologic exam skills and pathology while two students practiced using the slit lamp.

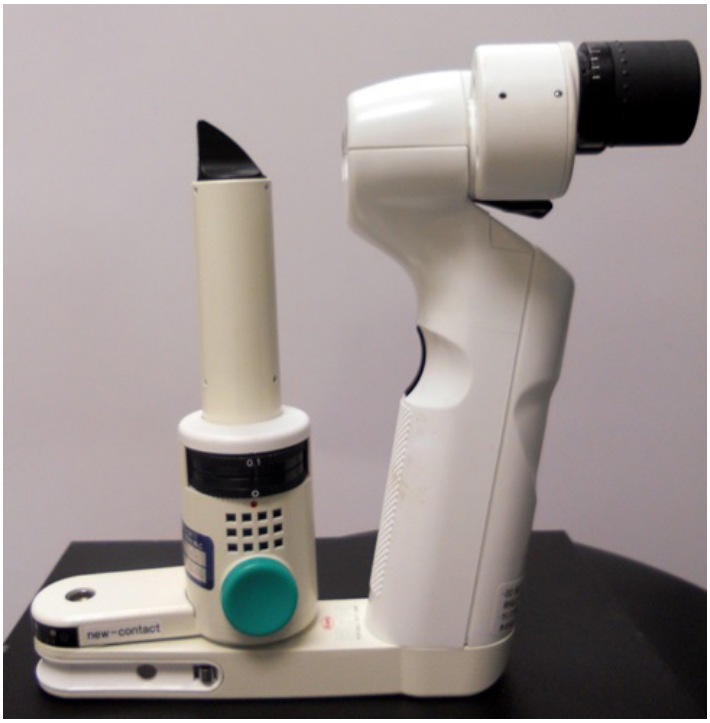

Figure 2. Portable slit lamp.

Tonometry

At the tonometry station, participants were introduced to the Tonopen (XL, Reichert Technologies, Depew, NY) and how it is used to measure intraocular pressure (Figure 3). The instructor taught the participants to calibrate the Tonopen, apply the protective cover, and assess the intraocular pressure using globe models,made of water-filled gloves (Figure 4).

Ophthalmoscope and Eye Pathology

The ophthalmoscope station had four ophthalmoscopes paired with eye models. These models were made from paper cups with 5 mm opening covers on top (Figure 5). Inside were images of different ophthalmologic pathology. The instructor taught the participants to hold an ophthalmoscope, find the red reflex, how to see the optic disc, and change the light filters. We also had a Panophthalmoscope (Welch Allyn, Skaneateles Fall, NY) for students to practice using.

Statistical Analysis

We hypothesized that the 40-minute teaching session would improve medical students' confidence in their ophthalmologic examination skills. The difference in confidence levels between pre- and post-workshop questionnaires was measured on each of the ophthalmologic examination skills listed below:

1) Checking visual acuity
2) Testing pupillary function
3) Testing extraocular movements
4) Using a Tonopen
5) Calibrating a Tonopen
6) Using a slit lamp
7) Examining the external eye
8) Examining the cornea
9) Examining the anterior chamber of the eye
10) Performing a fluorescein examination

We used the paired t-test for dependent variables with normal distributions and the Wilcoxon-rank test for non-parametric dependent variables.

RESULTS

Of the 30 students, the mean age was 25. Almost two-thirds (19) of the participants were male. The majority of the subjects (19) were first-year medical students with no prior experience performing an ophthalmologic examination (Table 1).

We found that the average confidence level before the teaching session were below 2 on a 1-4 Likert scale (1 being the least confident). Confidence levels in using the slit lamp had the highest improvement (2.17 95% CI [1.84-2.49]). Students reported the least improvement in their confidence in testing extraocular movements (0.73, 95% CI [0.30-1.71]) and pupillary function (0.73, 95% CI [0.42-1.04]) (Table 2). Table 2 shows the mean confidence level for each ophthalmologic examination that had normal distribution. The differences in confidence level between before and after teaching sessions were statistically significant.

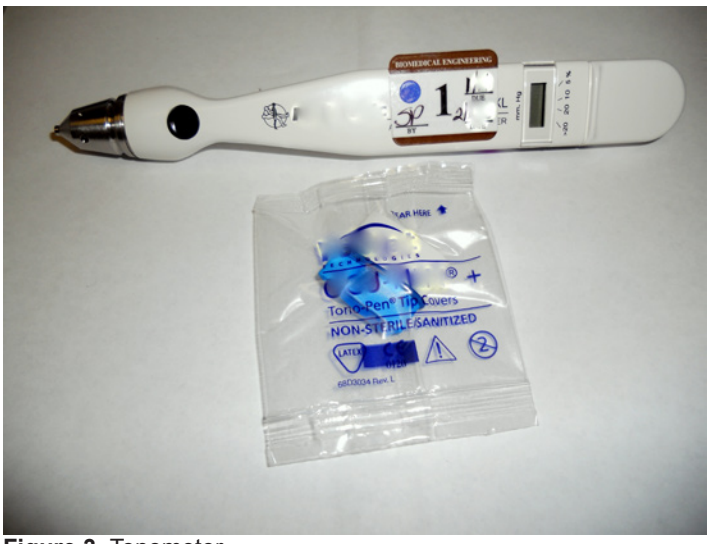

Figure 3. Tonometer.

Figure 4. Eye model made of glove filled with water.

Table 3 shows the median of confidence level for each ophthalmologic examination that had non-normal distribution. We observed the biggest difference in the median of confidence levels for tonometer use (4, p-value <0.05), which was statistically significant when compared before and after

Figure 5. Eye models made from cups with pathology pictures inside. Pathologies included central retinal artery and vein occlusion and retinal detachment.

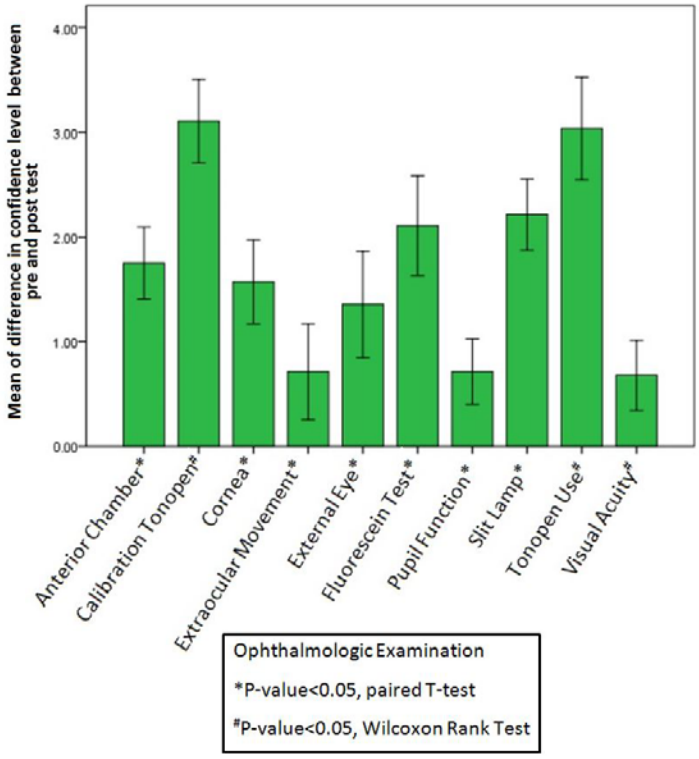

Figure 6. Difference in confidence level before and after an ophthalmology teaching session.

the teaching session. Overall the improvement in confidence levels was statistically significant across all portions of the ophthalmologic examination after completing the 40-minute teaching session (Figure 6).

DISCUSSION

Multiple methods have been explored to improve the efficiency of teaching procedure skills. The methods include computer-aided programs, simulations, and cadaver labs, which show convincing evidence of success, although they can be cost prohibitive in many instances.[1,2] Practicing procedures on real patients has been debated due to safety issues and patient dissatisfaction.[8,10] Using cadavers or animal models is expensive and limited by availability.[9] Computer interactive courses and virtual simulations have been considered by many educators as being equal to clinical skills workshops. A randomized study of both nursing students and medical students suggested that traditional hands-on training was superior to an interactive, virtual-reality computer intravenous catheter simulation.[3]

The "see one, do one, teach one" concept emphasizes the necessity of learning procedures by doing instead of observation.[7] Educators realize that a competency gap exists between the "see one, do one" model. Additional hands-on sessions under supervision are necessary to address the gap.[8,9] We designed a brief interactive workshop using low-cost equipment to improve students' familiarity with equipment and their hand-eye coordination skills.

In our workshop, the medical students practiced on each other after they became comfortable with the skill sets. This strategy provided hands-on experience on human subjects utilizing limited resources. It served as a bridge between cognitive understanding and actual manual skills. In addition, the workshop did not involve a formal lecture. We demonstrated that teaching procedural skills does not require in-depth medical knowledge to improve a practitioner's confidence.

The success of our workshop might also be attributed to the well-focused curriculum. We realized it was not possible to cover all the ophthalmologic examinations in depth in 40 minutes. Because our target audience was medical students interested in EM rather than ophthalmology, we selected three of the most commonly used ophthalmologic instruments: the slit lamp, tonometer, and ophthalmoscope. While the results of our study indicated that our 40-minute workshop resulted in significant improvement of confidence levels for the three skills, they also suggested only short-term improvement of confidence level in ophthalmologic examination. Future studies should implement a direct observation session to assess performance and retention of procedural skills in addition to self-reported confidence. However, the retention of procedural skills is unpredictable and different from the retention of medical knowledge. For example, a study on a short-course cardiopulmonary resuscitation training reported significantly lower skill retention after five months, whereas a

Table 1. Medical student demographic data in study examining student confidence in performing ophthalmologic exams.

Characteristic	Number (%)
Age (yr) (n=30)	Mean 25.03 (SD 2.86)
Medical school year (n=30)	
Year 1	19 (63.33)
Year 2	4 (13.33)
Year 3	2 (6.77)
Year 4	2 (6.77)
Other	3 (10.00)
Gender (n=30)	
Male	19 (63.33)
Female	11 (36.77)
Past experience with ophthalmology rotation (n=30)	0 (0.00)
Fluorescein exam (n=21)	2 (6.77)
Slit lamp exam (n=21)	4 (13.33)
Tonopen (n=21)	1 (3.33)

Table 2. Comparison of mean confidence levels in individual ophthalmologic examinations using a student t-test.

Ophthalmologic examination	Mean of pre-test confidence level (SD)	Mean of post-test confidence level (SD)	Mean: difference confidence level (95% CI)	P-value
Anterior chamber	1.17 (0.46)	2.90 (0.92)	1.73 (1.41–2.06)	<0.05
Cornea	1.79 (1.01)	3.38 (0.94)	1.59 (1.20–1.97)	<0.05
EOM	2.43 (1.65)	3.17 (1.46)	0.73 (0.30–1.71)	<0.05
External eye	2.17 (1.32)	3.50 (1.14)	1.33 (0.85–1.81)	<0.05
Fluorescein test	1.23 (0.68)	3.27 (1.31)	2.03 (1.57–2.50)	<0.05
Pupil function	2.57 (1.68)	3.30 (1.44)	0.73 (0.42–1.04)	<0.05
Slit lamp	1.27 (0.64)	3.43 (0.82)	2.17 (1.84–2.49)	<0.05

EOM, extraocular muscles

Table 3. Comparison of median of confidence levels in individual ophthalmologic examination using the Wilcoxin rank sum test.

Ophthalmologic examination	Median of pre-test confidence level (IQR)	Median of post-test confidence level (IQR)	P-value
Calibration of tonometer	1.00 (0.00)	4.00 (1.25)	<0.05
Tonometer use	1.00 (0.00)	5.00 (2.00)	<0.05
Visual acuity	3.00 (3.25)	4.00 (1.25)	<0.05

study on simulation-based mastery learning of central venous line insertions reported one-year retention of acquired skills.[11]

Our study demonstrates that short but structured procedural skill workshops can increase students' confidence levels before they enter clinical years. We observed significant improvement in procedural skills that use equipment. These procedures include slit lamp examination, fluorescein staining and tonometry. The results supported the idea that familiarity with equipment is an essential part of learning procedural skills. Therefore, educators should provide trainees ample access to procedural equipment. The opportunity to operate the equipment prior to performing procedures in live subjects may enhance a student's confidence significantly. Both EM residency and medical student educators could easily implement this workshop to increase hands-on experience and confidence levels when performing ophthalmologic examinations.

LIMITATIONS

Our study had several limitations. While we showed significant findings despite the small sample size, there are no currently validated tools designed specifically to assess procedural competency.[9] Therefore, we chose to use a pre- and post-test study design. Our outcome measures were temporally

related to our intervention. We did not test the subjects' confidence level with the skills at a later date. Neither did we assess the educator's evaluation of the subjects performing these skills. Future studies should also evaluate the students' procedural competency with real patients. For example, diagnosis of an ophthalmologic pathology in a globe model is greatly different from diagnosing a patient with a moving globe and small pupils.

CONCLUSION

Teaching procedural skills to medical students is a challenge in medical education. We created a 40-minute teaching session consisting of three stations focusing on tonometry, slit lamp, and fundoscopy. The session used two instructors and low-cost resources. We then used a short pre and post questionnaire to evaluate students' confidence levels. Our study demonstrated that this hands-on workshop significantly improved students' confidence in ophthalmologic examination, especially in using slit lamp and tonometry.

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Hand Washing Practices Among Emergency Medical Services Providers

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Introduction: Hand hygiene is an important component of infection control efforts. Our primary and secondary goals were to determine the reported rates of hand washing and stethoscope cleaning in emergency medical services (EMS) workers, respectively.

Methods: We designed a survey about hand hygiene practices. The survey was distributed to various national EMS organizations through e-mail. Descriptive statistics were calculated for survey items (responses on a Likert scale) and subpopulations of survey respondents to identify relationships between variables. We used analysis of variance to test differences in means between the subgroups.

Results: There were 1,494 responses. Overall, reported hand hygiene practices were poor among pre-hospital providers in all clinical situations. Women reported that they washed their hands more frequently than men overall, although the differences were unlikely to be clinically significant. Hygiene after invasive procedures was reported to be poor. The presence of available hand sanitizer in the ambulance did not improve reported hygiene rates but improved reported rates of cleaning the stethoscope (absolute difference 0.4, p=0.0003). Providers who brought their own sanitizer were more likely to clean their hands.

Conclusion: Reported hand hygiene is poor amongst pre-hospital providers. There is a need for future intervention to improve reported performance in pre-hospital provider hand washing.
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INTRODUCTION

Healthcare worker compliance with hand hygiene remains a pervasive problem in medicine. Physicians have notoriously poor compliance.[1-3] The lack of hand hygiene compliance results in transmission of community-acquired and hospital-acquired microorganisms between both patients and providers, which can lead to nosocomial infections. Unfortunately, compliance remains stubbornly low despite efforts to change. While poor hand hygiene is prevalent in the hospital, these behaviors may also be similar among pre-hospital providers. However, hygienic behavior has been infrequently studied in the pre-hospital healthcare worker population despite the fact that it is a key part of the healthcare system

Pre-hospital emergency care inherently increases the risks of spreading infection. Pre-hospital providers often have contact with multiple patients per day, with varying conditions and states of immunocompetence. Hand washing compliance among pre-hospital providers has not been studied in the United States. Emergency medical technicians and paramedics frequently come into contact with patients in their homes or other social environments. Their unique role and practice environment could permit the transmission of a high burden of nosocomial inocula to patients or introduce community-acquired infections into the hospital.

A 2011 study identified that patients who were treated and transported by Advanced Life Support (ALS) paramedics had a higher rate of nosocomial infection than patients not transported by ALS. While this study was a retrospective review of admitted patients, ALS transport was associated with an odds ratio (OR) of 1.42 for suffering from a nosocomial infection, compared to patients with community-acquired infections.[4] Admittedly, there may be a bias that ALS transported more ill patients who may be at risk of nosocomial infection at baseline.

Since emergency medical services (EMS) providers also operate the ambulance, there are many places for ambulance and personal equipment to become contaminated. One German study found that the highest areas of contamination were blood pressure cuffs, stethoscopes and the hand-washing area (not found on U.S., ambulances).[5] Disposing of multi-use items may quickly prove cost prohibitive when considering the high volume of emergency service calls in many systems.

Moreover, there is room for improvement within EMS providers' hand hygiene practices as well as ambulance and equipment cleaning. Merlin et al. found that 32% (16/50) of the stethoscopes used in a single EMS agency (providing both basic and ALS) grew methicillin-resistant *Staphylococcus aureus* (MRSA), and that 32% (16/50) of employees did not know the last time they had cleaned their stethoscopes. It also found that time from last cleaning was significantly associated with an increased chance of culturing MRSA (OR 1.86).[6]

Studying EMS worker hand hygiene practices is important for several reasons. Determining the rates of pre-hospital hand hygiene will help medical directors and educators develop policies to increase awareness and identify shortcomings in pre-hospital hygiene. It may also help identify obstacles to hand hygiene that prevent EMS providers from cleaning their hands adequately. It could help reduce transmission of microorganisms between patients and EMS providers and prevent contamination of equipment that patients frequently come into contact with, such as backboards, cervical collars, blood pressure cuffs, stethoscopes and other patient transport devices.

Our primary goal is to determine the rates of hand hygiene practices in a broad spectrum of EMS healthcare providers across a variety of clinical situations. Our secondary goal is to show the rates of providers' stethoscope cleaning. We expect our results to lead to further investigation of obstacles and potential solutions to the problem of infection control in the EMS setting.

METHODS

We designed an online survey distributed to EMS providers with questions about demographics and hand hygiene practices. The survey was sent to various organizations through a standardized e-mail that explained the purpose of the study, our goals, the length of the study and a link to the online survey (Appendix A). We used a convenience sample of EMS providers across a range of organizations to achieve a varied group (Appendix B).

Since the survey was sent out to large organizations for them to send to their distribution lists on a voluntary basis, we are unable to calculate a response rate.

The survey was designed to inquire about hand hygiene practices during different points of an EMS run, including prior to arrival at the scene, during patient treatment and after patient transfer. It was reviewed by all study members prior to distribution. The survey was screened by several EMS healthcare providers prior to generalized distribution in order to assess for appropriateness. Their feedback was incorporated into the survey in terms of the question inclusion, design and answer choices.

The survey received institutional review board approval at our institution.

We calculated frequencies as well as means with standard deviations (SDs) for each item on the survey. Means for hygiene items (responses ranged on a Likert scale from 1=Never to 5=Every time) were calculated for each subgroup. We defined subgroups by gender, age, level of training, whether paid/volunteer/both, years of experience, hygiene training, Body Substance Isolation (BSI) training, whether or not there was sanitizer in the ambulance or ambulance station, and the provider having his or her own sanitizer. Analysis of variance (ANOVA) was used to test differences in means between the subgroups. We used multivariate analysis of variance (MANOVA) to examine whether the cleaning responses were collectively different by subgroup. In these models, we included only a single predictor at a time.

Multivariable linear models were used to examine which predictors uniquely contributed to each response. In particular, we used a backwards stepwise regression model with all variables, with p-values greater than 0.05 eliminated from the model. Note that due to the large sample size and a desire to avoid over-fitting, we chose to use a strict alpha value (0.05) for the exit criteria. Also, note that in order to maintain comparability between models, only observations with data for all participant characteristics were included in these linear models.

We used proportional odds modeling as a means to determine the correct predictors for a multivariable model. Since results were similar to those obtained from the standard linear modeling, results are further described.

Physicians who responded were all EMS physicians who provided some pre-hospital supervision, education and administrative duties of the organization. The exact amount of pre-hospital patient contact was not investigated.

RESULTS

There were 1,494 survey respondents. Overall frequencies (percentages) as well as means with SDs are presented in Figure 1. Mean responses stratified by participant characteristics are presented in Figure 2, along with p-values for differences between the subgroups, 95% confidence

	Responses					
Variable	Male	Female				Mean (SD)
Gender	1,073 (72%)	421 (28%)				
	18–29	30–39	40–49	50–59	60+	
Age	416 (28%)	360 (24%)	367 (25%)	249 (17%)	104 (7%)	
	First responder	EMT	AEMT	Paramedic	Physician	
Training	41 (3%)	667 (45%)	64 (4%)	705 (47%)	16 (1%)	
	Volunteer	Paid	Both			
Paid/volunteer	386 (26%)	810 (56%)	272 (18%)			
	1–5	6–10	10–19	20–29	30+	
Years of experience	366 (25%)	256 (17%)	447 (30%)	276 (18%)	155 (10%)	
	Once	Multiple	Never			
BBP training	129 (9%)	1,336 (89%)	26 (2%)			
	Once	Multiple	Never			
BSI training	106 (7%)	1,370 (92%)	14 (1%)			
	Yes	No				
Sanitizer in ambulance	1,387 (94%)	95 (6%)				
	Yes	No				
Sanitizer in station	1,365 (92%)	126 (8%)				
	Yes	No				
Brings own sanitizer	380 (25%)	1,113 (75%)				
	Never	Rarely	Sometimes	Most of the time	Every time	
Cleans before patient	175 (12%)	394 (26%)	343 (23%)	394 (26%)	190 (13%)	3.0 (1.2)
Cleans after skin contact	21 (1%)	66 (4%)	165 (11%)	430 (29%)	813 (54%)	4.3 (0.9)
Cleans when contact finishes	2 (<1%)	6 (<1%)	76 (5%)	412 (28%)	997 (67%)	4.6 (0.6)
Uses gloves	1 (<1%)	16 (1%)	167 (11%)	522 (35%)	779 (52%)	4.4 (0.7)
Uses gloves with equipment	40 (3%)	252 (17%)	579 (39%)	454 (31%)	159 (11%)	3.3 (1.0)
Cleans after using equipment	28 (2%)	199 (13%)	435 (24%)	492 (33%)	332 (22%)	3.6 (1.0)
Cleans after driving	134 (9%)	341 (23%)	397 (27%)	329 (22%)	264 (18%)	3.2 (1.2)
Cleans after invasive procedures	228 (16%)	273 (19%)	227 (16%)	218 (16%)	456 (33%)	3.3 (1.5)
Cleans stethoscope	99 (7%)	223 (16%)	490 (34%)	426 (30%)	186 (13%)	3.3 (1.1)

Figure 1. Frequencies (percentages) and means (standard deviations, SDs) for participant characteristics and responses of emergency medical services personnel in hand hygiene study.
EMT, emergency medical technician; *AEMT*, advanced emergency medical technician; *BSI*, body substance isolation; *BBP,* blood borne pathogens

Variable	Responses			Mean (SD)
	Male	Female		
	Soap	Sanitizer	Do not clean after	
Cleans after hands visibly contaminated	1258 (84%)	239 (16%)		
	Soap	Sanitizer	No preference	
Soap or Sanitizer preference	1059 (71%)	255 (17%)	185 (12%)	
	Yes	No	I don't know	
Must use soap with GI illness	839 (56%)	534 (36%)	124 (8%)	

Figure 1. Continued.

Responder characteristic		Response								
		Clean before contact	Clean after skin	Clean after over	Gloves	Gloves supplies	Clean after equipment	Clean driving	Clean invasive procedures	Stethoscope
Gender	Male	2.9 (1.2) 2.9, 3.0 1071	4.3 (0.9) 4.2, 4.3 1071	4.6 (0.6) 4.5, 4.6 1068	4.4 (0.8) 4.3, 4.4 1064	3.3 (1.0) 3.2, 3.3 1064	3.6 (1.0) 3.5, 3.6 1065	3.1 (1.2) 3.0, 3.2 1060	3.2 (1.5) 3.1, 3.3 1018	3.2 (1.1) 3.1, 3.3 1022
	Female	3.2 (1.2) 3.1, 3.3 419	4.4 (0.9) 4.3, 4.5 418	4.7 (0.5) 4.7, 4.8 419	4.4 (0.7) 4.4, 4.5 415	3.4 (0.9) 3.3, 3.5 415	3.7 (1.1) 3.6, 3.8 415	3.3 (1.3) 3.2, 3.4 399	3.6 (1.5) 3.4, 3.7 378	3.4 (1.1) 3.3, 3.5 396
	MANOVA p<0.0001	*<0.0001*	*0.0038*	*<0.0001*	*0.29*	*0.052*	*0.22*	*0.0057*	*<0.0001*	*0.0010*

Figure 2. Mean response (standard deviations) stratified by responder characteristics, followed by the 95% confidence interval in the 2nd line, and the absolute number of responses in the 3rd line, per response category. P-values (in italics) are included to test for differences in means of individual responses based on responder characteristic. Multivariate analysis of variance (MANOVA) p-values test whether there is a measurable collective difference over all responses.
MANOVA, multivariate analysis of variance

intervals (CI) and the absolute number of responses.

Women reported that they were significantly more likely to clean their hands across almost every category, especially before patient contact and after performing invasive procedures ($p<0.0001$ for both). The largest gender difference in reported hand hygiene was seen after invasive procedures, with a mean difference on the Likert scale of 0.4 (Males, 95% CI [3.1–3.3]; Females, 95% CI [3.4–3.7]) Overall, women were reportedly more likely to clean their hands in almost every single situation in the survey; absolute differences were small and ranged from 0.1–0.2, and may not be clinically significant.

Increased respondent age was also associated with significantly higher likelihood of reported hand hygiene. Specifically, those 60 years of age or older stated that they were more likely to clean their hands before patient contact, after driving the ambulance and after performing invasive procedures, as opposed to all of the age groups below them ($p<0.0001$ for all three). The difference on the Likert scale for the three aforementioned situations are 0.5, 0.7, and 0.6 respectively, which suggests a clinical difference.

Level of training and years of experience did not provide many clear relationships regarding hand hygiene practices. However, contrary to most studies performed in the in-hospital environment, EMS physicians were found to clean their hands significantly more than most other groups, specifically in the before patient contact category (largest difference of 1.1, $p<0.0001$) and after invasive procedures (largest difference of 1.3, $p<0.0001$). Although the absolute numbers of physician responses was low, it maintained statistical significance.

Age	18-29	2.9 (1.1) 2.8, 3.0 416	4.3 (0.9) 4.2, 4.4 416	4.5 (0.7) 4.4, 4.6 415	4.4 (0.7) 4.3, 4.5 411	3.3 (1.0) 3.2, 3.4 413	3.4 (1.1) 3.3, 3.5 414	2.8 (1.2) 2.7, 2.9 401	3.4 (1.5) 3.2, 3.5 391	3.2 (1.1) 3.1, 3.3 399
	30-39	2.9 (1.3) 2.8, 3.0 360	4.3 (0.9) 4.2, 4.4 360	4.6 (0.6) 4.5, 4.6 358	4.4 (0.7) 4.3, 4.5 357	3.3 (0.9) 3.3, 3.4 358	3.7 (1.0) 3.6, 3.8 356	3.2 (1.2) 3.1, 3.3 357	3.0 (1.5) 2.9, 3.2 349	3.3 (1.0) 3.2, 3.4 346
	40-49	3.1 (1.2) 2.9, 3.2 365	4.3 (1.0) 4.2, 4.4 366	4.7 (0.6) 4.6, 4.7 364	4.4 (0.7) 4.3, 4.5 364	3.3 (0.9) 3.2, 3.4 362	3.7 (1.0) 3.6, 3.8 364	3.3 (1.1) 3.2, 3.5 364	3.1 (1.5) 2.9, 3.3 351	3.2 (1.1) 3.1, 3.3 347
	50-59	3.2 (1.2) 3.1, 3.4 247	4.4 (1.0) 4.2, 4.5 245	4.7 (0.6) 4.6, 4.8 248	4.4 (0.7) 4.3, 4.5 246	3.3 (1.0) 3.2, 3.4 247	3.7 (1.1) 3.6, 3.8 246	3.3 (1.2) 3.2, 3.5 242	3.5 (1.5) 3.3, 3.7 219	3.3 (1.1) 3.1, 3.4 231
	60+	3.4 (1.3) 3.1, 3.6 104	4.4 (0.9) 4.2, 4.6 104	4.7 (0.5) 4.6, 4.8 104	4.3 (0.7) 4.2, 4.5 103	3.1 (1.0) 2.9, 3.3 100	3.5 (1.0) 3.3, 3.7 102	3.5 (1.0) 3.2, 3.7 98	4.0 (1.3) 3.7, 4.2 88	3.4 (1.1) 3.2, 3.6 97
	MANOVA p<0.0001	*<0.0001*	*0.47*	*<0.0001*	*0.73*	*0.091*	*<0.0001*	*<0.0001*	*<0.0001*	*0.44*
Training	First responder	3.2 (1.2) 2.8, 3.6 41	4.6 (0.8) 4.3, 4.8 41	4.7 (0.6) 4.5, 4.9 41	4.6 (0.6) 4.4, 4.8 40	3.6 (1.1) 3.2, 3.9 41	3.9 (1.0) 3.6, 4.2 40	3.3 (1.5) 2.8, 3.7 40	4.2 (1.2) 3.8, 4.7 33	3.5 (1.2) 3.1, 4.0 33
	EMT	3.0 (1.2) 2.9, 3.1 665	4.3 (0.9) 4.3, 4.4 664	4.6 (0.6) 4.6, 4.7 664	4.4 (0.7) 4.3, 4.5 662	3.3 (1.0) 3.2, 3.4 658	3.5 (1.1) 3.4, 3.6 661	3.2 (1.2) 3.1, 3.3 641	3.5 (1.5) 3.4, 3.7 591	3.2 (1.1) 3.1, 3.3 632
	AEMT	3.6 (1.3) 3.3, 3.9 64	4.5 (0.9) 4.2, 4.7 64	4.7 (0.6) 4.5, 4.8 64	4.6 (0.6) 4.4, 4.7 63	3.5 (0.9) 3.3, 3.8 64	4.1 (0.9) 3.9, 4.3 62	3.5 (1.3) 3.1, 3.8 63	3.7 (1.4) 3.4, 4.1 62	3.5 (1.1) 3.3, 3.8 64
	Paramedic	3.0 (1.2) 2.9, 3.1 704	4.2 (0.9) 4.2, 4.3 704	4.6 (0.6) 4.5, 4.6 702	4.4 (0.8) 4.3, 4.4 699	3.3 (0.9) 3.2, 3.3 700	3.7 (1.0) 3.6, 3.7 701	3.1 (1.2) 3.1, 3.2 700	3.0 (1.4) 2.9, 3.1 696	3.3 (1.0) 3.2, 3.4 674
	Physician	4.1 (1.0) 3.5, 4.6 15	4.3 (0.8) 3.8, 4.7 15	4.7 (0.6) 4.3, 5.0 15	4.1 (1.0) 3.5, 4.6 15	3.4 (1.0) 2.8, 3.9 14	3.8 (1.1) 3.2, 4.4 15	3.1 (1.3) 2.3, 3.8 14	4.3 (1.1) 3.7, 4.9 15	3.7 (1.0) 3.2, 4.3 15
	MANOVA p<0.0001	*<0.0001*	*0.078*	*0.50*	*0.019*	*0.087*	*<0.0001*	*0.39*	*<0.0001*	*0.022*

Figure 2. Continued.
EMT, emergency medical technician; *AEMT*, advanced emergency medical technician; *MANOVA*, multivariate analysis of variance

Paid EMS providers were slightly more likely to report hand hygiene after using equipment, whereas volunteer EMS providers were more likely to report they cleaned their hands after invasive procedures. However, neither of these findings is likely to be clinically significant.

Surprisingly, the presence of hand sanitizer in the ambulance did not make a difference in hand hygiene, except it slightly increased the likelihood of providers cleaning their stethoscopes (p=0.041). However, the presence of hand sanitizer in the ambulance bay was significantly associated with reported increased hand hygiene before patient contact (absolute difference 0.5, p=0.0001) and cleaning the stethoscope (absolute difference 0.4, p=0.0003). This may imply that the availability of cleaning agents just prior to being dispatched may increase hand hygiene compliance. This could be a subtle but important outcome, given our previous finding.

Providers who brought their own hand sanitizer were more likely to clean their hands before patient contact (absolute

Status	Volunteer	3.1 (1.2) 2.9, 3.2 386	4.3 (0.9) 4.2, 4.4 384	4.7 (0.6) 4.6, 4.7 383	4.3 (0.7) 4.3, 4.4 380	3.3 (1.0) 3.2, 3.4 379	3.4 (1.1) 3.3, 3.5 380	3.1 (1.3) 3.0, 3.3 360	3.7 (1.5) 3.5, 3.8 325	3.1 (1.2) 3.0, 3.2 326
	Paid	3.0 (1.3) 2.9, 3.1 816	4.3 (0.9) 4.2, 4.4 817	4.6 (0.6) 4.5, 4.6 816	4.4 (0.7) 4.4, 4.5 812	3.3 (0.9) 3.3, 3.4 813	3.7 (1.0) 3.6, 3.8 817	3.2 (1.2) 3.1, 3.3 812	3.1 (1.5) 3.0, 3.2 795	3.3 (1.1) 3.2, 3.4 779
	Both	3.1 (1.1) 2.9, 3.2 271	4.2 (0.9) 4.1, 4.3 271	4.6 (0.6) 4.5, 4.6 271	4.3 (0.8) 4.2, 4.4 270	3.2 (0.9) 3.1, 3.3 270	3.5 (1.0) 3.4, 3.6 266	3.1 (1.2) 3.0, 3.3 270	3.3 (1.4) 3.1, 3.5 259	3.4 (1.0) 3.2, 3.5 267
	MANOVA p<0.0001	*0.32*	*0.35*	*0.15*	*0.042*	*0.22*	*<0.0001*	*0.81*	*<0.0001*	*0.010*
Years experience	1-5	3.0 (1.2) 2.9, 3.2 364	4.4 (0.9) 4.3, 4.5 365	4.5 (0.7) 4.5, 4.6 365	4.6 (0.6) 4.5, 4.6 362	3.5 (1.0) 3.4, 3.6 362	3.5 (1.1) 3.4, 3.6 363	3.0 (1.3) 2.9, 3.2 346	3.7 (1.5) 3.5, 3.8 335	3.2 (1.2) 3.1, 3.3 348
	6-10	2.9 (1.2) 2.8, 3.1 255	4.2 (0.9) 4.1, 4.3 256	4.5 (0.6) 4.5, 4.6 255	4.4 (0.7) 4.4, 4.5 254	3.3 (1.0) 3.2, 3.4 255	3.5 (1.0) 3.4, 3.6 255	3.1 (1.2) 2.9, 3.2 251	3.1 (1.6) 2.9, 3.3 238	3.4 (1.1) 3.2, 3.5 245
	10-19	2.9 (1.2) 2.8, 3.0 447	4.2 (1.0) 4.1, 4.3 444	4.6 (0.6) 4.6, 4.7 446	4.3 (0.7) 4.3, 4.4 442	3.3 (0.9) 3.2, 3.3 442	3.7 (1.0) 3.6, 3.8 440	3.2 (1.2) 3.1, 3.3 441	3.1 (1.4) 3.0, 3.3 417	3.3 (1.1) 3.2, 3.4 422
	20-29	3.1 (1.2) 3.0, 3.2 275	4.3 (0.9) 4.2, 4.4 275	4.6 (0.6) 4.6, 4.7 273	4.2 (0.8) 4.1, 4.3 273	3.2 (0.9) 3.1, 3.3 275	3.6 (1.0) 3.5, 3.7 273	3.3 (1.1) 3.1, 3.4 274	3.2 (1.4) 3.0, 3.4 264	3.2 (1.0) 3.0, 3.3 259
	30+	3.3 (1.2) 3.1, 3.5 155	4.3 (1.0) 4.2, 4.5 155	4.7 (0.5) 4.6, 4.8 154	4.3 (0.7) 4.2, 4.4 154	3.2 (1.1) 3.0, 3.3 150	3.6 (1.1) 3.5, 3.8 155	3.3 (1.3) 3.1, 3.5 153	3.4 (1.5) 3.1, 3.6 148	3.4 (1.0) 3.3, 3.6 150
	MANOVA p<0.0001	*0.0025*	*0.053*	*0.0078*	*<0.0001*	*0.0004*	*0.016*	*0.013*	*<0.0001*	*0.043*
Hygiene training	Yes, once	2.7 (1.3) 2.5, 2.9 129	4.3 (0.9) 4.2, 4.5 129	4.5 (0.7) 4.4, 4.7 129	4.4 (0.7) 4.3, 4.6 127	3.3 (1.0) 3.1, 3.5 126	3.4 (1.12) 3.2, 3.6 128	3.0 (1.3) 2.8, 3.3 120	3.7 (1.5) 3.4, 4.0 117	2.9 (1.2) 2.7, 3.1 119
	Yes, multiple times	3.1 (1.2) 3.0, 3.1 1333	4.3 (0.9) 4.2, 4.3 1331	4.6 (0.6) 4.6, 4.6 1329	4.4 (0.7) 4.3, 4.4 1324	3.3 (1.0) 3.2, 3.3 1325	3.6 (1.0) 3.6, 3.7 1324	3.2 (1.2) 3.1, 3.3 1313	3.2 (1.5) 3.2, 3.3 1255	3.3 (1.1) 3.3, 3.4 1273
	No	2.7 (1.3) 2.2, 3.2 26	4.6 (0.6) 4.3, 4.8 26	4.3 (0.8) 4.0, 4.7 26	4.5 (0.6) 4.2, 4.7 26	3.3 (0.8) 2.9, 3.6 25	3.2 (1.1) 2.8, 3.6 25	2.9 (1.4) 2.3, 3.5 24	3.4 (1.6) 2.7, 4.1 22	2.6 (1.3) 2.1, 3.2 25

Figure 2. Continued.
MANOVA, multivariate analysis of variance

difference 0.6), after using equipment (absolute difference 0.3), driving (absolute difference 0.3) ($p<0.0001$ for all three), or performing invasive procedures (absolute difference 0.3, $p=0.0003$). They also reported they were more likely to clean their own stethoscope (absolute difference 0.6, $p< 0.0001$).

DISCUSSION

Our study represents the largest study to date of EMS personnel and hand hygiene. While only a few studies have investigated hand hygiene and infections in the pre-hospital environment, historically, compliance has been poor among

	MANOVA p<0.0001	*0.0064*	*0.27*	*0.043*	*0.55*	*0.97*	*0.014*	*0.18*	*0.013*	*<0.0001*
BSI training	Yes, once	2.6 (1.2) 2.3, 2.8 106	4.3 (1.0) 4.1, 4.5 106	4.5 (0.7) 4.4, 4.6 106	4.5 (0.7) 4.3, 4.6 103	3.2 (1.0) 3.0, 3.4 105	3.3 (1.1) 3.1, 3.5 105	3.0 (1.4) 2.7, 3.3 98	3.6 (1.5) 3.3, 3.9 93	2.8 (1.1) 2.6, 3.0 99
	Yes, multiple times	3.1 (1.2) 3.0, 3.1 1366	4.3 (0.9) 4.3, 4.4 1365	4.6 (0.6) 4.6, 4.7 1363	4.4 (0.7) 4.3, 4.4 1355	3.3 (1.0) 3.3, 3.4 1355	3.6 (1.0) 3.6, 3.7 1358	3.2 (1.2) 3.1, 3.3 1343	3.3 (1.5) 3.2, 3.3 1289	3.3 (1.1) 3.3, 3.4 1304
	No	2.9 (1.3) 2.1, 3.6 14	4.3 (0.7) 3.9, 4.7 14	4.1 (0.9) 3.6, 4.7 14	4.4 (0.6) 4.1, 4.8 14	3.2 (1.1) 2.6, 3.8 14	3.1 (1.3) 2.3, 3.8 14	2.6 (1.5) 1.8, 3.5 14	3.4 (1.6) 2.3, 4.4 11	2.6 (1.5) 1.6, 3.5 12
	MANOVA p<0.0001	*0.0004*	*0.99*	*0.0017*	*0.53*	*0.58*	*0.0004*	*0.097*	*0.089*	*<0.0001*
Soap in ambulance	Yes	3.0 (1.2) 3.0, 3.1 1385	4.3 (0.9) 4.3, 4.4 1383	4.6 (0.6) 4.6, 4.6 1381	4.4 (0.7) 4.4, 4.4 1376	3.3 (1.0) 3.2, 3.3 1375	3.6 (1.0) 3.6, 3.7 1374	3.2 (1.2) 3.1, 3.2 1357	3.3 (1.5) 3.2, 3.4 1299	3.3 (1.1) 3.2, 3.3 1315
	No	2.9 (1.2) 2.7, 3.2 95	4.1 (1.1) 3.9, 4.4 95	4.5 (0.7) 4.3, 4.6 95	4.4 (0.8) 4.2, 4.5 93	3.2 (1.1) 3.0, 3.4 94	3.5 (1.2) 3.3, 3.8 95	3.0 (1.2) 2.7, 3.2 94	3.4 (1.5) 3.1, 3.7 90	3.0 (1.0) 2.8, 3.2 93
	MANOVA p=0.19	*0.41*	*0.076*	*0.014*	*0.87*	*0.42*	*0.58*	*0.090*	*0.41*	*0.041*
Soap in bay/station	Yes	3.1 (1.2) 3.0, 3.1 1362	4.3 (0.9) 4.3, 4.4 1361	4.6 (0.6) 4.6, 4.7 1360	4.4 (0.7) 4.4, 4.4 1351	3.3 (1.0) 3.3, 3.4 1352	3.6 (1.0) 3.6, 3.7 1354	3.2 (1.2) 3.1, 3.3 1332	3.3 (1.5) 3.2, 3.4 1278	3.3 (1.1) 3.2, 3.4 1292
	No	2.6 (1.2) 2.4, 2.8 125	4.1 (1.1) 3.9, 4.3 125	4.4 (0.7) 4.3, 4.6 124	4.3 (0.7) 4.2, 4.5 126	3.1 (1.0) 2.9, 3.3 124	3.3 (1.1) 3.1, 3.5 124	2.9 (1.2) 2.7, 3.1 125	3.1 (1.5) 2.9, 3.4 116	2.9 (1.1) 2.7, 3.1 124
	MANOVA p=0.0075	*0.0001*	*0.0040*	*0.0009*	*0.38*	*0.043*	*0.0028*	*0.016*	*0.23*	*0.0003*
Bring own soap	Yes	3.5 (1.2) 3.4, 3.6 350	4.4 (0.9) 4.4, 4.5 379	4.8 (0.5) 4.7, 4.8 379	4.4 (0.7) 4.3, 4.5 377	3.4 (1.0) 3.3, 3.5 376	3.8 (1.0) 3.7, 3.9 376	3.4 (1.1) 3.3, 3.6 374	3.5 (1.4) 3.4, 3.7 362	3.7 (1.0) 3.6, 3.8 367
	No	2.9 (1.2) 2.8, 2.9 1109	4.3 (0.9) 4.2, 4.3 1109	4.6 (0.6) 4.5, 4.6 1107	4.4 (0.7) 4.3, 4.4 1101	3.3 (1.0) 3.2, 3.3 1101	3.5 (1.0) 3.5, 3.6 1103	3.1 (1.2) 3.0, 3.1 1085	3.2 (1.5) 3.1, 3.3 1034	3.1 (1.1) 3.1, 3.2 1050
	MANOVA p<0.0001	*<0.0001*	*0.0005*	*<0.0001*	*0.39*	*0.21*	*<0.0001*	*<0.0001*	*0.0003*	*<0.0001*

Figure 2. Continued.
MANOVA, multivariate analysis of variance

healthcare providers. Despite simple solutions like alcohol gels, hand hygiene in the healthcare environment remains a concern.

Our study echoes a previous finding that women were reportedly more likely to clean their hands.[7]

The fact that older respondents reported that they were more likely to wash their hands was an unexpected finding, given the time spent on education for newer healthcare providers about the importance of BSI and the more contemporary, ubiquitous glove use. The recent push by the Centers for Disease Control and Medicare for prevention of infection by hand hygiene may not have had the desired effect on the younger population. Confusingly, other studies have shown that more experienced providers are actually less likely to clean their hands.[8] Perhaps the providers'

unique setting in EMS has led them to clean their hands more because they perform more frequent procedures. This result may inform the development of future education for hand hygiene.

The increased likelihood of physicians to report they cleaned their hands may both reflect the education physicians receive on the importance of hand hygiene for the prevention of disease transmission both to and from the patient, as well as physicians' direct interaction with known healthcare-acquired infections. Furthermore, sterile technique procedural education may have played a role. Finally, at least in the United States, their direct participation in field EMS is relatively uncommon outside of the educational arena. The specific situations requiring their involvement may be more likely to be more associated with more ill patients requiring procedures.

Providers who did not experience hand hygiene or BSI training reported they were less likely to clean their stethoscopes than those who had experienced it once or multiple times ($p<0.0001$). This may be a direct relationship between the amounts of training received and how often providers clean their stethoscopes. This is an important finding, since Merlin, et al. found a significant number of paramedics' stethoscopes were colonized with MRSA.[8] An increased rate of stethoscope cleaning could potentially lead to a decreased level of MRSA and other nosocomial infection transmission. This is an area where further research is required to identify a causal rather than associative relationship between infection training and stethoscope cleaning.

Consideration could be given to supplying each EMS provider with personal hand sanitizer, as it appears to be associated with increased reported hand hygiene. This is an inexpensive and potentially positive intervention, and should prompt further research.

We expected the increased availability of sanitizer in the ambulance to make a difference in hand hygiene due to its proximity to the EMS providers and ease of access. In-hospital studies have shown that the placement of gel dispensers has increased the compliance with hand hygiene.[9-11] Therefore, our finding deserves further study on the effects of having hand sanitizer easily available in the ambulance.

There were several concerning findings in this study that require further discussion. Nearly 10% of the respondents either only received blood borne pathogens training or BSI training once or never in their training. This is alarming, given the importance of infection prevention, and when combined with the trend seen in the study, future educational efforts on hand hygiene behavior might have a significant impact.

The reported compliance in situations involving invasive procedures was very concerning. Only 33% reported that they clean their hands after invasive procedures, and 16% reported that the never clean after invasive procedures. Despite the education efforts addressing hygiene, this is a troubling finding, which can potentially increase the risk of disease transmission. In the setting of pre-hospital medicine, with invasive procedures being performed in a non-sterile environment, such as the outdoors, or done in the moving environment of the back of an ambulance, the potential for an exposure significantly increases. Future efforts should be targeted to address this issue, such as supplying personal sanitizer to providers.

In addition, only 56% of the respondents knew that after treating patients with gastrointestinal illnesses, hand washing should occur with soap and water, due to pathogens that are not killed by alcohol-based sanitizers, such as Clostridium difficile and Norwalk virus.[12] Only 52% of respondents reported that they use gloves with every patient contact. Likewise, only 33% of respondents reported that they cleaned their hands after performing invasive procedures; however, this statistic may be skewed due to the lack of available hand hygiene supplies in the ambulance.

Only 13% reported cleaning their stethoscopes, which is concerning, given the above mentioned study by Merlin et al. about the presence of MRSA on paramedics' stethoscopes.

Furthermore, only 13% reported cleaning their hands before patient contact. These are all troubling findings, and they identify areas where further education can provide direct results and increase hygiene compliance in these situations.

LIMITATIONS

We acknowledge several limitations in our study. First, despite our large number of completed surveys, we used a convenience sample so there may have been a selection bias, in that those who chose to respond felt a personal interest, and therefore may have been more likely to over-estimate their hand hygiene practices. Likewise, we used self-report rather than direct observation of cleaning practices which may also have over-estimated the prevalence of hand hygiene. However, since both of these would be expected to skew the results in an over-estimate of actual practice, the areas of concern identified remain striking. Furthermore, we are unable to calculate a response rate due to the method of distribution of the study.

It would be resource intensive and impractical to employ a better methodology to study this topic, such as direct observation. Providing observers to be present on all of the ambulances, or a small selection of ambulances, is time consuming, requires a large amount of resources and is impractical as ambulances do not contain extra space and are cramped to operate in. Likewise, bias may be introduced if the EMS workers realize that they are having their hand washing practices observed, which may lead to a Hawthorne effect.

We note inherent difficulties similar to all retrospective studies in that there may have been recall bias and the findings may only represent an association rather than causal relationship. For example, providers who carry their own hand sanitizer may be particularly attuned to hygiene, and it may not therefore be true that simply issuing sanitizer to all providers will improve hygiene practices for all providers. We

also recognize that some of the associations identified may be due to the number of subgroups examined.

Similarly, although many of the results were statistically significant, due to the small absolute difference between the answers, they may not be clinically significant. Also, there may have been geographic bias. While the survey was distributed nationally, we did not know in which area of the country our respondents were practicing. In addition, the response rate per organization is not known.

CONCLUSION

Our study represents the largest study to date examining the relationship between EMS providers and hand hygiene.

Hand hygiene was reportedly poor overall. Two areas that require further investigation, based on the reportedly poor cleaning, are education on hand hygiene for providers, as well as supplying providers with individual bottles of hand sanitizer. In addition, future education should focus on the importance of cleaning the providers' stethoscopes, washing hands after any patient contact and the proper technique to clean after exposure to patients with gastrointestinal illness, as these were areas of reportedly poor performance. In an era focused on prevention of disease transmission not only from patient to provider, but provider to patient, this information offers a first step in identifying the problems with EMS provider hygiene, and should prompt more research in this area in order to increase compliance and improve infection rates.

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Telephone CPR Instructions in Emergency Dispatch Systems: Qualitative Survey of 911 Call Centers

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Introduction: Out-of-hospital cardiac arrest (OHCA) is a leading cause of death. The 2010 American Heart Association Emergency Cardiovascular Care (ECC) Guidelines recognize emergency dispatch as an integral component of emergency medical service response to OHCA and call for all dispatchers to be trained to provide telephone cardiopulmonary resuscitation (T-CPR) pre-arrival instructions. To begin to measure and improve this critical intervention, this study describes a nationwide survey of public safety answering points (PSAPs) focusing on the current practices and resources available to provide T-CPR to callers with the overall goal of improving survival from OHCA.

Methods: We conducted this survey in 2010, identifying 5,686 PSAPs; 3,555 had valid e-mail addresses and were contacted. Each received a preliminary e-mail announcing the survey, an e-mail with a link to the survey, and up to three follow-up e-mails for non-responders. The survey contained 23 primary questions with sub-questions depending on the response selected.

Results: Of the 5,686 identified PSAPs in the United States, 3,555 (63%) received the survey, with 1,924/3,555 (54%) responding. Nearly all were public agencies (n=1,888, 98%). Eight hundred seventy-eight (46%) responding agencies reported that they provide no instructions for medical emergencies, and 273 (14%) reported that they are unable to transfer callers to another facility to provide T-CPR. Of the 1,924 respondents, 975 (51%) reported that they provide pre-arrival instructions for OHCA: 67 (3%) provide compression-only CPR instructions, 699 (36%) reported traditional CPR instructions (chest compressions with rescue breathing), 166 (9%) reported some other instructions incorporating ventilations and compressions, and 92 (5%) did not specify the type of instructions provided. A validation follow up showed no substantial difference in the provision of instructions for OHCA by non-responders to the survey.

Conclusion: This is the first large-scale, nationwide assessment of the practices of PSAPs in the United States regarding T-CPR for OHCA. These data showing that nearly half of the nation's PSAPs do not provide T-CPR for OHCA, and very few PSAPs provide compression-only instructions, suggest that there is significant potential to improve the implementation of this critical link in the chain of survival for OHCA. [West J Emerg Med. 2015;16(5):736-742.]

INTRODUCTION

Out-of-hospital cardiac arrest (OHCA) is a leading cause of death in the United States with a survival rate of less than 8%.[1,2] The American Heart Association (AHA) has promulgated the "Chain of Survival" as a framework for the successful resuscitation of victims of OHCA.[3] The timing and quality of care provided in the first link of the "Chain" (immediate recognition and early bystander cardiopulmonary resuscitation [CPR]) is strongly associated with improved survival from cardiac arrest, yet bystander CPR is performed in less than one-half of all OHCAs.[3-6] Telephone-CPR (T-CPR) is the delivery of compression and/or ventilation instructions to callers of suspected OHCA cases. T-CPR has been recognized as an integral component of an emergency medical system response to OHCA and holds enormous potential to increase bystander response and thus survival from cardiac arrest.[7] Guidelines call for all dispatchers to be appropriately trained to provide T-CPR instructions and have an ongoing quality improvement mechanism to assure that all unresponsive adults who are not breathing normally receive appropriate T-CPR instructions as early as possible.[8,9]

A Public Safety Answering Point (PSAP) is a call center responsible for answering calls to an emergency telephone number for police, firefighting, and ambulance services. The purpose of this study is to describe current practices and resources available at the 9-1-1 call centers to provide T-CPR instructions to callers of OHCA events in the U.S.

METHODS

A survey of public safety answering points (PSAPs) in the U.S. and Canada was commissioned by the Emergency Cardiac Care Committee of the AHA to determine the availability of T-CPR instructions for medical emergencies. It was estimated that there are approximately 7,000 PSAP call centers that receive 9-1-1 emergency calls for law enforcement, fire, or medical emergencies in the United States, and this report focuses on the U.S. component of the survey.

We conducted an initial pilot survey of 391 PSAPs in five states (Colorado, Georgia, Iowa, Maryland, and Oregon). These were selected from a group of 11 states for which a complete list of PSAP e-mail addresses was readily available in order to determine feasibility of the online survey instrument and to study how the survey questions functioned. We contacted these PSAPs by e-mail with a message announcing the survey, a message linking to the survey itself, and up to three reminder e-mails for non-responders. The response rates, responder comments, and times to complete the online survey were collected and used to modify questions in the final survey. Modifications were limited to changes in the response options available for five of the 23 survey questions and rephrasing of one question for clarity. The pilot survey and the modifications that were made to the national survey are available as supplementary material (Supplement 1, Pilot Survey and Modifications to National Survey).

The final survey was conducted in the spring of 2010 and included all 50 states and the District of Columbia. We used a sequential strategy to identify PSAPs including contacting state officials, searching sheriff and police department websites, and then calling individual agencies. We identified 5,686 PSAPs; 4,159 (73%) had available e-mail addresses, and 3,555 (85%) of these e-mails were deliverable (Figure 1). Agencies were contacted in the same manner as in the pilot survey described above: a preliminary e-mail announcing the survey with a statement of endorsement from the lead state EMS official (when available) and options for completing the survey via mail or fax, an e-mail with a link to the survey, and up to three follow-up e-mails for non-responders. Messages were separated by two business days. We obtained institutional review board approval by SCL Health, Denver, CO, for this study.

Validation

After the completion of the survey, we conducted a follow-up study by telephone to compare responding and non-responding agencies. A random sample of 51 non-

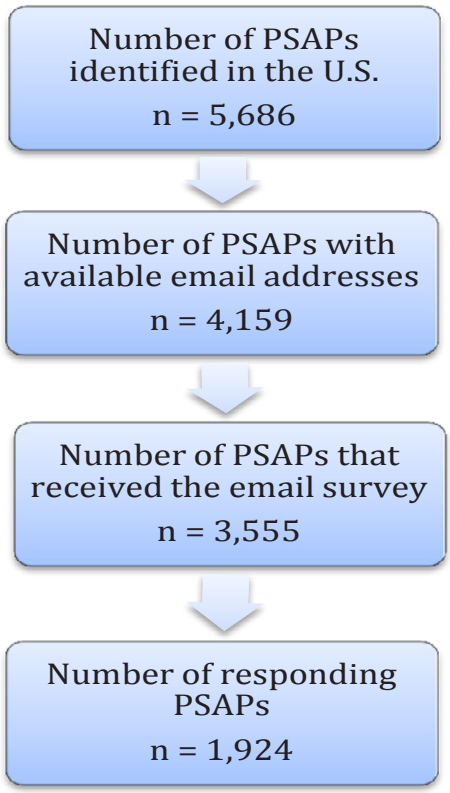

Figure 1. Number of responding public safety answering points in the United States.
PSAP, public safety answering point

responding agencies located within the five states with the lowest response rate (Illinois, Nebraska, New Jersey, South Dakota, Minnesota, with a 20%-26% response rate) and a random sample of 50 non-responding agencies located in the middle five responding states (New Mexico, New York, South Carolina, Kansas, and Virginia, with a 40%-44% response rate) were contacted. These agencies were asked to answer a truncated five-question version of the survey over the phone. We then compared responses from these non-responding agencies to those of responding agencies.

Statistical Methods

Proportions were compared using normal approximations of the binomial distribution and Fisher's exact method. We used one- and two-sided hypotheses at the 0.05 significance level. Means are reported with standard deviations (SD) and medians with interquartile ranges (Q1-Q3). Descriptive statistics are also reported. Analyses were performed in SAS Software 9.4 (SAS Institute, Cary NC) and R 3.1.3.[10]

RESULTS

Response Rate

Of the 5,686 identified PSAPs in the U.S., 3,555 (63%) received the e-mail survey. Of these, 1,924/3,555 (54%) responded to the survey (Figure 1). This response rate represents 34% (1,924/5,686) of the total number of identified PSAPs, 46% (1,924/4,159) of PSAPs with available e-mail addresses. Responding agencies represented all 50 states and the District of Columbia. Responses to selected question items reflecting the characteristics of PSAPs and their provision of T-CPR instructions are discussed at length below.

PSAP Characteristics

The vast majority of PSAPs were public agencies (n=1,888, 98%) versus privately owned (n=20, 1%). In large part, surveys were completed by management personnel at the individual PSAPs (n=1,658, 86%). Additionally, surveys were completed by law enforcement officers (n=115, 6%), dispatch personnel (n=91, 5%), and others including 9-1-1 coordinators (n=57, 3%). Table 1a and 1b shows the breakdown of PSAPs by administrative type. PSAPs were staffed by a median number of 10 dispatchers with an interquartile range (IQR) of 6 to 16. PSAPs reported handling a median of 12,000 9-1-1 calls annually with a median of 30% of calls resulting in EMS dispatch. Among respondents, 1,199 (62%) facilities identified as primary PSAPs (9-1-1 calls arrive directly), 51 (3%) identified as secondary PSAPs (9-1-1 calls are routed from a primary PSAP), and 659 (34%) identified as both (Table 1a and 1b).

Pre-arrival Instructions

Of 1,924 respondents, 1,021 (53%) PSAPs reportedly provide instructions for medical emergencies. On average, 87.65% (SD 29.47%) of the call-takers who provide

Table 1a. Characteristics of public safety answering points in the United States.

	N	%*
Type		
City police department	563	29
County sheriff office	381	20
State/province law enforcement	23	1
County or public agency serving one or more counties	361	19
Fire department	42	2
City and county agency	200	10
Fire and law enforcement	261	14
Joint law enforcement	18	1
Special commission	14	1
Other	14	1
Not indicated	47	2
PSAPs functioning as primary or secondary answering points		
Primary	1,199	62
Secondary	51	3
Both	659	34
Not indicated	15	1
Ambulance/EMS dispatch		
Number of PSAPs that directly dispatch ambulance/EMS	1,478	77
Quality improvement measures		
Number of PSAPs that monitor 10% or more of live calls**	448	23
Number of PSAPs that review 10% or more of recorded calls**	892	46
Number of agencies that review EMS run sheets	135	7
Number of agencies that review data from hospital records of patients transported by EMS	42	2
Number of agencies that review the time required for a caller to reach a dispatcher trained to deliver instructions	214	11
Number of agencies where EMD calls are reviewed by a supervisor, oversight committee, or peer review team	529	27
Number of agencies that complete a systematic quality review/report on a regular basis	392	20
Number of agencies with no formalized evaluation of dispatcher performance and call center services	265	14
Other measurement of dispatch service outcomes	85	4

EMS, emergency medical services; *PSAP*, public safety answering point; *EMD*, emergency medical dispatch
*Percentages are reported as a proportion of the total number of survey respondents (n=1,924).
**Facilities were asked to report the percentage of calls that are monitored/reviewed in 10% increments ranging from 0% to 100%.

Table 1b. Characteristics of public safety answering points in the United States.

	Median (Q1–Q3)	Average	Standard deviation
PSAP descriptions			
Number of dispatchers (n=1,875)	10 (6–16)	16.37	21.55
Number of annual 9-1-1 calls received (n=1,290)	12,000 (4,000–42,000)	53,000	150,015
Number of calls resulting in EMS dispatch (n=1,675)	30% (20%–50%)	37.61%	22.18%
Ambulance/EMS dispatch			
Time (seconds) to dispatch of Ambulance/EMS (n=1,120)	49 (30–60)	54.84	41.93
Time (seconds) to redirecting call to secondary PSAP if not directly dispatching EMS (n=322)	10 (5–30)	21.68	25.90
Dispatcher training			
Percentage of dispatchers providing instructions who are trained but not certified (n=1,021)	0% (0%–0%)	7.76%	23.43%
Percentage of dispatchers providing instructions who are EMD certified (n=1,021)	100% (100%–100%)	87.65%	29.47%
Quality improvement measures			
Percentage of live calls monitored by supervisory/training staff (n=448)	20% (10%–50%)	32.95%	28.41%
Percentage of recorded calls reviewed by supervisory/training staff (n=892)	20% (10%–50%)	33.71%	28.05%

PSAP, public safety answering point; *EMS*, emergency medical services; *EMD*, emergency medical dispatch

T-CPR instructions are certified as emergency medical dispatch dispatchers (for example, national academy of emergency dispatch [NAED] or association of public-safety communications officials [APCO] certified or another certification), and a further 7.76% (SD 23.43%) are trained, but not certified. A structured script is used by 83% of agencies providing T-CPR instructions, while 14% use only written guidelines, and 3% do not use guidelines or a script (Table 2). Of those agencies using a script or guidelines, the type of script or guidelines used for T-CPR instructions varies between PSAPs as shown in Figure 2.

Reportedly, 881 of 1,924 (46%) responding agencies provide no T-CPR or medical instructions for medical emergencies, and 273 (14%) report that they are unable to transfer callers with medical emergencies to another facility to provide T-CPR instructions (Figure 3).

Of the 1,924 respondents, compression-only CPR instructions are reportedly provided by 3% of agencies (67/1,924), 36% (699/1,924) reported traditional CPR instructions (including chest compressions and rescue breathing), 9% (166/1,924) reported some other instructions incorporating ventilations and compressions, and 5% (92/1,924) did not specify the type of instructions (Figure 3).

Table 2. Structured script and guideline-based protocol use at public safety answering points that provide instructions for medical emergencies.

Script/guideline use	n	%	Type of script/aid	n	%
Structured script	834	83	A manual system (e.g. printed cards)	507	61
Written guidelines	138	14	A computer-based system	318	39
No script or guidelines	30	3			
Total	1,002	100	Total	825	100

Validation

In the follow-up validation study comparing responding and non-responding agencies, the proportion of agencies that do not directly provide telephone instructions for medical emergencies did not differ significantly between responding and non-responding agencies in both the low-return subgroup (50/142 vs. 14/51, p=0.3126) and the mid-return subgroup (88/199 vs. 22/50, p=0.9775).

The proportion of agencies that use scripts or aids for the delivery of telephone instructions did not significantly differ between responding and non-responding agencies in the mid-return subgroup (89/109 vs. 24/28, p=0.7832). However, the use of scripts or aids among responding agencies is more prevalent than among non-responding agencies in the low-return subgroup (69/89 vs. 14/37, p<0.01). See supplemental material for an additional summary of the validation study (Supplement 2, Validation Study Summary).

DISCUSSION

Bystander CPR for witnessed OHCA is believed to strongly influence survival to hospital discharge.[11-13] Despite this, the rate of bystander CPR remains very low across the

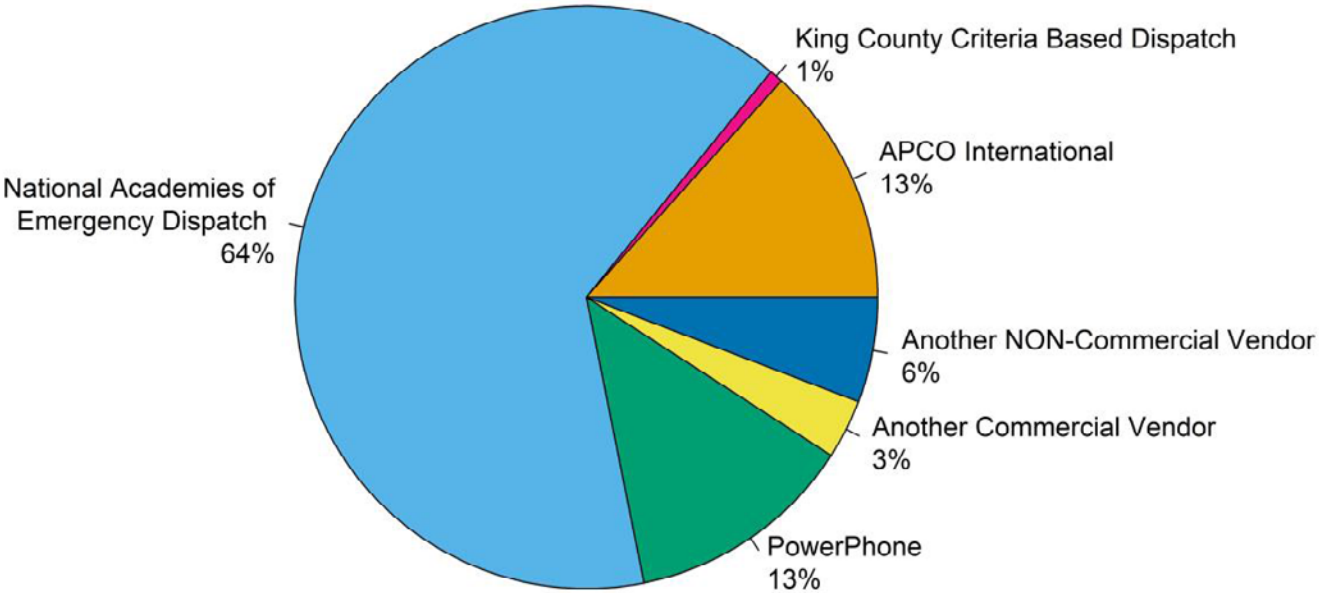

Figure 2. Script or guideline use by producing agency.
APCO, association of public-safety communications officials

U.S. and likely remains a central cause of dismal survival rates in these communities.[14,15] A recent AHA Scientific Advisory Statement has published specific recommendations for the provision of T-CPR instructions, including compression-only instructions for adults who suffer a sudden collapse and are not breathing normally, with the intention of improving the frequency and quality of bystander CPR being performed globally.[7] The statement had four central recommendations: 1) 9-1-1 callers should be formally and systematically questioned to determine whether the patient may have had a cardiac arrest, and if so, CPR pre-arrival instructions should be immediately provided; 2) CPR pre-arrival instructions should be provided in a confident and assertive manner and should include straightforward chest compression–only instructions to achieve early bystander hands-only CPR for the adult who suddenly collapses; 3) individual dispatcher and organizational-level performance can be measured by using a modest set of metrics; 4) these metrics should be incorporated into an integrated quality assurance program.[7]

A detailed understanding of the current T-CPR practices of PSAPs is an essential step towards understanding the direction forward for implementing these recommendations. To our knowledge, this survey represents the first nationwide assessment of the practices of PSAPs in the U.S. regarding T-CPR instructions for cardiac arrest. Previous, smaller surveys of PSAPs with regards to T-CPR instructions were either limited to 154 dispatch centers participating in the Resuscitation Outcomes Consortium (ROC) Network[16] and 25 EMS agencies participating in the Cardiac Arrest Registry to Enhance Survival (CARES),[17] and provide only limited detail regarding nationwide T-CPR practices. For these studies, survey response rates of 154/154 (100%) and 21/25 (84%) were observed, respectively.

Survival rates for OHCA can vary by as much as 500% regionally in the U.S.[14] A key aspect of EMS interventions associated with improved survival rates has been an increase in the rate of T-CPR.[18-20] These survey data show that while there are many 9-1-1 centers currently providing T-CPR instructions, a substantial proportion of centers that responded to this national survey do not; this may account for a significant portion of this variability. Previous studies have shown that communities with the highest survival rates over the past several decades have consistently focused on implementing, measuring, and benchmarking this key intervention in their systems.[19-22] The results of this survey suggest that there is significant potential to improve the T-CPR process through increased systematic implementation of CPR instructions, training, and quality improvement.

In addition to the need for T-CPR expansion, a closer look at the results shows significant room for improvement in the instructions provided to callers for adult OHCA. Only 3% of the responding agencies are providing instructions for compression-only CPR, which is guideline therapy for adult, out-of-hospital sudden cardiac arrest.[7,8,23,24]

LIMITATIONS

As a voluntary survey of PSAPs, this study is intrinsically limited. The answers provided by agencies are assumed to be accurate representations of their practice. Our validation follow up with non-responding agencies suggests that non-responders

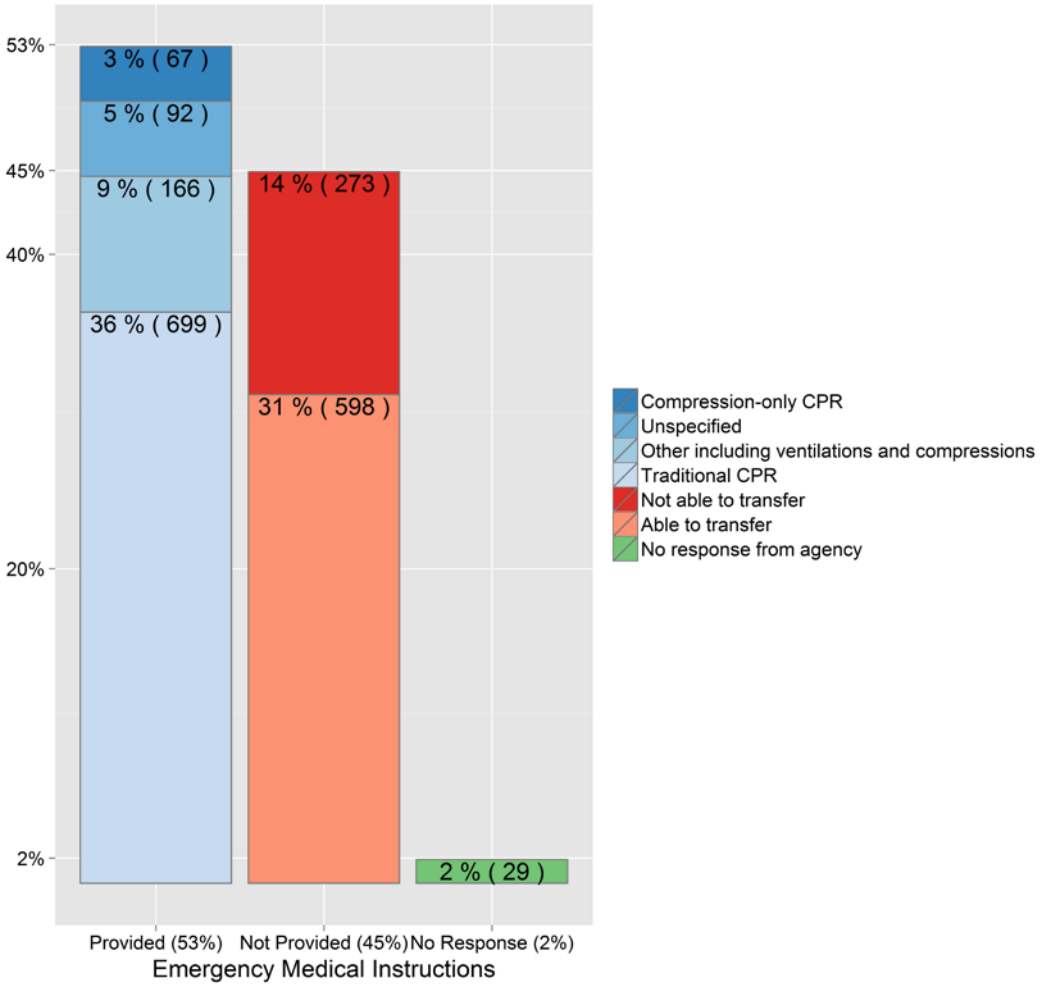

Figure 3. Proportion of public safety answering points providing telephone cardiopulmonary resuscitation (T-CPR) instructions and the type of CPR instructions provided to callers.

did not differ substantially with regards to the provision of T-CPR instructions for OHCA; however, we recognize that responding agencies are likely those most involved in this topic. Consequent to the methodology used to request survey participation, this study is limited to participation from PSAPs for which e-mail addresses were procured. Although survey responses may not reflect actual practice, we would expect that 9-1-1 centers not having a structured T-CPR program to be challenged to deliver consistent guideline-based instructions.

CONCLUSION

This large survey of PSAPs in the United States suggests that there is great variability in the implementation and measurement of the critical intervention of telephone-cardiopulmonary resuscitation instructions. There appears to be a significant opportunity to standardize and improve the delivery of telephone-CPR instructions.

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Variability in Criteria for Emergency Medical Services Routing of Acute Stroke Patients to Designated Stroke Center Hospitals

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Introduction: Comprehensive stroke systems of care include routing to the nearest designated stroke center hospital, bypassing non-designated hospitals. Routing protocols are implemented at the state or county level and vary in qualification criteria and determination of destination hospital. We surveyed all counties in the state of California for presence and characteristics of their prehospital stroke routing protocols.

Methods: Each county's local emergency medical services agency (LEMSA) was queried for the presence of a stroke routing protocol. We reviewed these protocols for method of stroke identification and criteria for patient transport to a stroke center.

Results: Thirty-three LEMSAs serve 58 counties in California with populations ranging from 1,175 to nearly 10 million. Fifteen LEMSAs (45%) had stroke routing protocols, covering 23 counties (40%) and 68% of the state population. Counties with protocols had higher population density (1,500 vs. 140 persons per square mile). In the six counties without designated stroke centers, patients meeting criteria were transported out of county. Stroke identification in the field was achieved using the Cincinnati Prehospital Stroke Screen in 72%, Los Angeles Prehospital Stroke Screen in 7% and a county-specific protocol in 22%.

Conclusion: California EMS prehospital acute stroke routing protocols cover 68% of the state population and vary in characteristics including activation by symptom onset time and destination facility features, reflecting matching of system design to local geographic resources. [West J Emerg Med. 2015;16(5):743-746.]

INTRODUCTION

In an effort to improve care and reduce the morbidity and mortality caused by stroke, the American Heart Association (ASA) developed recommendations for the development of stroke systems for specialized stroke care. The ASA recommendations include adoption of emergency medical

services (EMS) protocols for the identification and rapid transport of acute stroke patients to primary stroke centers (PSCs). Furthermore, it is recommended that EMS responders preliminarily notify the receiving hospital in order to alert the hospital-based acute stroke team of the incoming patient.[2] Thus, stroke systems are designed to streamline recognition, transport and initiation of care for acute stroke by establishing policies for preferentially routing stroke patients to designated stroke centers.

An increasing number of regions of the U.S. have adopted EMS stroke routing protocols since 2000.[1-2] Beginning with counties in Alabama and Texas, policies for routing acute stroke patients to primary stroke centers were in place in 16 states by 2010, covering 53% of the U.S. population.[1] Routing policies are determined on a county or state level and differ based on the needs and infrastructures of the regions they cover. Thus, a considerable variation exists between the parameters that determine conditions for initiation of routing in different regions across the country. Such parameters may include the following: maximum onset of stroke symptoms prior to transport or hospital arrival, criteria for detecting stroke cases by EMS responders, maximum routing time and a variety of others. We surveyed the counties of the state of California for acute stroke EMS routing policies and compared them based on the variables listed above.

METHODS

We contacted the local EMS agency (LEMSA) office for each county in California to inquire about the presence of routing policies for stroke. If a routing policy was in place, we obtained a copy of the policy. Upon review of each policy, we obtained characteristics that included the following: maximum time from symptom onset to EMS evaluation to qualify for routing; type of stroke identification tool; and whether there is a maximum transportation time limit qualifier. We also looked at the number of hospitals in each county and their designation as either a primary or comprehensive stroke center. County and state population information was obtained using the 2010 census data.

RESULTS

There were 33 LEMSAs serving 58 counties in California with populations ranging from 1,175 persons to nearly 10 million persons (mean 642,000, median 179,000). Counties varied in area ranging from 47 to 20,000 square mile (mean 2,690, median 1,540) and population density two to 17,000 persons per square mile (mean 661, median 104). Fifteen LEMSAs (45%) had acute stroke routing protocols, covering 23 counties (40%) and accounting for 68% of the overall state population (Table).

Counties with acute stroke routing protocols had higher population density (mean 1,500 vs. 140 persons per square mile, median 198 vs. 58 persons per square mile) compared to those without. All protocols designated a maximum time period from symptom onset to EMS evaluation to qualify for routing, but there was large variability ranging from two to eight hours, with a median of three hours (IQR 2.5-4) after symptom onset. Twelve of 23 (52%) allowed a maximum transport time of 30 minutes to qualify for diversion. In cases where transport time to the designated stroke center exceeded 30 minutes, patients would be routed to closest hospital. The median number of LEMSA-designated stroke hospitals per county in jurisdictions with routing was two (IQR 0-7, range 0–29). In the six counties without designated stroke centers, patients meeting criteria were transported out of county.

Table. Number of counties and local emergency medicine services agencies (LEMSAs) fulfilling key stroke routing policies.

Stroke routing protocol	Number of counties	Number of LEMSAs
Yes	23	15
No	35	18
Stroke detection criteria		
CPSS	20	13
LAPSS	1	1
own protocol	2	1
Max time of onset of symptoms for routing		
2-3hrs	12	4
3.5-4.5hrs	8	8
5-8hrs	3	3
Maximum routing time		
30 min	12	4
not specified	11	11
Number of receiving PSCs in county		
0	6	
1-5	10	
6-10	6	
>10	1	

CPSS, Cincinnati prehospital stroke screen; *LAPSS*, Los Angeles prehospital stroke screen; *PSCs*, primary stroke centers

Regardless of the presence of a stroke routing policy, most LEMSAs (32 of 33, 97%) and counties (55 of 58, 95%) had designated a prehospital stroke identification instrument. LEMSA used the Cincinnati Prehospital Stroke Screen/Face Arm Speech Time (N=23, 72%), county-specific protocols (N=7, 22%) and Los Angeles Prehospital Stroke Screen (N=2, 7%).

DISCUSSION

As of September 2013, 23 out of 58 California counties have implemented stroke routing policies, the first coming into effect in 2006 (Figure). These EMS prehospital acute stroke routing policies currently cover 68% of the state's population. There are benefits of stroke routing policies in improving care, but also in increasing the numbers of hospitals seeking stroke center certification.[3-5]

One barrier to initiating these acute stroke routing protocols may be lack of appropriate facilities in scarcely populated regions. Of the 23 counties with routing policies, six transport patients to out-of-county PSCs, providing one possible solution to this problem. All counties with routing policies have designated stroke recognition criteria and set a maximum time of onset of symptoms prior to routing, as stipulated by the ASA in establishing stroke systems of care. Furthermore, 12 of these counties limited transport time to 30 minutes, meaning that if transport to a PSC was estimated to exceed 30 minutes, the patient would be taken to a closer, non-stroke-certified receiving facility. Variation in routing policies between different counties demonstrates the necessity of adapting stroke systems of care to the resources and infrastructures available in different regions.

Acute stroke routing is likely to benefit patients whose onset of symptoms falls within the time limit of eligibility for intravenous thrombolysis, between 3 and 4.5 hours.[5-6] Thrombolysis, or acute stroke treatment, requires a synchronized and expeditious response to stroke emergencies involving prehospital, emergency department and hospital medical care. Well-trained first response personnel are required to identify potential stroke cases. Thus, all surveyed EMS routing protocols specify stroke recognition criteria to be used at the initial scene. If a stroke is suspected, the emergency responders must determine if the patient should be routed to the nearest designated stroke center instead of the nearest non-designated eligible facility. Protocols establish a straightforward method for making this decision by stipulating a maximum time for onset of symptoms prior to routing, and in some cases, limiting transport time. It is also necessary to alert the receiving facility of an incoming stroke case, in order to allow medical personnel to mobilize and prepare for potential acute stroke treatment.[8] Routing protocols streamline this course of events and allow a more efficient response to stroke emergencies.[7]

Based on the finding of this study, 32% of California's population does not have access to acute stroke routing. Future research should focus on establishing this figure on a national scale and determining the barriers that must be overcome in order to extend coverage to more people. Further work is also necessary to evaluate the difference in stroke patient outcomes between regions with and without stroke routing policies.

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Figure. Map of California counties with emergency medical services stroke routing. Grey indicates all counties with routing policies as of September 2013. Counties that route out-of-county are indicated with a grid pattern.

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Access to and Use of Point-of-Care Ultrasound in the Emergency Department

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Introduction: Growing evidence supports emergency physician (EP)-performed point-of-care ultrasound (PoC US). However, there is a utilization gap between academic emergency departments (ED) and other emergency settings. We elucidated barriers to PoC US use in a multistate sample of predominantly non-academic EDs to inform future strategies to increase PoC US utilization, particularly in non-academic centers.

Methods: In 2010, we surveyed ED directors in five states (Arkansas, Hawaii, Minnesota, Vermont, and Wyoming; n=242 EDs) about general ED characteristics. In four states we determined barriers to PoC US use, proportion of EPs using PoC US, use privileges, and whether EPs can bill for PoC US.

Results: Response rates were >80% in each state. Overall, 47% of EDs reported PoC US availability. Availability varied by state, from 34% of EDs in Arkansas to 85% in Vermont. Availability was associated with higher ED visit volume, and percent of EPs who were board certified/board eligible in emergency medicine. The greatest barriers to use were limited training (70%), expense (39%), and limited need (perceived or real) (32%). When PoC US was used by EPs, 50% used it daily, 44% had privileges not requiring radiology confirmation, and 34% could bill separately for PoC US. Only 12% of EPs used it ≥80% of the time when placing central venous lines.

Conclusion: Only 47% of EDs in our five-state sample of predominantly non-academic EDs had PoC US immediately available. When available, the greatest barriers to use were limited training, expense, and limited need. Recent educational and technical advancements may help overcome these barriers. [West J Emerg Med. 2015;16(5):747-752.]

INTRODUCTION

As ultrasound technology improves, and as pressures on emergency physicians (EPs) grow to see ever more patients quickly and cost effectively, there has been a surge in literature demonstrating that point-of-care ultrasound (PoC US) can decrease cost,[1] reduce need for additional diagnostic testing,[2] improve patient throughput[3] and patient satisfaction,[4] and may reduce need for imaging with ionizing radiation.[5] Accordingly, PoC US image acquisition and interpretation is now a core competency for emergency medicine residency training.

Despite this growing evidence base and improved training efforts, previous surveys of PoC US have demonstrated a utilization gap, most notably between rural and urban emergency departments (ED), low and high volume EDs, and EDs with a lower proportions of emergency medicine board certified/board eligible (EM BC/BE) EPs vs. EDs with more EM BC/BE EPs.[6] These distinctions are important because most individuals do not receive emergency care at

an academic center.[7] Building on previous work surveying PoC US at diverse practice sites across the United States,[6] we performed a more detailed survey to study PoC US utilization and determine specific barriers to utilization.

METHODS

Identifying Emergency Departments: NEDI-USA Survey

Our data are drawn from EDs in five diverse states: Arkansas, Hawaii, Minnesota, Vermont, and Wyoming. These states were chosen due to their geographic diversity and distribution of EDs, which include many non-academic EDs (only 4% of EDs in these states are a part of hospitals in the Council of Teaching Hospitals) and many EDs with lower patient volume, which are often not surveyed in ED operations research. To identify eligible EDs in the five states, in 2010 we used the 2009 version of the National Emergency Department Inventory (NEDI)-USA database, which provided a comprehensive list of all nonfederal U.S. hospitals with EDs. The methods for creation of the NEDI-USA database have been previously described.[8] Emergency Medicine Network (Boston, MA) staff compile NEDI-USA through original data collection and integration of information from a variety of sources (e.g., Intercontinental Marketing Services Health Hospital Market Profiling Solution, American Hospital Association Annual Survey Database, Flex Monitoring Team, and Association of American Medical Colleges). EDs were defined as emergency care facilities open 24/7, and available for use by the general public. We excluded federal hospitals (e.g., Veterans Affairs, Indian Health Service, and military hospitals), specialty hospitals (e.g., psychiatric hospitals), and college infirmaries. NEDI-USA was approved by the institutional review board of Massachusetts General Hospital. Each state investigator's institutional review board approved the study with a waiver of written informed consent. Responses were based on respondent estimates for the year 2009. NEDI-USA surveys were mailed to ED directors, with up to two follow-up mailings sent to non-respondents. If we received an incomplete or no response, mailed surveys were followed by telephone contact. We used a mailed survey rather than an online survey because we have found that many ED directors of smaller, rural EDs prefer mailed surveys and their participation is critical to the generalizability of data collected as part of the NEDI project.

Measuring Emergency Department Characteristics: NEDI-State Survey

After identifying eligible EDs with the NEDI-USA survey, we obtained detailed information on EDs with the NEDI-State survey. The NEDI-State survey is rooted in measuring basic, real world operational characteristic of the ED (see Supplementary Survey for questions, such as, "Is your emergency department open 365 days per year?"). The survey was initially developed by investigators within the Emergency Medicine Network. Following this phase, the survey was sent to multiple independent EP reviewers from across the United States to iteratively improve the survey and establish greater face validity. Physician reviewers were drawn from a variety of settings including members of one or more American College of Emergency Physicians chapter boards. The completed survey has been deployed successfully in 2006 in Massachusetts[9] and in 2009 in four states,[6] with >80% response rate in every state.

Ultrasound Variables

NEDI-State surveys included questions on basic ED characteristics, staffing, electronic resources, PoC US, timing of consultations, tests, and transfers, and ED crowding. The two key survey questions on PoC US were, "Is bedside ultrasound immediately available in the ED?" and, "In your ED, do the emergency physicians (not radiologists, cardiologists, etc.) use bedside ultrasound for clinical care?" EDs in four of the states (Arkansas, Hawaii, Vermont, and Wyoming) were asked additional questions to determine characteristics of PoC US use by EPs. In particular, EDs not reporting use of PoC US were asked to identify barriers to use.

Additional ED Variables

We categorized ED location as urban or rural (adjacent to urban or not adjacent to urban) using county-based 2003 urban influence codes (www.usda.gov). ED volume was represented by the number of patients seen per hour, calculated from annual visit volume. We used hospital admission rate as a surrogate for ED acuity. Patient population was categorized using the percent of patients uninsured or who self-pay. Characteristics of physician staffing included the total number of EP full-time equivalents (FTEs) and the proportion of physicians who were BC/BE EPs by the American Board of Emergency Medicine, American Osteopathic Board of Emergency Medicine, or the American Board of Pediatrics (Pediatric Emergency Medicine).

Statistical Analysis

We used descriptive statistics to summarize data on the overall sample and by presence or absence of PoC US. Bivariate associations between PoC US use and ED characteristics were calculated using chi-square and Fisher's exact tests. We used multivariable logistic regression to determine the independent odds of PoC US availability by each ED characteristic adjusted for other characteristics in the model. Two-tailed P-values were calculated, with $P<0.05$ representing statistical significance. Summary statistics were also used to display the proportion of EDs reporting specific barriers to PoC US and PoC US use patterns. We performed statistical analysis using SAS 9.3 (SAS Institute, Cary, NC).

RESULTS

From the NEDI-USA survey we identified 271 EDs in the five states. Overall, 242 of 271 sites provided data for analysis (89% response rate) from the NEDI-State survey, with >80% response rate in every state. Among the respondents, 201 provided complete information on PoC US (74%). Response

rates for availability of PoC US were equivalent across urban/rural status, admission rate, patient insurance status, number of physician FTEs, and proportion of physicians that were EM BC/BE EPs; response rates were lower among EDs with lower visit volume and across states (data not shown).

In unadjusted analyses, PoC US availability varied among states and was higher in urban EDs, higher volume EDs, higher acuity EDs, EDs with more physician staffing, and EDs with a higher proportion of EM BC/BE EPs (Table 1). PoC US availability was not associated with patient insurance status. In multivariable logistic models adjusting for all characteristics simultaneously, each state had markedly different odds of PoC US availability compared to Arkansas: Hawaii OR=5.2, 95% confidence interval [1.03-26.6]; Minnesota OR=6.7, [2.3-19.7]; Vermont OR=15.4, [2.0-121.3]; Wyoming OR=10.2, [2.3-45.0]. PoC US was more likely to be available in EDs with higher visit volume (≥3 patients per hour vs. <1 patient per hour, OR=9.9, [1.9-51.6]) and more EM BC/BE physicians as a percent of physicians staffed in the ED (≥80% vs. 0% to less than 20%, OR=4.3, [1.5-12.2]). PoC US availability did not differ by urban/rural status, admission rate, number of physician FTEs, or insurance status.

In our four-state sample (123 total EDs) with more detailed information on PoC US, 52% of sites had PoC US available in the ED. At 43% of sites, EPs used PoC US for care (Table 2). The most common reason for PoC US being unavailable or not used by EPs was limited training (70%), PoC US being too expensive (39%), or having limited need (perceived or real) (32%). Few sites (14%) reported that PoC US was either not supported or allowed as a reason for its unavailability.

At sites where PoC US was available for use by EPs, nearly 50% of EPs performed PoC US and used it daily (Table 3). Only 12% of EPs used PoC US ≥80% of the time to place central venous lines. Forty-four percent of EPs performing PoC US had privileges that did not require subsequent confirmatory radiology study, and another 22% had partial privileges. Nonetheless, nearly half of EPs performing PoC US could not bill separately for use and interpretation.

DISCUSSION

Given the growing evidence of the benefits of PoC US, it is incumbent on the emergency medicine community to identify barriers to PoC US utilization. Relying solely on the training of current residents to disseminate the use of PoC US does not address the barriers and needs of most practicing EPs, who trained prior to the widespread use of PoC US.

To our knowledge, this is the first multi-state survey to focus, at an individual ED level, on barriers to use of PoC US, a key skill for all EPs. As of 2009, only half of our sample of EDs had PoC US available in the ED. Availability differed by state, and was more common in EDs with higher volume, and EDs with a higher percentage of BC/BE EPs. These basic utilization findings are similar to those of Talley et al. from one year earlier in four different states,[6] and suggest reproducibility when this many EDs are sampled despite their location in different regions of the country. Our focus on barriers to use of PoC US builds on these confirmatory findings.

The prime reason for PoC US being unavailable or unused by EPs was lack of training. It is likely that a proportion of the 32% of respondents who did not have PoC US available or who did not use PoC US due to lack of perceived need would begin using PoC US if they had more training. Moreover, only 12% of EPs with PoC US used it more than 80% of the time to place central venous lines, which is now preferred due to its improved safety profile,[10] depicting a gap in procedural PoC US skills.

Academic centers will continue to train residents in ultrasound and recruit ultrasound fellows to grow the subspecialty. While these avenues will increase the prevalence of new EPs educated in PoC US, change will be slow if they are the sole methods the specialty relies upon. These educational methods do not address the need for many current EPs to become facile with US. Thankfully, the widespread use of asynchronous learning platforms has made it easier than ever to learn PoC US at little (if any) cost at anytime, from anywhere in the world. Education-oriented websites such as American College of Emergency Physicians' sonoguide.com continue to grow, as do free open-access medical education forums on websites, blogs, video logs, and other Internet-based resources.[11] Moreover, several studies have highlighted that PoC US images of adequate quality can be streamed over Internet or wireless phone networks. Combined with synchronous voice or video between the examiner and educator, this enables real time education during actual scanning. In-person training will always be highly valuable though. Notably, a recent randomized trial of internal medicine interns acquiring PoC US skills via faculty-guided or self-guided curricula showed both can improve the self-reported competence of medicine interns in PoC US, but faculty-guided training was superior to self-guided training in both intern preference and skills acquisition assessed with observed structured clinical examinations.[12] In-person training, as opposed to asynchronous training, may also be more effective at improving ultrasound-guided procedural skill. Thus, for the 19% of EPs who reported PoC US availability but did not use it to place central venous lines, in-person training via skills workshops and/or distance learning with mannequins may be more appropriate.

A substantial number of the EDs in our study also reported that PoC US was not available due to high cost, demonstrating market need for low-cost devices. Previously, the American market favored high technical capability over low cost, focusing companies on full-stack devices that were function-heavy and expensive. In the case of PoC US, there are burgeoning solutions from within and outside of the United States that hope to address cost. The most expensive component of current ultrasound devices is the piezoelectric crystals or ceramics that generate and receive sound waves. Companies like Butterfly Network (www.butterflynetinc.com) are leveraging capacitive micro-machined ultrasound transducers, which

Table 1. Availability of point-of-care ultrasound in five states (n=242 emergency departments).

	Total	Point-of-care ultrasound			P-value
	n	No n (%)	Yes n (%)	Unknown n (%)	PoC US available Yes vs. No
Total	242	88 (36)	113 (47)	41 (17)	
State					
Arkansas	61	37 (60)	21 (34)	3 (5)	0.002
Hawaii	23	7 (30)	16 (70)	0 (0)	
Minnesota	119	33 (28)	54 (45)	32 (27)	
Vermont	13	2 (15)	11 (85)	0 (0)	
Wyoming	26	9 (35)	11 (42)	6 (23)	
Urban/rural status					
Urban	77	20 (26)	45 (58)	12 (16)	0.04
Rural, adjacent to urban	102	25 (40)	27 (43)	11 (18)	
Rural, not adjacent to urban	63	43 (42)	41 (40)	18 (18)	
ED visit volume (patients/hour)					
<1	124	60 (48)	38 (31)	26 (21)	<0.001
1.0 to less than 2.0	52	17 (33)	27 (52)	8 (15)	
2.0 to less than 3.0	23	6 (26)	17 (74)	0 (0)	
≥3	43	5 (12)	31 (72)	7 (17)	
Admission rate					
0 to less than 10%	27	18 (67)	9 (33)	0 (0)	0.02
10 to less than 20%	95	37 (39)	58 (61)	0 (0)	
≥20%	55	20 (36)	34 (62)	1 (2)	
Unknown	65	13 (20)	12 (19)	40 (62)	
Number of physician FTEs					
0 to less than 5	76	49 (64)	26 (34)	1 (1)	<0.001
5 to less than 10	58	19 (33)	39 (67)	0 (0)	
≥10	40	7 (18)	32 (80)	1 (3)	
Unknown	68	13 (19)	16 (24)	39 (57)	
EM BC/BE physicians					
0% to less than 21%	83	49 (59)	33 (40)	1 (1)	<0.001
21% to less than 80%	26	10 (39)	16 (62)	0 (0)	
≥80%	61	11 (18)	49 (80)	1 (2)	
Unknown	72	18 (25)	15 (21)	39 (54)	
Uninsured or self-pay					
0% to less than 16%	80	29 (36)	51 (64)	0 (0)	0.08
16% to less than 30%	44	22 (50)	22 (50)	0 (0)	
≥30%	30	17 (57)	12 (40)	1 (3)	
Unknown	88	20 (23)	28 (32)	40 (46)	

PoC US, point-of-care ultrasound; *ED*, emergency department; *FTE*, full time employees; *EM BC/BE*, emergency medicine board certified/board eligible

Table 2. Reasons for use of point-of-care ultrasound by emergency physicians in four states (n=123 emergency departments).

	Total responses	No	Yes
	n	n (%)	n (%)
Is PoC US available in ED?	114	55 (48)	59 (52)
Do emergency physicians use PoC US for care?	108	62 (57)	46 (43)
Reasons for PoC US being unavailable or not used by emergency physicians			
Limited training	66	20 (30)	46 (70)
Too expensive	66	40 (61)	26 (39)
Limited need	66	45 (68)	21 (32)
Not supported/allowed	66	61 (92)	5 (8)
Other reasons	66	57 (86)	9 (14)

PoC US, point-of-care ultrasound; *ED*, emergency department

Table 3. Use patterns of point-of-care ultrasound (PoC US) in four states (n=123 emergency departments).

	n (%)
% of emergency physicians that use PoC US	44
1-20%	5 (11)
21-40%	8 (18)
41-60%	10 (23)
61-80%	6 (14)
81-100%	15 (34)
How often PoC US is used	44
Daily	22 (50)
At least once per week	13 (30)
At least once per month	5 (11)
Less than once per month	4 (9)
% of all central venous lines placed using PoC US	42
0%	8 (19)
1-20%	12 (29)
21-40%	6 (14)
41-60%	7 (17)
61-80%	4 (10)
81-100%	5 (12)
Emergency physicians have PoC US “privileges” not requiring confirmatory radiology study	41
No	14 (34)
Yes	18 (44)
Partial/in progress	9 (22)
Emergency physicians can bill separately for use and interpretation of PoC US	41
No	20 (49)
Yes	14 (34)
Partial/in progress	7 (17)

have the promise of making PoC US much cheaper as well as producing better image quality. Legacy companies are also manufacturing handheld devices with fewer functions and lower cost (generally $6,000-$8,000) compared to full-stack systems. Nonetheless, these technologies continue to be expensive or under development. There is real market need to develop targeted, low-cost PoC US devices.

Finally, our data indicate that 14% of EPs reported PoC US was not supported or allowed, and nearly half of EPs performing PoC US could not bill separately for use and interpretation of PoC US. While 14% may appear low, given the convincing evidence that PoC US improves the value of emergency care, this represents a substantial number of EPs practicing within cultures that are not aligned with practice trends. EPs can advocate for adopting PoC US in their practice using the existing evidence. If EPs could generate compensation for time spent using PoC US, it would be easier for an ED to afford purchasing US equipment. Billing for PoC US can be established quickly and generate revenue to offset the cost of training and performance. These data highlight the need for EPs to advocate at their local institutions and nationally for billing parity. Nonetheless, some EDs may truly not have a need for PoC US. For example, there is likely a greater return on investment in PoC US in EDs with high patient volume that must reduce throughput times to prevent crowding and patients leaving without being seen. This cost/benefit ratio may not be favorable for EDs with lower patient volume.

LIMITATIONS

This study has potential limitations, including the possibility of selection bias due to the specific states sampled, though consistency with the overall data from Talley et al.[6] suggests that any bias is minimal. Response bias may also affect our results. Nonetheless, we showed that response to PoC US questions in the overall sample did not vary by most ED characteristics. It is possible that data would be more accurate if measured at the level of individual EPs rather than at the level of the ED director. Yet, measuring data at the individual level – when it may reflect personal or system deficiencies – may cause individuals to falsely inflate those capabilities, obscuring the deficiencies we hoped to capture. Data acquisition at the level of the ED provides some degree of anonymity, possibly allowing respondents to be more forthcoming.

CONCLUSION

In summary, we found that only 47% of EDs in our five-state sample had immediate access to PoC US. When access was available and PoC US was not used, the most common barriers were lack of training, lack of need (perceived or real), and high cost. There are many plausible approaches to overcome these barriers, some of which are available currently and described above. Future research should continue to define barriers as they change over time, and describe and test novel solutions to increase utilization of PoC US in emergency care.

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Focused Cardiac Ultrasound Diagnosis of Cor Triatriatum Sinistrum in Pediatric Cardiac Arrest

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Cardiac arrest in the adolescent population secondary to congenital heart disease (CHD) is rare. Focused cardiac ultrasound (FoCUS) in the emergency department (ED) can yield important clinical information, aid in resuscitative efforts during cardiac arrest and is commonly integrated into the evaluation of patients with pulseless electrical activity (PEA). We report a case of pediatric cardiac arrest in which FoCUS was used to diagnose a critical CHD known as cor triatriatum sinistrum as the likely cause for PEA cardiac arrest and help direct ED resuscitation. [West J Emerg Med. 2015;16(5):753-755.]

INTRODUCTION

Congenital heart disease (CHD) is estimated to affect between four and thirteen of every 1,000 live births.[1-3] Despite this relatively low incidence, CHD constitutes one of the leading causes of perinatal and infant death.[4] The most common defect is ventricular septal defect (VSD), followed in frequency by atrial septal defect (ASD) and patent ductus arteriosus.[3] Critical CHD, defined as lesions requiring operative intervention within the first year of life, occur in approximately 25% of those with CHD.[5] Outcomes for patients with CHD are time-dependent, with early diagnosis and intervention improving morbidity and mortality.[6]

Cardiac arrest is rare in the pediatric population with an estimated incidence of 0.5 to 20 per 100,000 person years. While the majority of cardiac arrest in infants and young children are attributed to CHD, rates are lower in adolescents. For patients between 14 and 24 years of age, CHD has been implicated in 23% of cases of cardiac arrest while arrhythmias also constitute 23% of cases. Less common etiologies include dilated cardiomyopathy, long QT syndrome, myocarditis and hypertrophic cardiomyopathy.[7-8]

Emergency physicians and other non-cardiologists use focused cardiac ultrasound (FoCUS) to expedite diagnosis and direct real-time patient management. FoCUS augments clinical decision-making in the care of critically ill patients. It is particularly helpful in differentiating among the potential causes of shock and cardiac arrest and has been shown to change management in a majority of patients with pulseless electrical activity (PEA) cardiac arrest.[9-10]

In this article, we present a case of an adolescent out-of-hospital cardiac arrest due to a very rare form of CHD, known as cor triatriatrum sinistrum (CTS), in which FoCUS was instrumental in the diagnosis and management of the patient.

CASE REPORT

A 15-year old female with unknown past medical history presented to the emergency department (ED) after collapsing while walking. She was found to be acutely dyspneic by family and soon became pulseless. Bystander cardiopulmonary resuscitation (CPR) was initiated and emergency medical services was summoned. Upon arrival to the scene paramedics noted the patient to be in PEA. CPR was continued, bag-valve-mask ventilation was initiated, intravenous (IV) access was established and IV epinephrine was administered. Endotracheal intubation was attempted twice en route without success and was complicated by copious vomiting. Upon arrival to the ED, CPR was continued and the trachea was intubated. A venous blood gas showed a pH of 6.89, pCO_2 43mmHg, bicarbonate 8mmol/L, and a base excess of -24. After four minutes of CPR, an increase in end-tidal CO_2 was noted and subsequent pulse check confirmed return of spontaneous circulation (ROSC).

The treating emergency physicians then performed a

FoCUS using a phased-array probe (Phillips, Andover, MA). Images obtained in the parasternal and apical windows demonstrated a globally hypokinetic left ventricle with significant spontaneous echo contrast in all four chambers of the heart. The apical view demonstrated spontaneous echo contrast passing freely between the left and right ventricles through a large VSD (Figure 1). On the parasternal long axis view, the VSD was confirmed and a septation in the left atrium was noted (Figure 2, Video). FoCUS allowed for the emergency physicians to recognize the patient's congenital heart defect as the probable cause of the cardiac arrest. Approximately two minutes after ROSC, the patient's end-tidal CO_2 dropped precipitously and pulses were lost despite ongoing electrical activity on the monitor. ROSC was regained briefly after three additional rounds of CPR and IV epinephrine, but was subsequently lost again. Cardiothoracic surgery was consulted emergently as it was felt that initiation of extracorporeal membrane oxygenation (ECMO) would potentially stabilize the patient and allow bridge to definitive operative repair. Attempts were made at both percutaneous cannulation and cut-down of the femoral vessels to allow for placement of ECMO cannulae but were ultimately unsuccessful and resuscitative efforts were halted. Post-mortem autopsy was requested by the family and revealed a large VSD, CTS and evidence of biventricular heart failure.

DISCUSSION

CTS is a relatively rare congenital cardiac anomaly, found only in 0.1% of all children with CHD. First described in 1868, CTS is characterized by an abnormal septation of the left atrium by a fibromuscular membrane that divides the atrium into a proximal and distal chamber.[11-12] These chambers communicate by one or more fenestrations of the membrane and the amount of flow between the two chambers determines the severity of the lesion. CTS is often associated with other defects, most commonly a patent foramen ovale or ASD. The mortality of untreated CTS is significant. Without surgical removal of the extraneous atrial membrane, 75% of patients die in infancy or childhood; however, survival rates after surgical correction are excellent. While most cases of CTS are diagnosed in infancy, there are cases of the diagnosis being delayed by decades.[13]

CHD should be considered in all adolescent patients with sudden cardiac arrest, even if not diagnosed previously. Massin et al. demonstrated that approximately 10% of infants with cyanotic lesions are not diagnosed before discharge from the hospital. Furthermore, of those children with acyanotic lesions mandating surgical repair, 35.1% presented with hemodynamic instability requiring emergent intervention at an age beyond that recommended for elective repair.[14]

FoCUS is an important tool for the acute care clinician caring for the critically ill pediatric patient with or without known CHD. While there is a paucity of literature specifically examining the utility of FoCUS in pediatric patients, research in adults suggests it can effectively identify potentially reversible causes of PEA, such as cardiac tamponade due to pericardial effusion or structural heart defects.[15-16] There are multiple proposed algorithms for integration of FoCUS into the evaluation of PEA with each one highlighting the recognition of potentially reversible causes.[17-19] In this case, FoCUS facilitated the identification of CHD as the likely etiology for the patient's arrest, prompting emergent consultation with cardiothoracic surgery and attempts at ECMO. In summary, we present a case of an adolescent cardiac arrest due to a congenital heart defect that was discovered by FoCUS. This case highlights the need to consider CHD in the differential diagnosis of adolescent

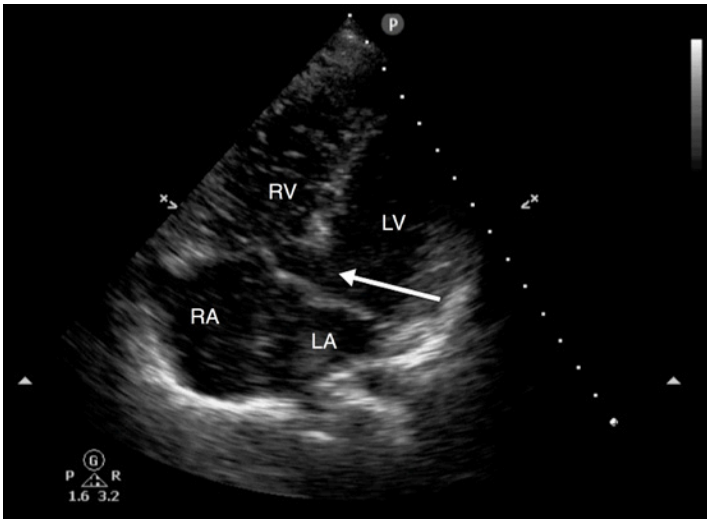

Figure 1. Apical four chamber view, slightly off axis, with a large ventricular septal defect (arrow).
RV, right ventricle; *LV*, left ventricle; *RA*, right atrium; *LA*, left atrium

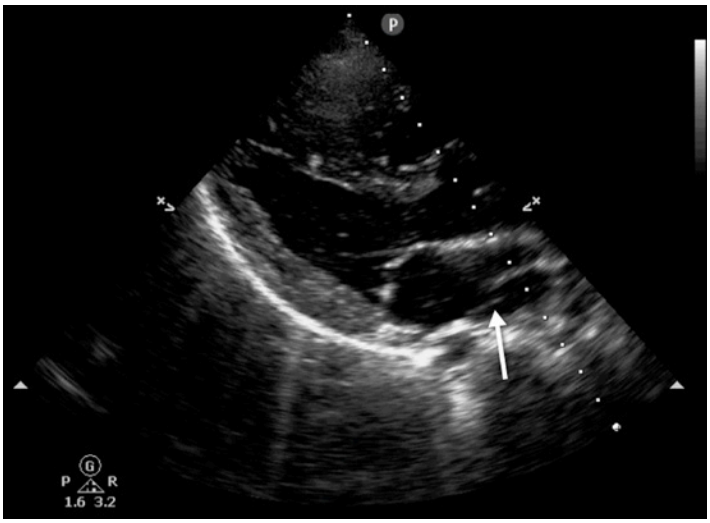

Figure 2. Parasternal long axis view showing double left atrium (arrow).

cardiac arrest and the utility of FoCUS in the management of critically ill pediatric patients.

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Video. Parasternal long axis view with large ventricular septal defect, double left atrium, and spontaneous echo contrast freely moving between the right and left ventricles.

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Bedside Ultrasound Evaluation Uncovering a Rare Urological Emergency Secondary to Neurofibromatosis

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CASE

A 56-year-old female presented to the emergency department (ED) with a chief complaint of urinary retention and overflow incontinence for 24 hours, preceded by progressive difficulty with voiding, worsening lower abdominal discomfort and bloating. Her past medical history was significant for small bowel obstruction and neurofibromatosis with an associated benign pelvic tumor that caused similar symptoms as a child, but had been known to be stable since that time. She had also recently been treated for a urinary tract infection. Her physical exam revealed tachycardia and a diffusely tender abdomen with a palpable, tender suprapubic mass extending just above her umbilicus.

Bedside ultrasonography was performed to visualize her kidneys and bladder and revealed bilateral hydronephrosis and a distended bladder with marked wall thickening (video), yielding further evaluation with computed tomography (CT). A urinary catheter was placed and 1,850 milliliters of urine were collected. CT of the abdomen and pelvis then confirmed bilateral hydronephrosis and a severely enlarged bladder with a diffusely thickened wall, consistent with the nodular appearance expected with neurofibroma of the bladder, as demonstrated in the figure. Laboratory analysis of urine and blood supported suspicion of urinary tract infection and obstructive uropathy, respectively. Histopathological analysis subsequently confirmed the presence of a neurofibroma.

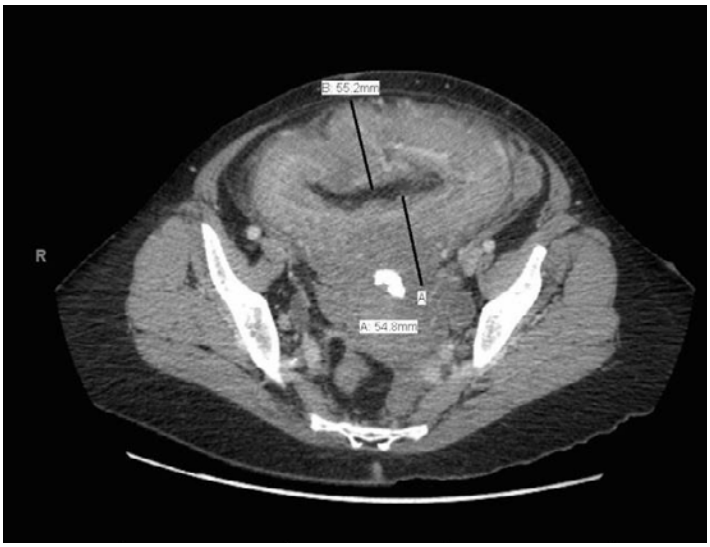

Figure 1. Computed tomography of enlarged, nondistended urinary bladder with diffusely thickened wall shown in transverse view after placement of a urinary catheter.

DISCUSSION

Neurofibroma of the bladder is an extremely rare manifestation of neurofibromatosis type 1, or von Recklinghausen disease, not typically seen in the ED.[1,2] Although the bladder is the most commonly affected site within the genitourinary system, there are less than 80 reported cases in the literature.[2] As in our patient, neurofibroma of the bladder can lead to obstructive uropathy with hydronephrosis.[3] Here, we used bedside ultrasonography in the ED for evaluation of symptomatology, which led to the preliminary diagnosis of this rare manifestation, further captured by CT.

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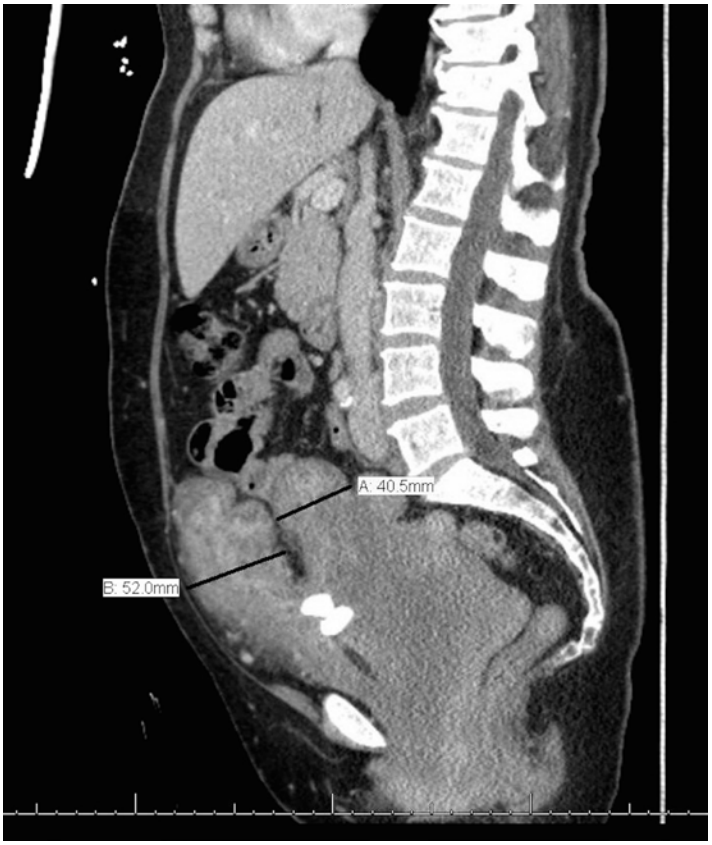

Figure 2. Computed tomography of enlarged, nondistended urinary bladder with diffusely thickened wall shown in sagittal view after placement of a urinary catheter.

Video. Ultrasound of enlarged, distended urinary bladder with diffusely thickened wall and resultant hydronephrosis, prior to placement of urinary catheter. Average bladder wall thickness is 2mm with distention.[4]

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Splenic Rupture Diagnosed with Bedside Ultrasound in a Patient with Shock in the Emergency Department Following Colonoscopy

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A 64-year-old male presented to the emergency department (ED) with near syncope and worsening left flank and shoulder pain. He had undergone a difficult colonoscopy two days prior due to a tortuous colon. Initial vital signs were normal. He looked uncomfortable and had significant left upper quadrant abdominal tenderness with guarding. Thirty minutes after ED arrival, his blood pressure dropped to 73/59 mmHg, requiring aggressive fluid resuscitation. Bedside focused assessment with sonography in trauma (FAST) exam demonstrated free fluid in the abdomen with mixed echogenicity of the spleen, suggestive of splenic injury. Computed tomography (CT) demonstrated a large subcapsular splenic hematoma with active extravasation and surrounding intraperitoneal free fluid (Figure, Video). He was admitted to the surgical intensive care unit. Hemorrhage continued after interventional radiology performed embolization of the splenic artery. He then required laparoscopic splenectomy on hospital day 2 to control bleeding. He subsequently did well and was discharged on hospital day 10.

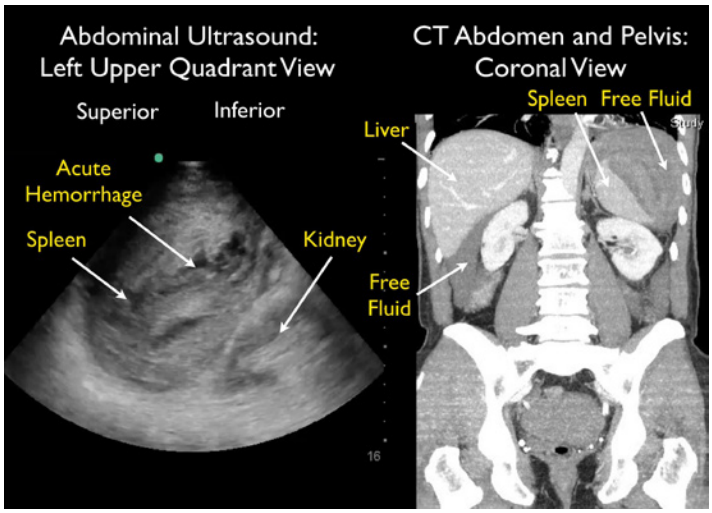

Figure. Splenic rupture after colonoscopy. Left image, ultrasound. Right image, computed tomography scan (CT).

Colonoscopy has been associated with spontaneous intra-abdominal organ injury. Jammal et al described a case of subcapsular liver hematoma associated with colonoscopy.[1] Lauretta et al described a case of splenic rupture following colonoscopy that had a delayed diagnosis due to initial physician consideration of alternate pathology, specifically intestinal rupture.[2] Shankar and Rowe described a case of splenic injury following colonoscopy and then reviewed the literature, finding a total of 93 cases.[3] Increasing age was found to be a risk factor. The authors also emphasized that patients may present with only moderate abdominal pain. A larger case series in 2012 by Aubrey-Bassler and Sowers described 613 case of splenic rupture without known risk factors. Of these, 327 occurred as a presenting manifestation of an underlying disease. Infections were found in 143 patients, with malaria most common (65 cases) and mononucleosis second (42 cases). Medical procedures were also highly associated with splenic rupture, and 87 cases were associated with colonoscopy.[4] In 2011 Fishback et al described the clinical and CT findings of 11 patients with splenic rupture after colonoscopy. CT demonstrated splenic injury with subcapsular hematoma and/or perisplenic hematoma in 10 cases and hemoperitoneum in eight cases.[5] Singla et al found 102 patients with splenic injury following colonoscopy.[6] The majority (73 patients) required operative intervention with 96% requiring splenectomy. This information should prompt emergency physicians to consider

splenic injury in patients presenting with abdominal pain (even mild) and/or shock in those who have recently undergone a colonoscopy. Bedside point-of-care ultrasound using the FAST exam may be effective in initially identifying these patients, especially those in shock requiring immediate resuscitation and surgical consultation like the patient discussed in this case.

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Video. Spleen rupture case.

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Elderly Woman with Abdominal Pain: Bedside Ultrasound Diagnosis of Diverticulitis

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A 72-year-old otherwise healthy female presented to the emergency department with two weeks of worsening abdominal pain. She was afebrile with normal vital signs. Her physical examination was notable for moderate abdominal tenderness without rebound to the left and suprapubic regions of the abdomen. Laboratory studies were remarkable for a white blood cell count of 13,000/mm^3. A focused bedside ultrasound over the patient's region of maximal discomfort revealed a thickened bowel wall and several small contiguous hypoechoic projections surrounding a hyperechoic center, suggestive of diverticulitis (Figure). She was given metronidazole and ciprofloxacin and her diagnosis of uncomplicated colonic diverticulitis was confirmed by computed tomography (CT) (Figure).

Acute diverticulitis resulting from inflammation of colonic diverticulum affects over half the population greater 65 years of age.[1,2] While an estimated 85% of cases resolve with nonoperative care, complications such as large abscesses, fistula formation, perforation, and peritonitis do occur.[1] CT is typically employed to diagnose presumed diverticulitis and recognize the presence of complicated disease, but for several decades ultrasound has been increasingly described as a similarly useful imaging modality.[1-5]

Particularly in cases of suspected uncomplicated diverticulitis, abdominal ultrasound may reach the diagnostic reliability of CT.[1,2,4,5] Ultrasound may detect edema leading to loss of normal bowel architecture, identify inflamed diverticula, and expose mesenteric or omental fat.[2-4] Key described songraphic findings include the following: edematous diverticula with thickened hypoechoic walls and hyperechoic centers, air containing diverticula with subsequent hyperechoic acoustic shadowing artifact, enlarged colonic walls greater then 5mm, and surrounding hyperechoic zones representing inflamed fat.[1-4] Focused bedside imaging of the area of pain and tenderness may aid in initiation of early antibiotic treatment pending any additional confirmatory studies, but imaging can be hindered by neighboring bowel gas and CT or other complementary imaging may be warranted to search for complications or reveal alternative diagnoses.[1,2]

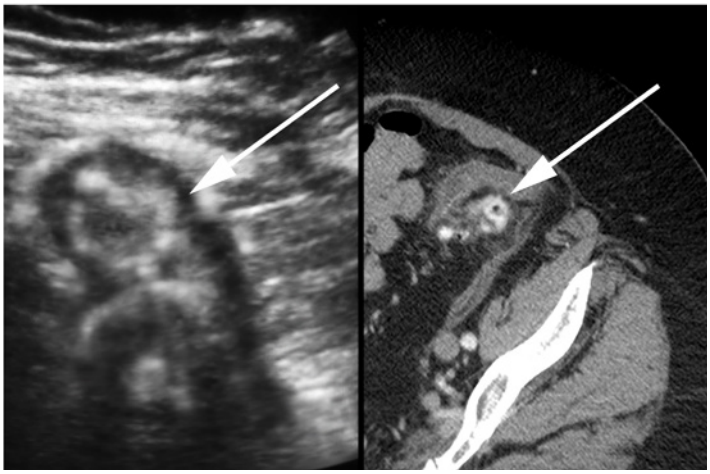

Figure. Transabdominal sonographic view of the patient's abdomen (Left) and associated axial computed tomography (Right) revealing inflamed diverticula (arrow). Related imaging findings of diverticulitis such as edematous diverticula with thickened hypoechoic walls and hyperechoic centers, and surrounding hyperechoic zones representing inflamed fat.

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Ruptured Splenic Artery Aneurysm: Rare Cause of Shock Diagnosed with Bedside Ultrasound

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Splenic artery aneurysm rupture is rare and potentially fatal. It has largely been reported in pregnant patients and typically not diagnosed until laparotomy. This case reports a constellation of clinical and sonographic findings that may lead clinicians to rapidly diagnose ruptured splenic artery aneurysm at the bedside. We also propose a rapid, but systematic sonographic approach to patients with atraumatic hemoperitoneum causing shock. It is yet another demonstration of the utility of bedside ultrasound in critically ill patients, specifically with undifferentiated shock. [West J Emerg Med. 2015;16(5):762-765.]

INTRODUCTION

Ruptured splenic artery aneurysm (SAA) is a rare condition that is challenging to diagnose given the nonspecific presentation. Non-specific abdominal pain is common in the emergency department (ED) representing 4-5% of complaints.[1] The incidence of SAAs is low, seen incidentally in only 0.78% of patients undergoing angiography.[2] Of these, only about 10% will rupture.[3] We report a case of splenic artery aneurysm rupture that emphasizes the value of ultrasound performed in the ED in shortening the differential, decreasing time to diagnosis, and altering the management plan with benefits in patient outcome. This study did not need to be approved by our university's institutional review board, as case studies are not considered by our institution to be "human subjects' research."

CASE REPORT

A 41-year-old woman presented to the ED with sharp, stabbing chest pain radiating into the abdomen and the back with nausea and diaphoresis. She reported diffuse abdominal pain for several months, and admitted to only occasional alcohol use. Cholecystectomy was her only surgical history.

Initial vital signs were BP 82/60 and pulse 110. Physical examination showed a diffusely tender abdomen with increased pain in the left upper quadrant and epigastric regions. Vital signs improved initially with an intravenous (IV) fluid bolus.

The initial differential included upper gastrointestinal bleeding, sepsis, myocardial infarction, aortic emergencies, pregnancy complications including ectopic, and perforated viscus.

Chest radiograph and electrocardiogram were normal. Despite initial stabilization, the patient again became hypotensive with signs of profound shock including an ashen appearance, decreased mental status, and weak, thready pulses.

A bedside ultrasound was performed to evaluate the patient's physiology and potential etiology of shock. The cardiac views were limited but showed no effusion or obvious right ventricular dilation, and left ventricular function appeared vigorous (Figure 1, Frame 1). The visualized portions of the abdominal aorta were of normal caliber as seen in Figure 1, Frame 2. Extensive free peritoneal fluid with areas of increased and mixed echogenicity was noted in Morison's pouch (Figure 1, Frame 3, and Video), the paracolic gutters and pelvis (Figure 1, Frame 4, and Video). There was extensive clot formation in the epigastrium and left upper quadrant (Figure 2, Frames 1-3) but not surrounding the spleen, which appeared normal (Figure 2, Frame 4). There were no obvious adnexal masses (Figures not available due to technical machine storage malfunction) and the previously

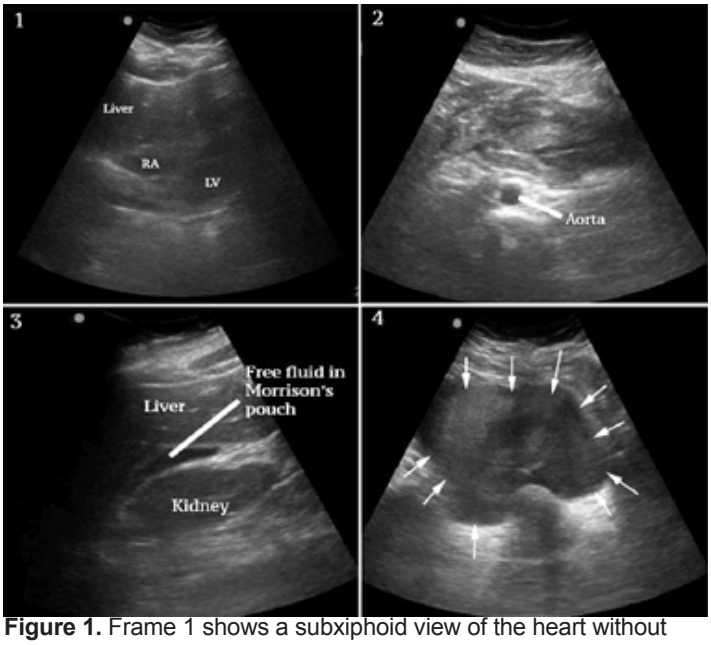

Figure 1. Frame 1 shows a subxiphoid view of the heart without pericardial effusion or RV dilation. Additonally, left ventricle (LV) function was vigorous. RA-right atrium. Frame 2 shows a portion of the abdominal aorta with a normal diameter. Frame 3 shows free fluid in Morison's pouch. Frame 4 shows fluid with mixed and increased echogenicity in the pelvis consistent with blood (arrows).

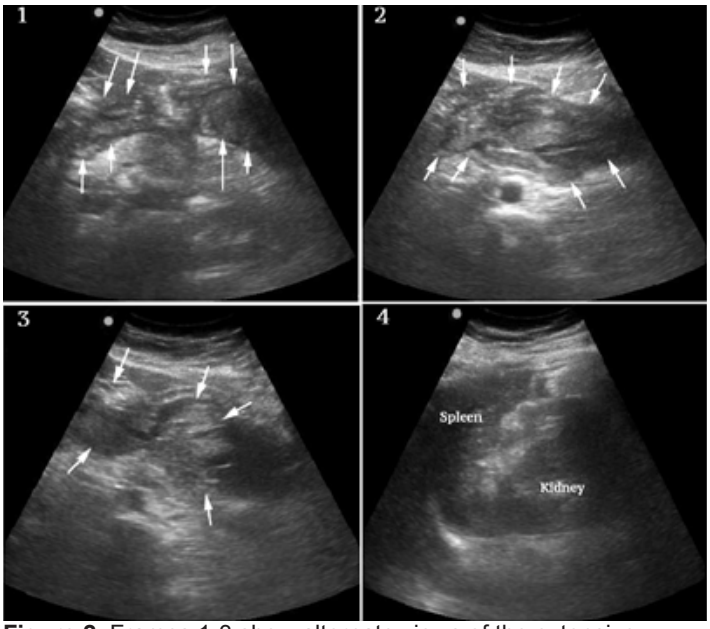

Figure 2. Frames 1-3 show alternate views of the extensive and organized clot formation in the epigastrium and left upper quadrant (arrows). Frame 4 shows the spleen which is grossly normal in size and appearance.

ordered human chorionic gonadotropin (HCG) had returned negative.

At this point the differential was modified and included spontaneous splenic rupture, but from previous clinician experience, this was felt less likely due to the normal appearance of the spleen on ultrasound. Hemorrhagic pancreatitis was considered, but the extent of intraperitoneal hemorrhage and clinical presentation did not appear consistent. Ruptured ectopic pregnancy and hemorrhagic ovarian cyst were also felt unlikely given the lack of adnexal mass and negative HCG. SAA was felt the most likely diagnosis given the overall clinical and sonographic findings, specifically diffuse atraumatic hemoperitoneum, the localized clot formation in the epigastrium and left upper quadrant and lack of findings to support other differential considerations.

Adequate IV access was assured and resuscitation with blood was initiated while the patient was taken immediately to radiology for computed tomography (CT) angiography, which showed multiple SAAs and ongoing hemorrhage. Interventional radiology and surgery were consulted. The patient was taken to a dual angiography/operating room suite where splenic artery embolization was performed, followed by open evacuation of hematoma, splenectomy, distal pancreatectomy and further hemorrhage control. Resuscitation followed a massive transfusion protocol, resulting in total administration of seven units of packed red blood cells, four units of fresh frozen plasma, one unit each of platelets and cryoprecipitate, in addition to autotransfusion during surgery. She did well postoperatively.

DISCUSSION

Ruptured SAAs are an uncommon cause of hemorrhagic shock but the splenic artery accounts for 60% of visceral aneurysms.[2] SAAs have a 4:1 female to male ratio statistically related to multiparity with a mean of 3.5 pregnancies.[2] This is believed to be related to hormonal influences and increased splenic arterial wall stress from portal hypertension during pregnancy. Portal hypertension from other causes is also believed to be a contributing factor.[2] Our patient had no known risk factors for a ruptured SAA other than her female gender, making her low probability for this diagnosis.

After rupture, SAAs cause significant blood loss with hemodynamic instability typically occurring in 6-96 hours, giving time for repair if diagnosed. The mortality ranges from 10-36% in non-pregnant patients[3-4] but doubles for pregnant patients and those with pre-existing portal hypertension.[4] Rapid diagnosis and intervention are critical.

Initial presentation of rupture is chest pain followed by hemodynamic instability 6-96 hours later. The delayed blood loss is caused by the "double rupture phenomenon," where blood is initially contained within the lesser omental sac, delaying the onset of intraperitoneal hemorrhage.[5] This provides a window for diagnosis and treatment that may reduce the current mortality rate.

Ruptured SAA is most frequently reported in pregnancy. Only a few reported cases described the use of bedside ultrasound to identify hemoperitoneum prior to open laparotomy. Jackson et al.[4] described two cases of females with hemodynamic collapse: one in a patient at 35-weeks gestation and another in a woman with signs of shock and a suspected

obstetric etiology. Grousolles et al.,[5] report a woman at 6-weeks gestation presenting with signs of shock and an initial suspected diagnosis of ruptured ectopic pregnancy. Heitkamp et al.[6] report a woman at 31-weeks gestation complaining of sudden severe abdominal pain and hypotension, with hemoperitoneum on ultrasound, who underwent laparotomy where a suspected ruptured SAA was identified and surgically treated.

The diagnosis of SAA primarily occurs when a CT with contrast is ordered as part of the work up of abdominal pain or during exploratory surgery for non-traumatic hemoperitoneum.

Etiologies of non-traumatic hemoperitoneum with hemodynamic instability include ruptured vascular neoplasm in a solid organ, spontaneous splenic rupture, ruptured ectopic pregnancy, uterine rupture during pregnancy, uterine artery rupture, or intraperitoneal abdominal aortic aneurysm rupture. A ruptured hemorrhagic ovarian cyst may cause hemoperitoneum, but hypotension is atypical.[7] When SAA occurs during pregnancy, 70% are initially diagnosed as uterine ruptures.[8]

When using ultrasound to assess cases of non-traumatic shock with hemoperitoneum, a careful consideration of the differential diagnosis with a rapid but systematic sonographic evaluation may suggest the most likely etiology. In this case, the absence of clot or fluid around the spleen implied spontaneous spleen rupture was unlikely. This belief was based mostly on clinician experience, but there have also been reports of spontaneous spleen rupture that report splenomegaly, perisplenic hematoma and/or fluid collections as common sonographic findings.[9] The absence of adnexal masses and negative HCG made ectopic or other adnexal etiologies seem unlikely. The normal diameter of the aorta made intraperitoneal abdominal aortic rupture unlikely. Other uterine pathology was felt unlikely given the grossly normal size of the uterus and the fact that these are typically complications of later pregnancy. Lastly, the localized, extensive clot formation in the epigastrium and left upper quadrant strongly suggested a ruptured SAA. Additional analysis with color and Doppler modalities could be considered for similar cases, but were not performed in this case. Preliminary diagnosis made using a modified rapid ultrasound in shock[10] protocol in patients with hemodynamic instability correlates strongly with final diagnoses,[11] suggesting ultrasound has potential in guiding first-line therapeutic approach as it did in this case.

CONCLUSION

We report a patient who presented with nonspecific complaints and undifferentiated hypotension where bedside ultrasound assisted in drastically altering the differential. Identifying the rare diagnosis of ruptured splenic artery aneurysm early led to rapid intervention and a more favorable outcome for the patient. This case further illustrates the utility of bedside ultrasound in the evaluation of critically ill patients, specifically in undifferentiated shock. We suggest a rapid but systematic sonographic evaluation to assist in determining the etiology of nontraumatic hemoperitoneum causing shock. The absence of sonographic signs of other etiologies combined with the finding of extensive clot formation in the epigastrium and left upper quadrant may suggest ruptured splenic artery aneurysm earlier in the patient's course, expediting diagnosis and management, and potentially improving outcome.

Video. Narrated overview of the key findings and video clips. Free peritoneal fluid and intraperitoneal clot is shown as well as a normal appearing spleen.

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Not What It Seems: Deep Tissue Infection Presenting as Cellulitis

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A 34-year-old male with diabetes presented to the emergency department with four days of progressively worsening redness, swelling and pain to his left buttock. The patient denied fevers, chills, rectal pain or purulent drainage from his rectum. His initial vital signs were heart rate of 82; blood pressure of 146/92; and temperature of 98.2°F. The left buttock had a poorly circumscribed area of induration; however, there was no fluctuance or crepitace. Rectal exam was unremarkable. Because the patient's buttock pain was disproportionate to his exam findings, a point-of-care ultrasound was performed to determine if a more extensive process was present. The ultrasound demonstrated cobblestoning, fascial thickening with edema, and a large 4.5cm fluid collection extending and adjacent to the rectum (Figure 1). A computed tomography (CT) of the pelvis with IV contrast confirmed the presence of a perirectal abscess (Figure 2).

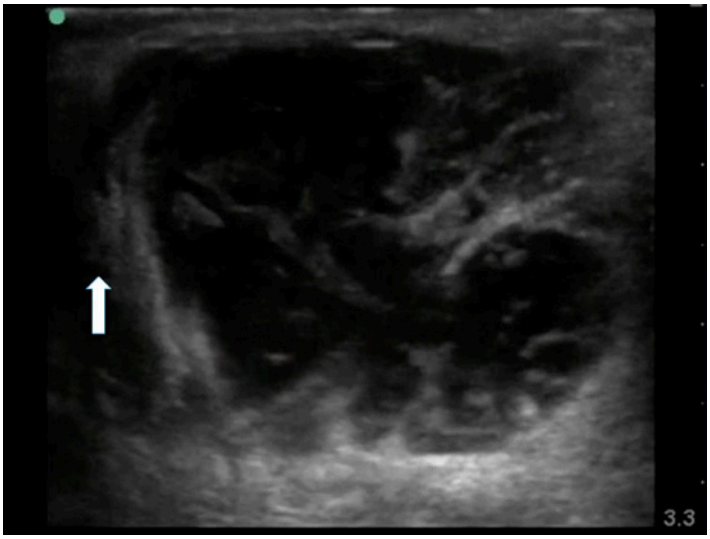

Figure 1. Large fluid collection adjacent to the rectum (white arrow).

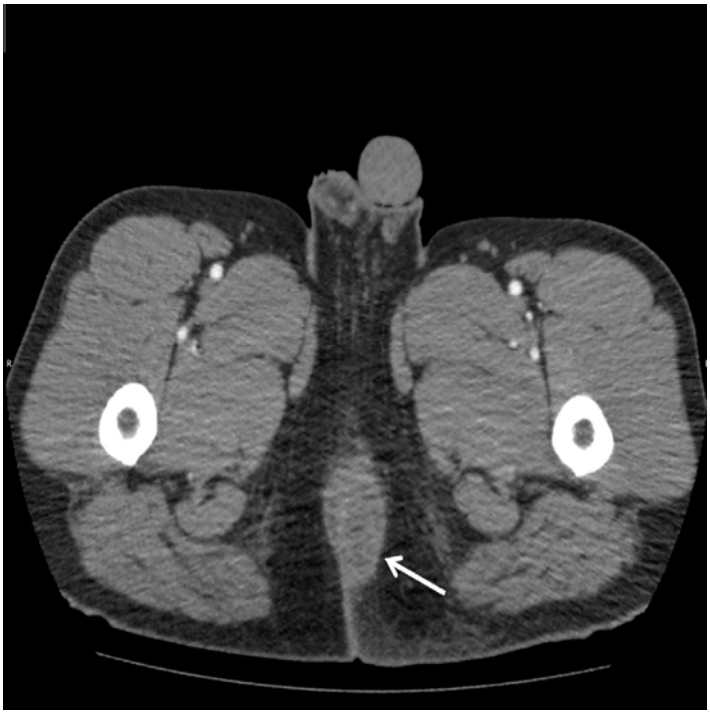

Figure 2. Pelvic CT showing peri-rectal fluid collection (white arrow).

Perirectal abscesses and fistulas are common in adults. Abscess formation begins as an infection of the anal glands. Over time, this infection can spread to surrounding tissues leading to fistula formation in roughly 40% of patients. The ratio of occurrence in males to females in the adult population is 2:1. Diagnosis of a peri-rectal abscess is clinical; however, ultrasound and CT can be used in indefinite cases. Treatment requires surgical incision and drainage with packing and follow up. Reoccurrence occurs in roughly 10% of patients. The patient was seen by a surgeon who performed a bedside incision and drainage,

and the patient was started on IV antibiotics and discharged the next day.

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Emergency Physician Attitudes, Preferences, and Risk Tolerance for Stroke as a Potential Cause of Dizziness Symptoms

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Introduction: We evaluated emergency physicians' (EP) current perceptions, practice, and attitudes towards evaluating stroke as a cause of dizziness among emergency department patients.

Methods: We administered a survey to all EPs in a large integrated healthcare delivery system. The survey included clinical vignettes, perceived utility of historical and exam elements, attitudes about the value of and requisite post-test probability of a clinical prediction rule for dizziness. We calculated descriptive statistics and post-test probabilities for such a clinical prediction rule.

Results: The response rate was 68% (366/535). Respondents' median practice tenure was eight years (37% female, 92% emergency medicine board certified). Symptom quality and typical vascular risk factors increased suspicion for stroke as a cause of dizziness. Most respondents reported obtaining head computed tomography (CT) (74%). Nearly all respondents used and felt confident using cranial nerve and limb strength testing. A substantial minority of EPs used the Epley maneuver (49%) and HINTS (head-thrust test, gaze-evoked nystagmus, and skew deviation) testing (30%); however, few EPs reported confidence in these tests' bedside application (35% and 16%, respectively). Respondents favorably viewed applying a properly validated clinical prediction rule for assessment of immediate and 30-day stroke risk, but indicated it would have to reduce stroke risk to <0.5% to be clinically useful.

Conclusion: EPs report relying on symptom quality, vascular risk factors, simple physical exam elements, and head CT to diagnose stroke as the cause of dizziness, but would find a validated clinical prediction rule for dizziness helpful. A clinical prediction rule would have to achieve a 0.5% post-test stroke probability for acceptability. [West J Emerg Med. 2015;16(5):768-776.]

INTRODUCTION

Dizziness is a common presenting symptom in the emergency department (ED) that is usually benign, but rarely the harbinger of stroke, particularly in the posterior circulation. Nationally, dizziness and vertigo symptoms accounted for 4% of ED visits overall in 2011.[1] The total cost for these visits was estimated at $4 billion, which reflects the often-substantial resources involved in evaluating these patients in the ED with neuroimaging, specialty consultation, and hospital admission.[1,2] Although dizziness-related ED visits and use of imaging studies during these visits increased from 1995-2004, there was no corresponding increase in the diagnosis of cerebrovascular disease among these patients.[3] The prevalence of stroke was low in patients with dizziness as well: 3.2% of all ED patients with undifferentiated dizziness and only 0.7% of patients with isolated dizziness (dizziness, vertigo or imbalance without motor, sensory or language findings) were diagnosed with stroke or transient ischemic attack (TIA).[4]

Within this context, a clinical prediction rule to risk-stratify patients with dizziness could be useful in decision-making and resource utilization. Clinical prediction rules rely on readily obtainable historical, physical examination and clinical data to provide a standardized risk assessment for bedside decision-making. For example, the Pediatric Emergency Care Applied Research Network head injury clinical decision rule helps clinicians identify children at risk of clinically important brain injury after head trauma, in order to target the use of computed tomography (CT) imaging.[5]

As part of the process for developing a useful clinical prediction rule for dizziness in the ED, a better understanding of emergency physicians' (EP) perceptions of their current practice and attitudes towards currently available diagnostic aids is crucial. Recently, a three-step bedside evaluation developed and tested by expert neuro-otologists (head-thrust test, gaze-evoked nystagmus, and skew deviation [HINTS]) has been proposed to clinically differentiate central from peripheral etiologies of vertigo, but its actual use in current emergency practice is unknown.[6] Similarly, the required performance of a clinical prediction rule for dizziness evaluation to be clinically useful for EPs is also unknown. Therefore, we conducted a survey of EPs to assess their current practice, their attitudes and preferences for decision support, and to determine the specific risk thresholds that would make a clinical prediction rule useful in evaluating dizziness in the ED.

METHODS

Study Design and Population

We conducted a cross-sectional survey of EPs at the 21 EDs in the Kaiser Permanente Northern California (KPNC) system from August to October 2013. KPNC is an integrated healthcare delivery system that serves more than 3.7 million members; in 2013, there were nearly one million visits to the 21 community EDs systemwide.

We developed a comprehensive list of all EPs working across the system through individual contact with department leaders. EPs working more than five ED shifts per month were eligible to participate in this study. We excluded physicians who had been employed by KPNC for fewer than two months. These parameters were chosen to ensure the survey population included staff physicians with sufficient experience to understand the workings of the specific healthcare setting (resource availability, consultation services, etc). Study investigators were also excluded. These eligibility procedures were similar to prior EP survey studies conducted by our research group.[7,8]

The KPNC Institutional Review Board approved the study protocol and waived the requirement for written informed consent.

Survey Content and Administration

We consulted the relevant literature on posterior circulation stroke and dizziness to develop the content of the survey**.** Specifically, we included items on specific history, exam findings, and clinical decision aids for evaluating stroke in patients with dizziness from the medical literature.[9-12] We used answer choices with a 5-point Likert response format for agreement with statements (strongly agree, somewhat agree, neutral, somewhat disagree, and strongly disagree) and presented geometric series of probabilities for risk thresholds. Each question in the survey included "decline to answer" as a response option. The complete survey is available in an online appendix.

We pilot tested the instrument with the study project manager, the study investigators, the stroke neurologist (ASK) and four EPs not involved in survey construction, to ensure ease of use, relevance and comprehensibility. Responses from individuals who participated in pilot testing were not included in the analysis dataset. Based on the pilot testing, the initial questions were reorganized into sections that covered specific domains (e.g. the section eliciting the respondent's suspicion for stroke based on specific exam and history findings), and we eliminated items from the section eliciting the specific targets for a candidate clinical prediction rule for EPs in order to focus on targets that were felt to be most relevant to practicing EPs in real time (e.g. admission and imaging decisions rather than estimating long-term stroke risk). We also modified the Likert response format choices to present uniform language across items from different sections of the survey instrument.

Email invitations for the electronic survey (SurveyMonkey, Palo Alto, CA) were sent to all 535 eligible EPs. We sent repeat invitations to non-respondents. Individuals who submitted partial or complete responses to the survey instrument received a $10 gift card; invitees who chose not to complete the survey could also write research staff to request a $10 gift card.

The survey contained clinical scenarios and questions designed to ascertain EP perceptions of their practice patterns and attitudes towards dizziness as a presentation of posterior

stroke. Domains covered included self-reported use of bedside diagnostic tests, confidence in use of these tests, perceptions about utility of clinical decision aids to guide imaging, admission and disposition decisions, and demographic information about the respondents.

The first part of the survey was a clinical vignette. EPs were asked to estimate risk of stroke in two clinical vignettes of ED patients with dizziness: 1) a patient with undifferentiated dizziness with no other information provided; and 2) a patient aged 75 years with isolated dizziness, no neurologic findings on examination, and a normal electrocardiogram and hematocrit. Response choices were arranged in a geometric series with eight choices from 1/800 (0.125%) to 1 in 25 (4%), based on previously reported estimates placing the risk of stroke at 2-4% for undifferentiated dizzy patients and 0.5-1% of patients with isolated dizziness.[1,2,4,6,13,14]

In the second section, questions were designed to elicit the whether particular historical elements (15 symptom quality and vascular risk factors) and physical examination findings increased or decreased (greatly increase, somewhat increase, neutral, somewhat decreased, greatly decrease) EP's suspicion for a stroke as a cause of dizziness, followed by questions about their perceived use of neuroimaging (CT, magnetic resonance imaging (MRI)) and specialist consultation for patients with dizziness (very frequently, frequently, occasionally, rarely, never). This section also queried EPs on perceived use and confidence in the use of common exam elements: HINTs, ABCD^2, Epley maneuver and Dix-Hallpike testing (strongly agree, somewhat agree, neutral, somewhat disagree, and strongly disagree).[9]

In the third portion of the survey, respondents were queried about their areas of concern in the evaluation of patients with dizziness (overutilization of imaging, excluding stroke on clinical grounds alone) and their perceptions about the usefulness and appropriate target for a candidate clinical prediction rule (decision to obtain neuroimaging, disposition decision, or an assessment of the 30-day risk for disabling stroke).

To ascertain the requisite post-test probability in order for a dizziness-specific clinical prediction rule to be perceived as clinically useful to EPs, we asked respondents about necessary post-test probability of a clinical prediction rule targeting dizziness assuming a pre-test stroke probability of 3% (based on current evidence of stroke prevalence in patients with dizziness).[4,6] We presented a geometric series of probability choices that included known estimated stroke risk for patients with dizziness, as well as acceptable post-test risk thresholds identified in studies of other conditions such as acute coronary syndrome and pulmonary embolism.[15] Respondents were presented with choices in both probability and percentage formats (e.g., 1 in 100 and 1%).

Finally we collected demographic information such as age, gender and years in practice after residency.

Data Analysis

ASK and MVK performed the statistical analysis using Stata (v13, College Park, TX). Descriptive statistics were tabulated. We excluded missing responses from the analysis. We evaluated the impact of longer tenure in practice post-residency on risk thresholds using the Wilcoxon rank-sum test on the acceptable risk threshold for a clinical prediction rule. Using these post-test probabilities and an estimate of the pre-test risk of stroke from the literature, we calculated the necessary likelihood ratio for a candidate clinical prediction rule to be considered clinically useful by EPs. Non-responders and responders were evaluated using the K-sample equality of medians test (tenure in practice) and the z-test (gender).

RESULTS

Characteristics of the Respondents

The response rate was 68% (366 respondents from 535 invitations). Respondents' median time in practice after residency was eight years (range 1-40 years; interquartile range 4-14 years); 37% were female, and most were board certified in emergency medicine (92%) (Table 1). Non-responders (n=169) were 30% female, with median time in practice after residency of 10 years (range 1-38 years; interquartile range 5-16 years); board certification data is not available for non-responders. Bivariate analysis did not reveal significant differences between the responders and non-responders.

Current Practices for Evaluating Dizziness in the ED

Respondents underestimated the stroke risk for patients with undifferentiated dizziness: 68% (n=247) estimated stroke risk at 0-1%, actual stroke risk 2-4%. For isolated dizziness, 50% of respondents overestimated the stroke risk at 2-4% (n=179) while 36% (n=131) correctly estimated stroke risk at 0.5-1%, actual stroke risk 0.5-1%. The actual stroke risk was drawn from previously reported estimates placing the risk of stroke at 2-4% for undifferentiated dizzy patients and 0.5-1% of patients with isolated dizziness.[1,2,4,6,13,14]

The impact of the specific description of dizziness, associated symptoms, and elements of the past medical history on the suspicion for stroke is illustrated in Table 2. Respondents reported that symptom quality influenced their suspicion for a central cause of dizziness, as did the presence of typical vascular risk factors such as age, diabetes, and hypertension.

Current practice preferences for obtaining imaging and specialty consultation in dizziness patients are presented in Figure 1. Three-quarters of respondents reported frequent or very frequent use of head CT in the ED evaluation of dizziness (74%; n=260), although the same proportion of respondents agreed with the statement that CT was overused in the evaluation of dizziness (75% strongly or somewhat agreed; n=268).

Respondents' agreement with statements about self-reported use of and confidence in using bedside diagnostic and physical examination findings and a commonly used clinical prediction rule for TIA (ABCD^2) is shown in Figure 2.

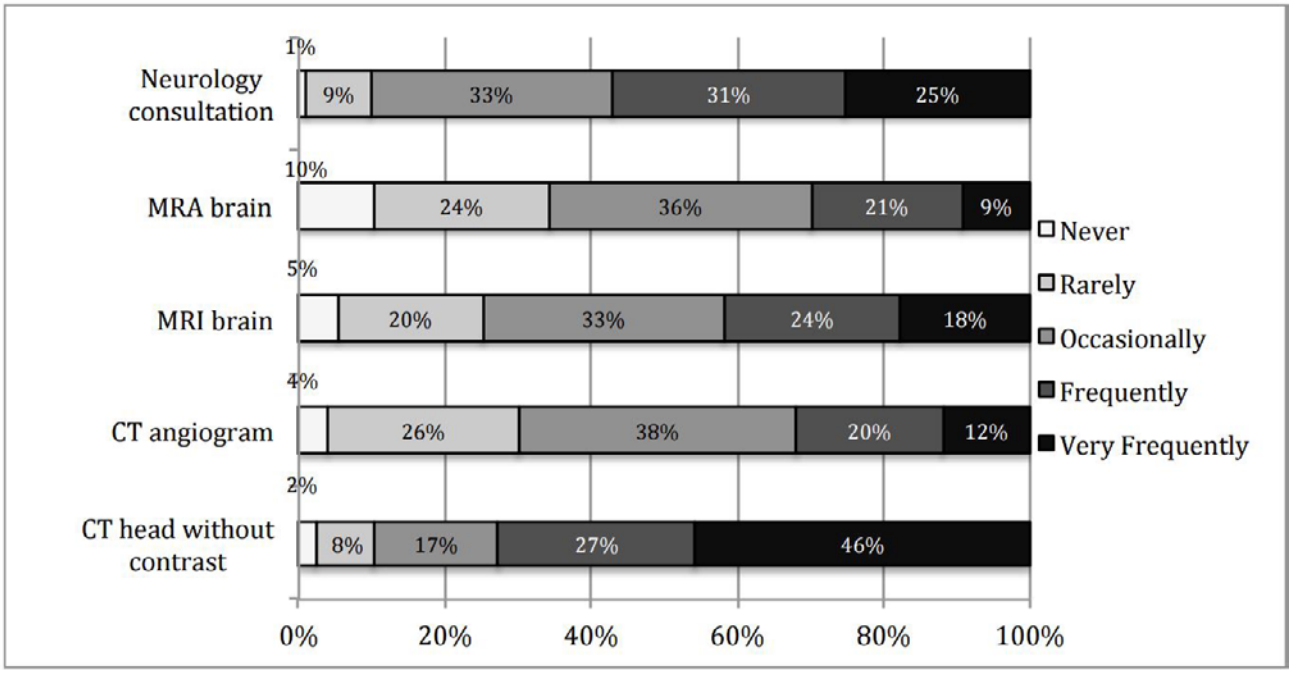
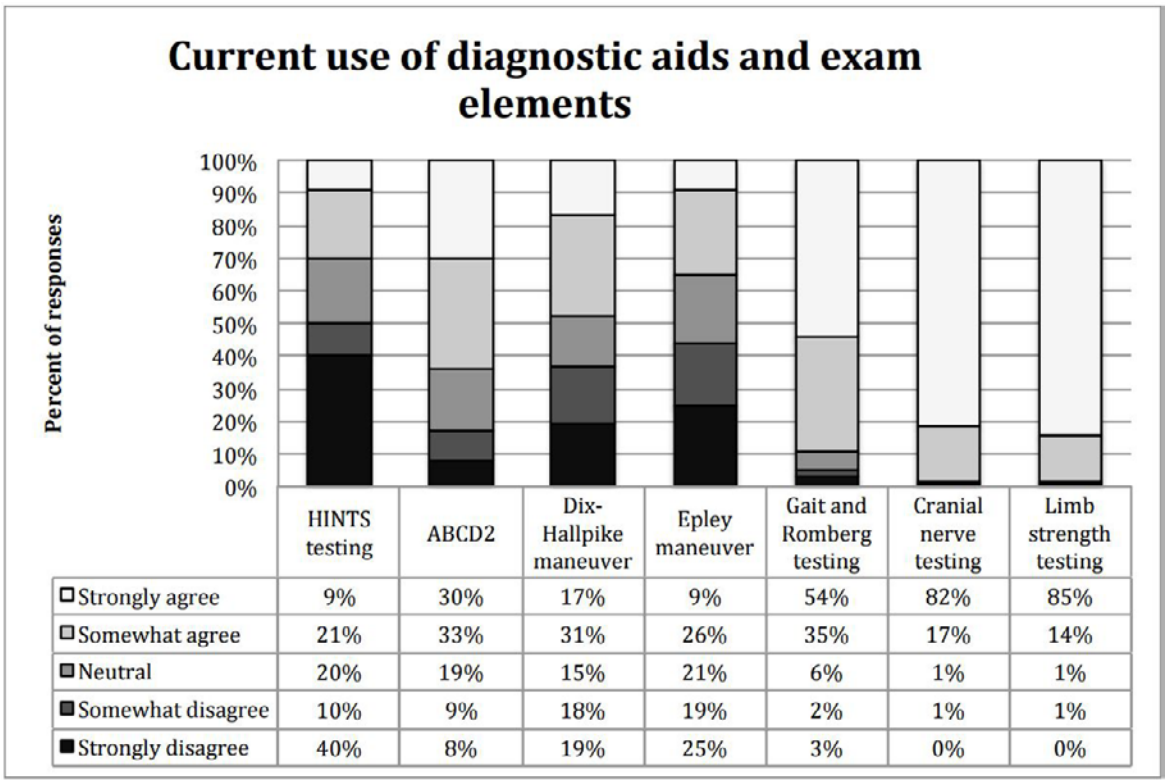


Figure 1. Current use of consultation and neuroimaging to evaluate dizziness in the emergency department[a].
[a]Survey question 5: percentages indicate percent of respondents choosing a given answer.
MRA-magnetic resonance angiogram
MRI-magnetic resonance imaging
CT-computed tomography



	HINTS testing	ABCD2	Dix-Hallpike maneuver	Epley maneuver	Gait and Romberg testing	Cranial nerve testing	Limb strength testing
Strongly agree	9%	30%	17%	9%	54%	82%	85%
Somewhat agree	21%	33%	31%	26%	35%	17%	14%
Neutral	20%	19%	15%	21%	6%	1%	1%
Somewhat disagree	10%	9%	18%	19%	2%	1%	1%
Strongly disagree	40%	8%	19%	25%	3%	0%	0%

Figure 2. Respondents' reporting of their perceived current use of bedside tests and clinical prediction rules to evaluate for posterior stroke among emergency department patients with dizziness[a].
[a]Survey question 4, a-g, statement i
HINTS-Head impulse, nystagmus, test of skew
ABCD2-to predict 30 day risk of stroke after transient ischemic attach

Table 1. Demographic characteristics of 366 emergency physician (EP) respondents and 169 EP non-respondents at 21 emergency departments.

	Respondents	Non-respondents	
	n (%)	n (%)	
Gender[a]			
Female	133 (37)	51 (30)	p=0.11
Male	224 (63)	118 (70)	
Board certified in emergency medicine[a]			
Yes	332 (92)	Data unavailable	
No	25 (7)	Data unavailable	
Years in practice[a]			
Median	8 years	10 years	p=0.06
Interquartile range	4-14 years	5-16 years	

[a]9 respondents did not answer this question.

Confidence in applying these bedside diagnostic and physical exam tests and how often they were applied is reported in Figure 3. Respondents reported the lowest confidence in and likelihood of applying Dix-Hallpike and HINTS testing of the queried elements.

When EPs were asked whether they felt they were likely to use these specific tests if the tests were validated for the evaluation of stroke as a cause of dizziness, over 85% of respondents reported they were likely to use cranial nerve testing (89%), limb strength (86%) and gait evaluation (89%), while 58% reported they were likely to use Dix-Hallpike and 66% reported they were likely to use HINTS testing.

Perceived Utility of Clinical Prediction Rules for Dizziness

EPs perceived estimating the immediate and 30-day risk of stroke, identifying candidates for hospital admission and identifying candidates for neuroimaging studies as appropriate targets for a clinical prediction rule (Table 3).

Risk Thresholds for Stroke for a Clinical Prediction Rule for Dizziness

Responses for target post-test probability for a clinical prediction rule on dizziness and stroke, including the non-numeric choices of "Decline to answer," "I would not get a CT (or MRI) scan to evaluate posterior circulation stroke, " and "A clinical prediction rule will never be as useful as neuroimaging" are presented in Figure 4, with the distribution of responses clustered around 0.25%-1% post-test probability of stroke, for those who identified a target post-test probability. Missing responses were low (0-3%), but we did observe a 10% decline-to-answer rate for questions relating to desired post-test probability, and this may have biased our results. Regarding using a clinical prediction rule to forgo neuroimaging in a patient with dizziness, 4% and 6%, respectively, of respondents marked that a clinical prediction rule would never be as useful as neuroimaging (CT or MRI). Fifty respondents (14%) reported that they would not obtain a CT to evaluate posterior circulation stroke as a cause of dizziness. Of those respondents who did indicate a numeric ideal post-test probability for a clinical prediction rule, at the median, respondents reported they would require a post-test probability of stroke of 0.5% for a clinical prediction rule to be clinically useful, to support not obtaining a head CT, or to support not obtaining MRI.

We further analyzed responses indicating a probability assuming linear distribution of the probabilities. First, we calculated mean probabilities: 0.65% (clinically useful), 0.58% (to support not obtaining a head CT), and 0.56% (to support not obtaining MRI). Using the stated 3% pre-test stroke probability, we generated likelihood ratios (LR) of 0.22, 0.19 and 0.19, respectively.

DISCUSSION

The major findings of the study are: 1) in current practice, EPs self-report a greater reliance on symptom quality and basic elements of the neurologic examination than on more specialized bedside maneuvers such as Dix-Hallpike or HINTS testing to evaluate ED patients with dizziness; 2) stroke risk, hospital admission, and neuroimaging are all perceived as appropriate targets for a decision support with a validated clinical prediction rule; 3) the risk threshold preferred for clinical utility is on the order of 0.5% and is similar for these various decision targets.

Previous studies have reported that a patient's description of dizziness symptoms is often inconsistent; hence, reliance on symptom quality to differentiate the cause of dizziness symptoms, as we saw in our study, may be misplaced.[12] Tarnutzer et al cite multiple studies in which terms relating to the quality of dizziness (e.g. vertigo, lightheadedness or unsteadiness) were inconsistently applied by patients and provided little predictive value on stroke risk.[13] Based on these data, we avoided focusing on the quality of dizziness symptoms (e.g. vertigo vs. lightheadedness), although we did note that respondents reported differing degrees of suspicion for stroke based on the description of dizziness. The presence of stroke risk factors and of motor, sensory, and speech findings increased EPs' suspicion of stroke as a cause of dizziness, which are consistent with the typical diagnostic elements used in evaluating stroke more generally.

Of the bedside tests queried, respondents also indicated the lowest use of and confidence in applying HINTS. It is possible that the time required at the bedside to perform HINTS and Dix-Hallpike test or the frequency of use required to feel competent to apply these tests are a deterrent to their use in day-to-day clinical practice; however, this is unclear. Alternatively, respondents may not have been familiar with the interpretation or utility of these tests, especially HINTS, to evaluate for a

Table 2. Impact of various historical and exam factors on the suspicion for stroke as cause of dizziness in the emergency department.

Finding[a]	Greatly increase n (%)	Somewhat increase n (%)	Neutral[b] n (%)	Somewhat decrease n (%)	Greatly decrease n (%)
Age over 45	59 (16)	256 (70)	40 (11)	7 (2)	1 (0.5)
Diabetes mellitus	111 (31)	230 (64)	19 (5.3)	0 (0)	1 (0.3)
Prior history of stroke	233 (64)	127 (35)	3 (0.8)	0 (0)	1 (0.3)
Suddenness of onset of dizziness symptoms	19 (5)	98 (27)	157 (43)	68 (19)	21 (6)
Spinning sensation	7 (1.9)	39 (11)	206 (57)	86 (24)	24 (6.7)
Constant dizziness, worsening with movement	24 (6.7)	140 (39)	113 (31)	73 (20)	13 (3.6)
Intermittent dizziness that resolves when not moving	5 (1.4)	22 (6.1)	64 (18)	166(46)	105 (29)
Associated nausea and vomiting	5 (1.4)	41 (11)	265 (73)	45 (12)	6 (1.7)
Hypertension at evaluation (blood pressure≥140/90 mmHg)	20 (5.5)	219 (60)	123 (34)	2 (0.6)	0 (0)
Nystagmus	15 (4.2)	68 (19)	197 (55)	66 (19)	10 (2.8)
Unilateral weakness	321 (88)	34 (9.4)	6 (1.7)	1 (0.3)	1 (0.3)
Unilateral sensory loss	297 (82)	51 (14)	9 (2.5)	5 (1.4)	2 (0.6)
Inability to walk	175 (48)	125 (34)	62 (17)	1 (0.3)	0 (0)
Double vision	282 (77)	68 (19)	13 (3.6)	0 (0)	1 (0.3)
Speech disturbance	328 (90)	26 (7)	7 (1.9)	1 (0.3)	1 (0.3)

[a]Among non-missing; range of missing responses: 2-10.
[b]Neutral=neither increase nor decrease.

Table 3. Potential targets for a clinical prediction rule for dizziness.

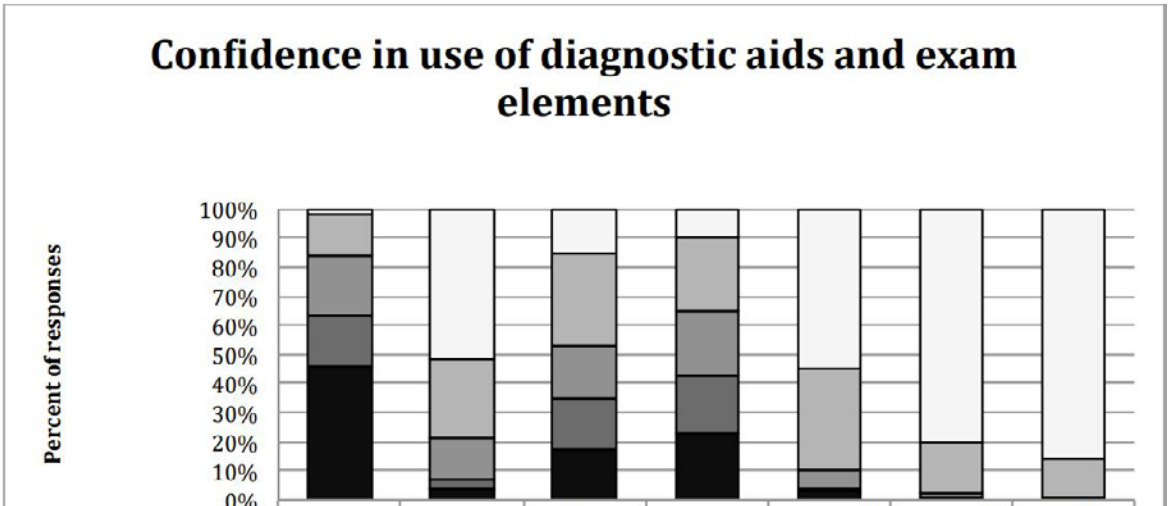
Target[a]	Strongly agree n (%)	Somewhat agree n (%)	Neutral n (%)	Somewhat disagree n (%)	Strongly disagree n (%)
To assess immediate stroke risk in ED patients with dizziness	245 (68)	98 (27)	13 (3.6)	3 (0.8)	3 (0.8)
To exclude stroke as a cause of dizziness in ED patients WITHOUT neuroimaging	276 (76)	69 (19)	12 (3.2)	3 (0.8)	1 (0.3)
To help decide whether to obtain neuroimaging in ED patients with dizziness	258 (71)	84 (23)	15 (4)	4 (1)	1 (0.3)
To help determine whether an ED patient with dizziness warranted admission	222 (61)	98 (27)	28 (7.7)	11 (3)	3 (0.8)
To assess the 30-day risk of disabling stroke in ED patients with dizziness	193 (53)	120 (33)	29 (8)	14 (1.9)	6 (1.7)

ED, emergency department
[a]Among non-missing; range of missing responses: 2-10.

central cause of dizziness. To date, no studies have assessed EP performance of HINTS testing; current literature reflects performance of the HINTS test by neurologists, neuro-ophthalmologists and neuro-otologists.[6,16,17]

Overall, EPs identified the decision to admit a patient, the decision to obtain neuroimaging, and the assessment of immediate and short-term stroke risk as useful targets for a clinical prediction rule. Our findings are consistent with previous research that EPs would find validated clinical prediction rules useful in clinical practice.[8,18,19] In a survey of priorities for clinical prediction rules, EPs ranked assistance in identifying serious or central cause of dizziness as a top priority.[18] Despite this identified clinical need, no current clinical prediction rules have focused on the evaluation of dizziness. One proposed bedside aid to assess the risk of stroke, HINTS, has been reported to have an LR of 0.04 for excluding stroke, but was developed in a highly selected and high-risk subpopulation of dizziness patients (59.5% of this cohort had posterior stroke and all had been admitted to the hospital).[16] Whether it performs as well in a lower-risk population or in the hands of front-line EPs remains uncertain.

The acceptable post-test probability of stroke (approximately 0.5%) among ED patients identified in this study is comparable to the risk thresholds for low-risk suspected acute coronary syndrome and for pulmonary embolism. That the post-test probability thresholds for these decisions were



	HINTS	ABCD2	Dix-Hallpike maneuver	Epley maneuver	Gait and Romberg testing	Cranial nerve testing	Limb strength testing
Strongly agree	2%	51%	15%	10%	55%	80%	86%
Somewhat agree	14%	27%	31%	25%	35%	18%	13%
Neutral	21%	14%	18%	22%	6%	1%	1%
Somewhat disagree	17%	3%	17%	20%	1%	1%	0%
Strongly disagree	46%	4%	17%	23%	3%	0%	0%

Figure 3. Agreement with feeling confidence in use of specific diagnostic aids and history and exam elements[a].
[a]Survey question 4, a-g, statement ii
HINTS-Head impulse, nystagmus, test of skew
ABCD2-to predict 30 day risk of stroke after transient ischemic attack

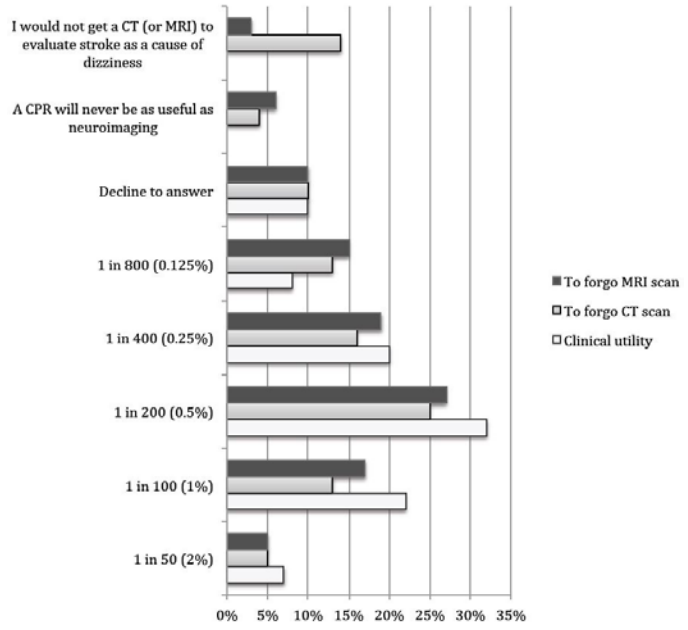


Figure 4. Ideal posttest probability for a CPR to be useful in evaluating patients with dizziness.[a,b]
[a]9 missing responses
[b]Survey question 8: first two choices were not an option for the question about clinical utility
MRA-magnetic resonance angiogram
MRI-magnetic resonance imaging
CT-computed tomography

similar may reflect the baseline concern for identifying a posterior stroke or general risk tolerance for critical diagnoses. Pines and Szyld identified a 0.5% post-test probability of pulmonary embolism after D-dimer testing and a 1.1-1.5% post-test probability of acute coronary syndrome in low-risk patients after stress testing (SPECT and exercise echocardiogram), assuming a pre-test probability of 10%.[15] However, whether this risk threshold could be reliably achieved via a dizziness clinical prediction rule based on readily available historical, physical exam and clinical data is uncertain.

We found that EPs tended to overestimate stroke risk associated with isolated dizziness, perhaps explaining the relatively frequent imaging use identified in previous studies.[1] In one large healthcare system in 2008, 30% of patients evaluated for dizziness in the ED underwent either head CT or MRI.[20] The more frequent use of CT (compared to MRI) may reflect the variable and limited availability of MRI as well as the initial priority of identifying non-ischemic causes of dizziness such as intracerebral hemorrhage; however, registry data suggests that only about 10% of all strokes are hemorrhagic in etiology, and in a review of patients with intracerebral hemorrhage, only 2.2% had dizziness as the primary symptom.[21,22]

A stroke and dizziness prediction rule could appropriately reduce resource utilization and radiation exposure for this common symptom. Given the low

prevalence of stroke as a cause of dizziness (reported at 2-4% for all dizziness and 0.5-1% for isolated dizziness), a study to develop and validate a clinical prediction rule for dizziness and stroke may require identifying a higher-risk subpopulation to have a sufficiently high event rate in order to be feasible.[4,6]

LIMITATIONS

This study had several potential limitations. Since the survey included EPs in a single integrated healthcare system in a distinct geographic region, our results may not generalize to other locations or practice settings. It is worth noting, however, that the KPNC system serves a heterogeneous population that is broadly representative of the surrounding population.[23,24]

We pilot tested the survey among a small group of physicians including the study investigators; this limited pretesting may have limited the opportunity improve the acceptability and reliability of the survey as applied to a larger group as well as the particular range of content domains that were covered. We chose the range of responses for risk thresholds for our instrument based on the literature on risk thresholds for other serious emergency conditions (acute myocardial infarction and pulmonary embolus), and we chose the specific symptoms and findings for our instrument based on previously reported factors that could influence the suspicion for stroke among patients with dizziness, but there may be other factors that were not included in our instrument that could influence an EP's estimates for the risk of stroke in a given patient with dizziness.[15] In constructing the survey we also chose to use the term dizziness rather than vertigo or lightheadedness because previous data has shown that specific descriptors are inconsistently used by patients and have limited prognostic value.[12,19]

The suboptimal response rate (68%), though similar to other surveys of EPs, subjects our results to non-responder bias.7,8,25 However, non-responders had similar demographic characteristics as responders (gender proportion and tenure in practice).We consulted the relevant literature on survey studies of EPs in developing the format and content to achieve validity but the survey relied on EPs' self-reporting of their current practice as well as of their use of diagnostic tests and consultation, which might not reflect their true practice.[7,8,18] Perceptions of how physicians think they practice may not reflect their actual practice and utilization patterns, but in a survey format, data on actual ordering and utilization could not be collected. Respondents did receive an incentive for thoughtful completion of the survey to mitigate survey fatigue and non-responder bias.

Although we pilot tested the instrument for ease of use and reliability, survey fatigue could have reduced the reliability of items that were elicited later in the survey. Similarly, anchoring bias in the clinical vignette questions and the questions about risk reduction may have influenced responses for subsequent questions. Probabilities were presented in two formats to mitigate differences in responses due to the method of presentations (e.g., 1 in 100 and 1%). Missing responses were low (0-3%). Ten percent of respondents marked "decline to answer" for the questions about desired clinical prediction rule post-test probabilities for clinical utility, forgoing CT and forgoing MRI; these responses and the responses "I would not obtain a CT (or MRI) to evaluate posterior circulation stroke" and "A clinical prediction rule will never be as useful as neuroimaging" were excluded from the numeric analysis of desired post-test probability.

Our use of a Likert response format follows more recent usage of 5-point answer choices, but the distance between the response choices cannot be assumed to be either continuous or equidistant, limiting the scope of possible statistical analyses. Carifio and Perla address the problems with conversion of Likert response format to a continuous variable for interpretation, especially for the interpretation of survey questions individually.[26]

Despite these limitations, we believe the survey provides insights into physician practice, preferences and attitudes for the evaluation of dizziness in the ED.

CONCLUSION

EPs rely on history and physical exam elements over bedside diagnostic tests such as HINTS and Dix-Hallpike to evaluate ED patients with dizziness. Overall, respondents had a favorable view of the utility of a clinical prediction rule to assist in making decisions about neuroimaging and admission for patients with dizziness and possible stroke. A successful clinical prediction rule to assist in decision-making about neuroimaging or admission would require a reduction in the post-test probability of stroke to approximately 0.5% in order to be clinically useful to most respondents.

Authors Contributions

This work was supported by American Heart Association Grant 0875020N (A. Kim). All authors participated in the development of the survey. MVK, ASR and HRI were responsible for survey distribution and collating results. ASK and MVK conducted the analyses. MVK and ASK drafted the manuscript. All authors participated in manuscript revision.

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Tension Pneumoperitoneum Caused by Obstipation

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Emergency physicians are often required to evaluate and treat undifferentiated patients suffering acute hemodynamic compromise (AHC). It is helpful to apply a structured approach based on a differential diagnosis including all causes of AHC that can be identified and treated during a primary assessment. Tension pneumoperitoneum (TP) is an uncommon condition with the potential to be rapidly fatal. It is amenable to prompt diagnosis and stabilization in the emergency department. We present a case of a 16-year-old boy with TP to demonstrate how TP should be incorporated into a differential diagnosis when evaluating an undifferentiated patient with AHC. [West J Emerg Med. 2015;16(5):777-780.]

CASE

A 16-year-old Hispanic male presented to our emergency department (ED) with difficulty breathing that his mother first noted on the previous night. He had a history of muscular dystrophy (MD), frequent seizures and severe developmental delay causing him to be non-verbal at baseline. He also had a long-standing history of constipation. His mother had not noted any new symptoms until the previous night when he appeared to develop difficulty breathing. Upon arrival to the ED he was found to be in respiratory distress. His vital signs were significant for the following: heart rate 144 beats/minute; blood pressure of 43/22mmHg; temperature of 35.2ºC; and respiratory rate of 44 breaths/minute. Pulse oximetry waveform was initially undetectable. On initial exam we noted markedly but symmetrically diminished lung aeration, a tensely distended abdomen and mottled skin with cyanosis. When we attempted supplemental ventilation with bag valve mask we noted high airway pressures. Concurrent with obtaining intravenous access and placing the patient on continuous monitoring, we obtained portable supine chest (Figure 1) and left lateral decubitus abdominal (Figure 2) radiographs.

After noting massive pneumoperitoneum and elevation of the diaphragm we suspected tension pneumoperitoneum (TP) as the cause of shock. We positioned the patient in the right lateral decubitus position and placed three 14-gauge needles through the left abdominal wall, just lateral to the rectus musculature, and we advanced each needle until a rush of air was heard. As air was evacuated the patient's abdominal distension visibly resolved. We soon noted decreased airway resistance and improved aeration. Within minutes the patient's blood pressure improved to 93/47mmHg, and his pulse oximetry waveform became detectable at 93%. A repeat chest radiograph showed markedly improved pneumoperitoneum and diaphragmatic excursion with persistently dilated loops of bowel (Figure 3).

The patient was then taken to the operating room where he was found to have purulent peritonitis, and a 1.5cm cecal perforation was identified and repaired. A large rectal scybalum was also noted, and as there was no other bowel pathology identified during laparotomy, the cause of our patient's bowel perforation was determined to be obstipation. We suspect that his preexisting communication difficulties caused a delay in presentation, allowing his constipation to progress to bowel perforation.

DISCUSSION

Pneumoperitoneum is a radiographic term defined as free air within the peritoneal cavity. This finding usually suggests a perforated viscous, but up to 15% of cases occur in the absence of perforation.[1] Pneumoperitoneum can occur post-procedurally or from passage of air from thoracic, abdominal, gynecologic or idiopathic sources (Table). Post-procedural pneumoperitoneum can follow

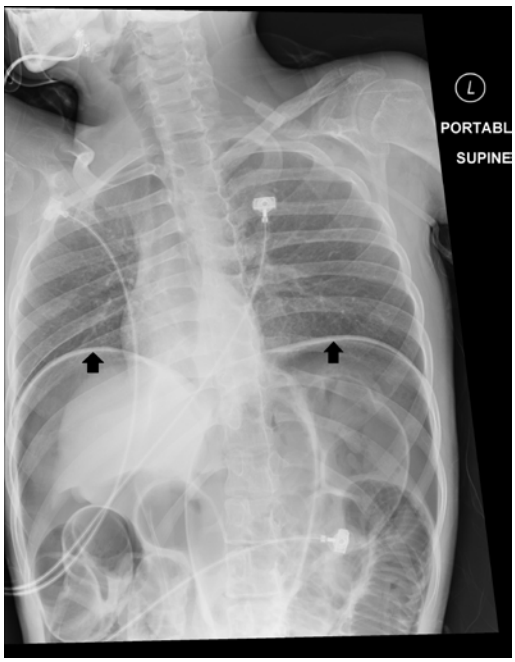

Figure 1. Initial chest x-ray demonstrating elevated diaphragm (black arrows).

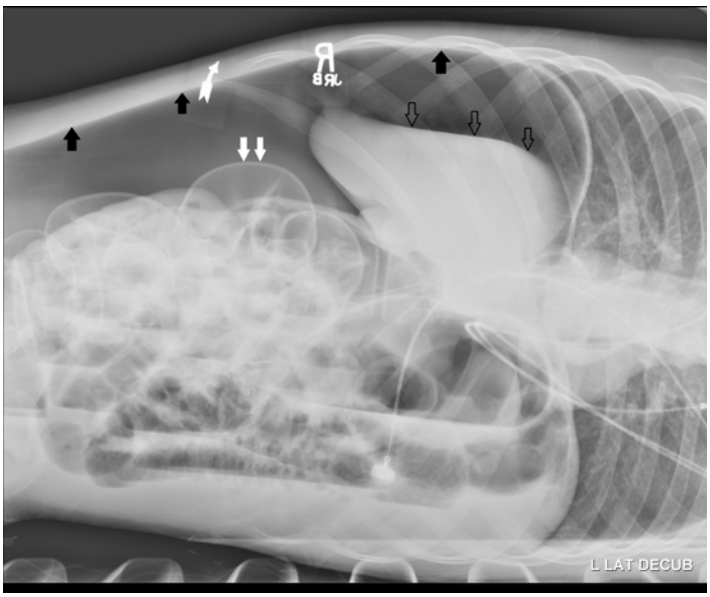

Figure 2. Initial abdominal film, in left lateral decubitus position demonstrating large amount of free air (black arrows), dilated loops of bowel (double white arrows) and inferior and medial displacement of the liver ("saddle bag sign" [triple clear arrows]).

percutaneous tube placement, laparotomy, laparoscopy and endoscopy. After laparoscopy air is expected to be visible on imaging for one week but may last up to four weeks.[2] Approximately 0.1% of endoscopic procedures will result in pneumoperitoneum.[3] The majority of these cases are the result of microperforation and do not result in peritonitis. In thoracic sources high intrathoracic pressure leads to introduction of air into the peritoneum via either

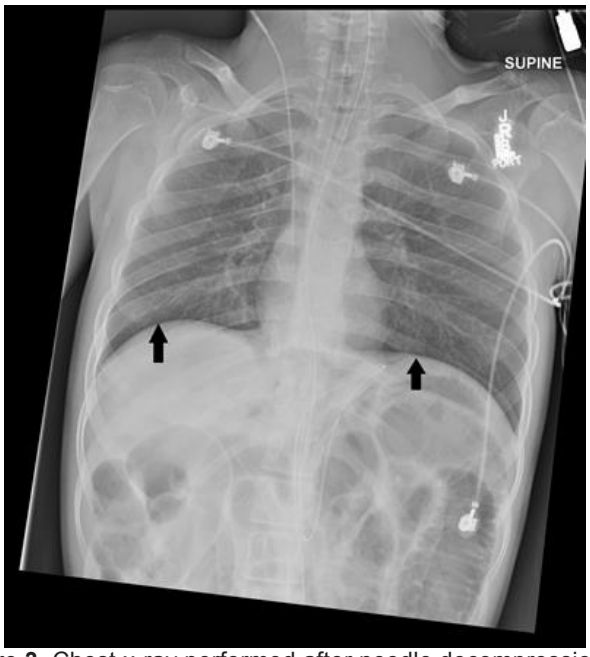

Figure 3. Chest x-ray performed after needle decompression of abdomen demonstrating improved diaphragmatic excursion (black arrows).

diaphragmatic defects or perivascular connective tissue, allowing the mediastinum to communicate with the peritoneum. Pneumoperitoneum from abdominal sources occur through perforation of a hollow viscous, gas-forming bacterial infection (abscess or peritonitis) or rupture of gas-filled cysts within the alimentary tract wall (pneumatosis cystoides). Gynecologic sources of pneumoperitoneum are a result of the anatomic communication between the fallopian tubes and the peritoneal cavity and can occur under any circumstances that cause the pressure of air within the gynecologic organs to exceed the intraabdominal pressure (IAP) (mean IAP is between 16 and 20mmHg with a maximum of 25.5mmHg in non-pathologic states).[4] The rate of pneumoperitoneum caused by processes that do not require surgical intervention has been estimated at 10%, so it is helpful to divide pneumoperitoneum into surgical and non-surgical categories.[5] A method has been proposed to identify cases of pneumoperitoneum that do not require surgical intervention. If all of the following criteria are met it may be reasonable to consider non-surgical management: pneumoperitoneum is identified incidentally, there is a benign alternative explanation for the presence of air, there is no free fluid in the abdomen, and there are no signs of peritonitis or sepsis.[6] While this method has not been prospectively validated, it is reasonable to consider managing with advanced imaging and serial examinations in these potentially non-surgical cases.

TP is an extreme form of pneumoperitoneum that occurs when intraabdominal free air reaches pressures high enough to impede venous return to the heart and to inhibit diaphragmatic excursion. Diminished venous return

Table. Causes of pneumoperitoneum.

Category	Cause
Abdominal	Anastomotic leak
	Collagen vascular diseases
	Diverticulosis (jejunal or sigmoid)
	Perforation of hollow viscus
	Pneumatosis cystoides intestinalis
	Rupture of intra-abdominal abscess
Gynecologic	Coitus
	Knee-chest exercise
	Pelvic inflammatory diseases
	Post-partum exercise
	Vaginal insufflation
	Vaginal douching
Thoracic	Adenotonsillectomy
	Asthma
	Barotrauma/thoracic trauma
	Bleb rupture (spontaneous)
	Bronchopulmonary fistula
	Bronchoscopy
	Cardiopulmonary resuscitation (can occur from blunt trauma, positive pressure ventilation or both)
	Pneumothorax/pneumomediastinum
	Positive end-expiratory pressure ventilation
	Pulmonary tuberculosis
	Severe coughing
Post-procedural	Laparoscopy/laparotomy
	Endoscopy
	Gynecologic examination procedures
	Postpolypectomy syndrome
	Percutaneous enteric tube placement/displacement
	Peritoneal dialysis
Other	Gas forming bacterial infection
	Idiopathic

leads to decreased diastolic filling thereby decreasing cardiac output. This manifests as hypotension and decreased systemic perfusion. Inhibition of diaphragmatic excursion decreases tidal volume. If the patient is unable to compensate with an increased respiratory rate this will result in decreased minute ventilation and manifest as hypercarbic respiratory distress. If not diagnosed and treated promptly, TP will rapidly lead to death.

TP was first described in the medical literature by Oberst in 1917 when a grenade explosion resulted in gastric perforation.[7] TP has since been reported as a complication of bowel perforation secondary to endoscopy, peptic ulcer disease and bowel obstruction.[8-12] It is theorized that TP results from viscous perforation when overlying omental fat acts as a one-way valve, allowing gas to reach high pressures in the peritoneal cavity. It appears that barotrauma-induced TP without any viscous perforation is particularly rare, but this has also been reported.[13] Of particular interest to emergency physicians are cases of TP following positive pressure ventilation during cardiopulmonary resuscitation with associated gastric rupture.[14,15] Because the air is extraluminal, a gastric tube will not improve ventilation in these cases. Upon our review of the literature, we were unable to identify any previously reported cases of TP caused by constipation. We suspect that our patient's history of MD, combined with his non-mobile and non-verbal status resulted in this novel presentation of TP. MD is known to be associated with increased colonic transit times, resulting not only from direct damage to smooth muscle, but also due to immobility and weak abdominal musculature contributing to constipation.[16,17] Additionally, our patient was non-verbal. His inability to communicate his symptoms allowed his condition to progress unnoticed until it resulted in spontaneous perforation of his colon, a condition more commonly described in elderly patients with constipation.[18] His non-verbal status further allowed this catastrophe to go unnoticed until it led to TP and its associated respiratory distress, the symptom that prompted his mother to bring him to the ED for evaluation.

The diagnosis of TP should be suspected in patients who present with respiratory distress associated with abdominal distension. Physical exam findings reveal high airway pressures, a tensely distended abdomen and poor systemic perfusion in TP. This diagnosis can be supported by chest and abdominal radiographs showing low lung volumes and a large amount of intraperitoneal free air. Sometimes the liver can also be observed to be inferiorly and medially displaced (the "saddle bag" sign). Initial treatment of TP consists of percutaneous needle decompression. The vast majority of reported cases of TP are associated with a perforated viscous. These patients should be emergently transferred to the operating room for diagnostic and therapeutic laparotomy unless there is highly compelling evidence to suggest that no such perforation has occurred.

CONCLUSION

TP should be included in the differential diagnosis when assessing undifferentiated patients presenting to the ED with acute hemodynamic compromise. These patients present with hypotension, respiratory distress, a tensely distended abdomen and high inspiratory pressures. The diagnosis of TP can be supported by portable radiographs, and it can be confirmed with diagnostic and therapeutic needle decompression of the abdomen.

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ST-Elevation Myocardial Infarction After Sumitriptan Ingestion in Patient with Normal Coronary Arteries

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Sumitriptan has been used by millions as a migraine abortant; however, there have been studies showing angina pectoris, coronary vasospasm, and even myocardial infarction in patients with predisposing cardiac risk factors. The majority are patients using the injectable form subcutaneously. We present the case of a patient who presents with ST-elevation myocardial infarction, with no cardiovascular risk factors, after ingesting oral sumitriptan for her typical migraine. [West J Emerg Med. 2015;16(5):781-783.]

INTRODUCTION

Injectable triptans used for abortive migraine therapy have been on the U.S. market since 1993. They have been associated with instances of chest pain, coronary vasospasm, and myocardial infarction; but rarely have serious adverse events with oral triptans been reported in literature.

Patients with acute coronary syndrome, which includes ST-elevation myocardial infarction (STEMI), Non-STEMI, and unstable angina, present to emergency departments (EDs) in the U.S. and abroad frequently. In the last decade EDs have made great advances in decreased mortality and morbidity for these patients. Those advances include decreased time to coronary catheterization, use of thrombolytics, and access to emergency medical services (EMS).

We present the case of a patient who developed STEMI one hour after ingesting sumitriptan for her typical migraine. Nitroglycerine was administered by EMS, which helped relieve the coronary artery vasospasm that was causing the myocardial infarction. Triptan-induced vasospasm and infarction must be considered in patients with recent migraine treatment, even in those without cardiac risk factors.

CASE REPORT

A 49-year-old Caucasian female presented to a community ED by EMS after having abrupt onset chest pain following ingestion of sumitriptan for migraine. She reportedly took sumitriptan orally approximately 60 minutes prior to treat the typical symptoms of her migraine, which she has had intermittently for years. She had taken sumitriptan multiple times in the past without incident. Shortly after taking her medication she had an acute onset of sub-sternal chest pressure, which radiated to her jaw. This pain started at rest and had never occurred before.

She had a past medical history of migraine and depression, for which she took sumitriptan and desvenlafaxine, respectively. Desvenlafaxine is a serotonin–norepinephrine reuptake inhibitor (SNRI) that she has been taking for years. Her last dose of sumitriptan prior to the incident was several weeks before. She had no history of coronary artery disease (CAD), diabetes mellitus, pulmonary disorders, tobacco abuse, cocaine use, or any recent illness or injury. She did not take exogenous estrogen nor had any family history of heart disease.

She called EMS after having 30 minutes of constant chest pain that radiated to her jaw. She was assessed by the local EMS crew and was given 324mg aspirin PO and 0.4mg nitroglycerine sublingually. Her initial EMS 12-lead electrocardiogram (ECG) showed ST elevations in I, aVL, V1, and V2. She also had ST depressions in II, III, aVF, and V3-V6 (Figure 1). The ECG was transmitted electronically to the ED. The emergency physician interpreted the ECG as a likely anterior myocardial infarction with reciprocal changes in the inferior and lateral leads. The cardiac catheterization lab was activated and the cardiologist on call contacted.

During patient transport, her pain gradually improved

after administration of the nitroglycerine and a second ECG was electronically transmitted (Figure 2) which showed some improvement in the ischemic changes. Once she arrived to the ED, her chest pain had nearly resolved, she had stable vitals and her arrival ED ECG showed resolution of ischemic changes (Figure 3). Cardiac enzymes showed an initial troponin of 0.05ng/mL. Urine drug screen was negative, confirming that no recreational drug use, to include cocaine, was used. Cardiology was present in the ED and elected to take the patient for emergent coronary angiography.

Coronary angiography demonstrated severe constriction of the left anterior descending artery responsive to intracoronary nitroglycerin. There were no lesions suggesting CAD. The left ventricular systolic function was normal with an ejection fraction of 60%. She was diagnosed with severe spasms of the left anterior descending artery leading to myocardial infarction. The patient was transferred to a step-down bed and discharged from the hospital the next morning. The patient's cardiologist advised her to avoid all anti-migraine medication and to use sublingual nitroglycerin tablets as directed to prevent further angina.

DISCUSSION

Sumitriptan belongs to the anti-migraine medication class called the triptans, which targets the 5-hydroxytryptamine (5-HT1) serotonin receptor in vascular smooth muscle. Initially, these medications were believed to abort migraines by targeting the vasoconstricting 5-HT1 receptors solely in the cerebral vasculature.[1] Coronary circulation was believed to possess only serotonin 5-HT2 receptors, ensuring that coronary vasoconstriction would be avoided in triptan use. Despite this, there have been studies showing vasoconstrictive effects in the coronary circulation with the injectable form of these medications.[2] There have been few reports of patients having myocardial ischemia or infarction with the oral form of sumatriptan,[5,9] as in this case, with even fewer showing coronary angiographic evidence of coronary spasm.[6]

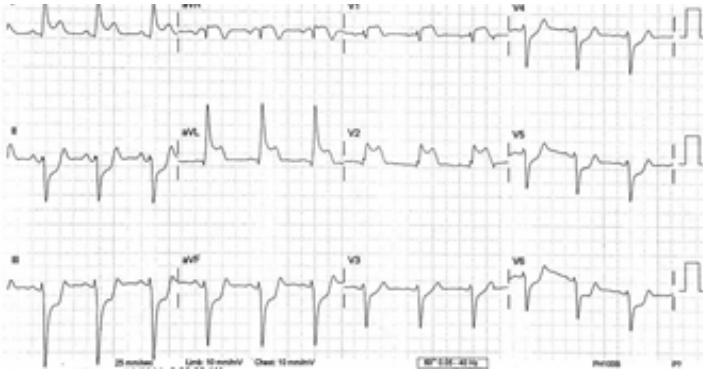

Figure 1. Initial emergency medical services electrocardiogram showing ST-segment elevations across precordial leads consistent with anterior ST-elevation myocardial infarction with reciprocal changes.

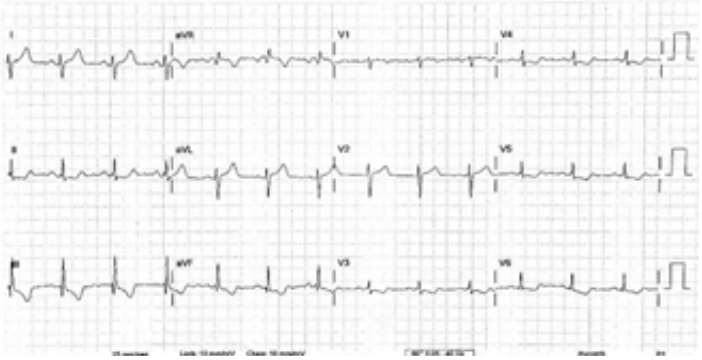

Figure 2. Post-nitroglycerine electrocardiogram with interval improvement of ST-elevation myocardial infarction.

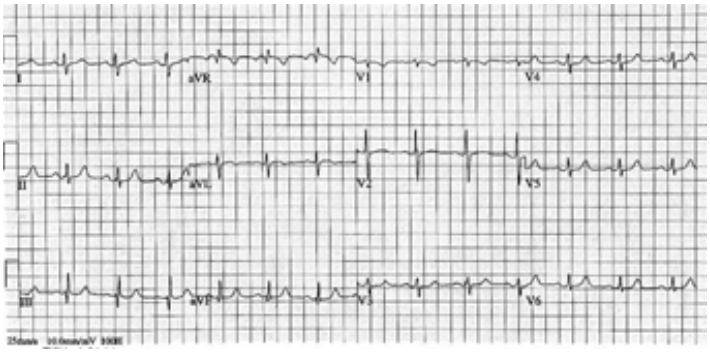

Figure 3. Post-nitroglycerine electrocardiogram with resolution of ST-elevation myocardial infarction.

Based on the limited evidence, it is recommended that triptans be avoided in patients with a history of Prinzmetal's angina, uncontrolled hypertension, and ischemic stroke or heart disease.[7] Variant angina (VA), which is also referred to as Prinzmetal angina, is a condition characterized by episodes of angina pectoris, usually at rest and can have an association with ST-segment elevation on the ECG, both of which were present on our patient.[11] The coronary artery vasospasm, caused by spasm of the smooth muscle layer of the arterial wall, generally occurs in the absence of high grade coronary artery stenosis.[10] The transient myocardial ischemia will cause angina and myocardial infarction can occur in some cases. Spasm can occur in the absence of any preceding increase in myocardial oxygen demand, as was the case with our patient whose pain started at rest. Spasm can occur in angiographically normal coronary vessels, as in our patient, or at the site of atherosclerotic plaques of varying severity.[4]

Multiple drugs including ephedrine-based products, cocaine, marijuana, alcohol, butane, and amphetamines often accompany episodes.[3,4] VA can also be associated with other vasospastic disorders, such as Raynaud's phenomenon.[8] Myocardial infarction can lead to life-

threatening arrhythmia and is usually due to concurrent obstructive CAD. The fact that our patient had no lesions on coronary angiography is uncommon.

A recent study by Acikel et al. in 2010,[12] described a similar case of a 48-year-old woman who presented with Prinzmetal-VA with diffuse ST-segment elevation on the ECG. That patient was using zolmitriptan and citalopram. They proposed a correlation between the vasospasm caused by a triptan and the possible increased risk of vasospasm caused by elevated serotonin levels in the plasma from the selective serotonin reuptake inhibitors (SSRI).[10] The patient in their case had a cardiac risk factor of chronic tobacco abuse, which was absent in our case. The zolmitriptan was taken 10 hours prior to the onset of her chest pain, where the sumitriptan in our case was taken within the hour. Their patient's ECG showed diffuse ST-elevations, where ours was localized to the anterior leads with reciprocal changes in the inferior leads.

CONCLUSION

In summary, patients should be counseled on the potential cardiovascular risks of sumitriptan, even if there is no prior history of CAD. If there are cardiac risk factors, this medication should be avoided, or first attempted under close medical supervision. This case should also make providers aware of the possible additive effects of triptans and SSRI/SNRIs when it comes to cardiovascular disease. Noninvasive cardiac imagining like computed tomography or magnetic resonance angiography may play a future role in screening patients to determine if it is potentially safe to use sumitriptan or other anti-migraine medications. This case enforces the need for timely EMS response and early transmission of ECGs to emergency physicians.

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A Surprising Finding of Remote Ischial Avulsion

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A 25-year-old male presented to the ski clinic after colliding with a tree while snowboarding. He had immediate sharp pain at his "tailbone," but denied numbness and weakness. Past medical history was initially reported as unremarkable. On exam, he demonstrated midline tenderness over the sacrum. Pelvic radiography was performed (Figure).

Imaging revealed an acute vertebral fracture, but it also demonstrated a large irregular left ischium to our surprise. When questioned further, the patient reported a hamstring injury in high school leading us to diagnose this finding as an old left ischial apophysial avulsion injury resulting in an osseous excrescence.

Ischial avulsion injuries are most commonly seen in adolescence and young adults.[1] Ischial avulsion injury tends to happen during a strong contraction of the hamstring muscles with activity like sprinting or jumping.[1-3] In puberty, the secondary ossification center appears at the apophysis and does not fuse until adolescence.[1] This bone is weak compared to muscle and ligaments; therefore, the young skeleton is more prone to fracture and osseous avulsions.[4-5]

Radiograph is recommended to evaluate for a possible avulsion injury if there is pain over the ischial tuberosity, swelling at the hamstring origin or a palpable step-off.[1-2] Diagnosis is often made by plain radiography; typically as a sliver of bone displaced inferiorly and laterally from the ischium.[6] Ultrasound can be used to view other hamstring injuries; however, deep injuries often require magnetic resonance imaging, especially in athletes with massive muscle masses.[4-5]

Avulsion fracture can commonly be misdiagnosed as a hamstring strain. However, unlike a muscular hamstring injury, avulsion fracture requires longer recovery, avoidance of hamstring stretching for four weeks and possible surgery.[1,3] However, other forms of rehabilitation can be started at the time of diagnosis. The major indication for surgery is displacement of bone fragment greater than two centimeters.[2] If left untreated, the patient may experience recurrent discomfort with sitting for periods of time, pain with running, and even muscle wasting.[1] Also, the displaced fragment can lead to an exaggerated healing process and large mass of bone that can mimic neoplasm, such as an osteochondroma or even an Ewing's sarcoma in the subacute phase of healing.[4-6]

Underlying pathology that should be considered with ischial avulsion injuries include apophysitis of the tuberosity, bone tumor, metastases and osteoporosis.[5] Myositis ossificans traumatica is often seen following a sports injury, but is rarely seen in the hamstrings.[4]

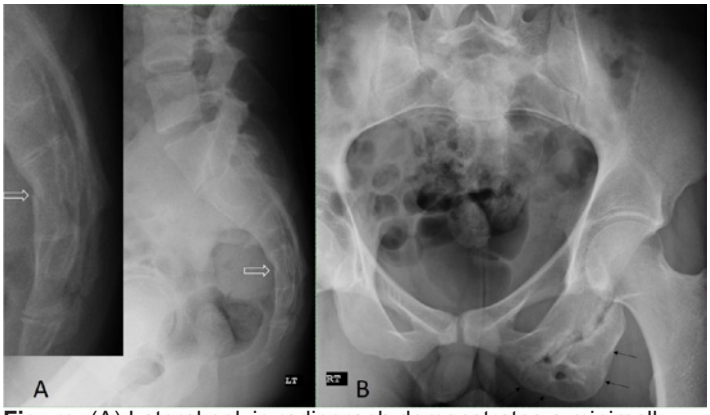

Figure. (A) Lateral pelvic radiograph demonstrates a minimally displaced transverse fracture of the S4 vertebrae (open arrows); (B) Anteroposterior pelvic radiograph reveals an incidental old left ischial apophysial avulsion injury (arrows).

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Hydrocele of the Canal of Nuck

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A 31-year-old gravida 3 Para 3 female with no past medical history, presented to the emergency department complaining of a painless "boil" to the right groin, which had been enlarging for over two months. Although it was generally painless, she did suffer mild dyspareunia at times. Antibiotics prescribed by her primary doctor failed to resolve this mass so she decided to present to the emergency department.

The patient had never experienced any lesion or swelling in that region throughout her life. She denied any prior history of sexually transmitted infections. Her physical examination was unremarkable except for a large (10x5cm) fluctuant mass within the right labia majora (Figure). Her inguinal region had no adenopathy. The mass was non-tender to palpation and was without warmth. The overlying skin was clear without erythema or lesions. It readily transilluminated and upon auscultation, no sounds were noted. Bedside ultrasound confirmed the cystic structure. Because this was inconsistent with a labial or Bartholin's cyst abscess, consultation with gynecology was obtained. Their leading differential diagnosis was hydrocele of the canal of Nuck. Computed tomography was confirmatory.

Female hydroceles of the canal of Nuck are analogous to scrotal hydroceles in male patients.[1] They are most common in adult patients and extremely rare in pediatrics, even though the process vaginalis usually obliterates by the first year of life.[2] Clinical suspicion is encouraged by absence of signs of infections. Ultrasound, computed tomography and magnetic resonance imaging can all help in the diagnosis; however, confirmation is with surgical exploration and pathological examination.[1] Although extremely rare, fluctuant mass lesions in the female inguinal region should be closely scrutinized for the possibility of a patent canal of Nuck with associated pathology such as a hernia sac, hydrocele or non-communicating cyst.

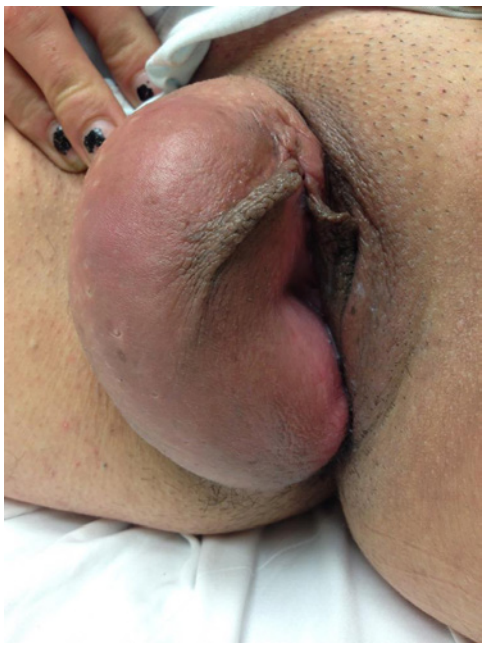

Figure. Swelling of the right labia major.

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Fatal Tension Pneumoperitoneum Due to Non-Accidental Trauma

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A previously healthy two-year-old boy presented to the emergency department with vomiting. He was cyanotic with mottling of both lower extremities. He was in respiratory distress with retractions and diminished breath sounds. His abdomen was distended and rigid. He had a pulse of 170 beats per minute, blood pressure of 144/69mmHg and respiratory rate of 42 breaths per minute. He was endotracheally intubated. Chest and abdominal radiographs demonstrated a tension pneumoperitoneum (Figure 1).

Abdominal decompression was performed with a 16-gauge needle in the left lower quadrant. Bilateral tube thoracotomies were also performed. Post-decompression radiograph demonstrated continued free air but normal lie of organs and viscera (Figure 2). The patient then went into cardiopulmonary arrest. Chest compressions, epinephrine, bicarbonate, atropine and calcium gluconate were administered, but he did not regain spontaneous circulation. Subsequent autopsy and investigation determined the patient had been a victim of non-accidental trauma resulting in gastric rupture.

In pediatric patients tension pneumoperitoneum is a rare

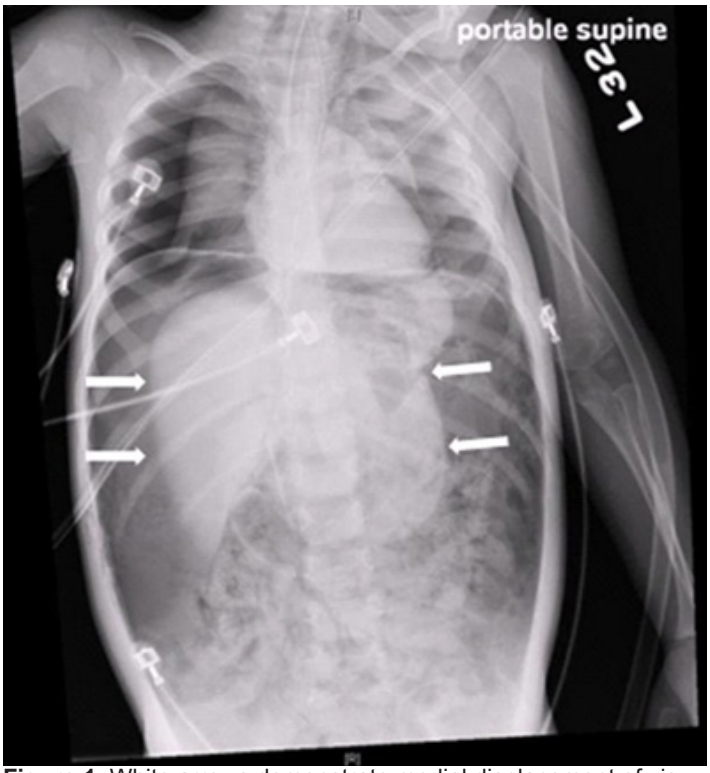

Figure 1. White arrows demonstrate medial displacement of viscera. Free air is present.

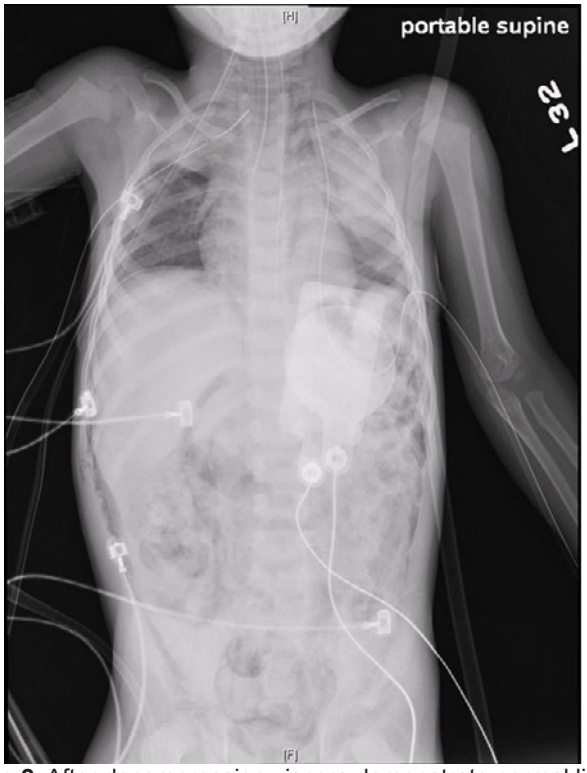

Figure 2. After decompression viscera demonstrate normal lie. Free air is still present.

complication described after reduction of intussusceptions, mouth-to-mouth breathing, iatrogenic bowel perforations, and positive pressure ventilation.[1-4] It has not been described as a complication of non-accidental trauma. The increase in intra-abdominal pressure causes multiple physiologic derangements including decreased cardiac return via compression of the inferior vena cave and respiratory failure due to splinting of the diaphragms.[3]

Initial symptoms include abdominal pain and distension followed by hypoxia and shock.[1-4] Diagnosis is clinical, but radiographs will demonstrate free air and medial displacement of the solid organs and viscera.

If not recognized and promptly treated tension pneumoperitoneum can rapidly lead to cardiopulmonary arrest. Treatment is emergent needle decompression followed by definitive laparotomy repair.[4] Emergency medicine clinicians should be familiar with tension pneumoperitoneum as a cause of respiratory distress and cardiovascular collapse in the pediatric patient, as early recognition and treatment is critical in improving survival.

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Uterine Incarceration: Rare Cause of Urinary Retention in Healthy Pregnant Patients

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Gravid uterine incarceration (GUI) is a condition that is well discussed in literature; however, there are few acute diagnoses in the emergency department (ED). We present a case series where three multiparous females presented to the ED with non-specific urinary symptoms. On bedside ultrasound, each patient was noted to have a retroverted uterus and inferior bladder entrapment under the sacral promontory. GUI is a rare condition that can lead to uremia, sepsis, peritonitis, and ultimately maternal death. Emergency physicians should include GUI in their differential diagnosis in this patient population and use bedside ultrasound as an adjunct to diagnosis. [West J Emerg Med. 2015;16(5):790-792.]

INTRODUCTION

Gravid uterine incarceration (GUI) is a relatively rare condition that results in the uterus becoming trapped between the sacral promontory and the pubic symphysis during pregnancy.[1] As the uterus becomes more gravid, the cervix becomes superiorly displaced and can eventually lead to bladder outlet obstruction. We report a case series of uterine incarceration where otherwise-healthy patients presented to the emergency department (ED) between approximately 13 weeks and 21 weeks estimated gestational age with dysuria, urgency, frequency, and low back pain after being recently seen by obstetrics and gynecology (OBGYN) which could not determine the cause for the patients' symptoms. In this case series we present three cases of uterine incarceration diagnosed by ultrasound in the ED, discuss previously published cases, and discuss the implications for emergency physicians.

CASE REPORT

Three multiparous patients with pertinent history and symptomatology (Table) presented to the ED with dysuria, urgency, frequency, and low back pain between two and six weeks in duration. Further review of systems was otherwise negative. The patients denied all toxic habits including alcohol, drugs and tobacco, and did not use any medications other than prenatal vitamins.

Patient #1 had been seen recently by OBGYN where she underwent evaluation for dysuria/urinary tract infection that was negative. Because of her unremitting symptoms and despite reassurance, she came to the ED for evaluation. Initial laboratory evaluation of the patient revealed only bacterial vaginosis. A bedside ultrasound assessment was performed that showed normal-appearing kidneys, and was negative for free abdominal fluid or pericardial effusion. The inferior bladder pole was entrapped by the gravid uterus, and contained a significant volume of urine (Figure).

Upon these findings, the patients underwent straight Foley catheterization with return of 180mL urine that resulted in alleviation of symptoms.

Patient #2 presented with progressively increasing difficulty with urination over a period of two weeks. She underwent physical exam and formal laboratory evaluation that was unrevealing for any infectious process. She was evaluated by bedside ultrasound, which again revealed trapping of the bladder pole by the gravid uterus. She also underwent straight catheterization and was instructed on self-catheterization with next-day follow up with OBGYN.

Patient #3 had a more acute onset of her retention that developed over a two-day period. She was evaluated in a

Table. Multiparous patients with symptoms indicating possible gravid uterine incarceration.

Patient	Age	EGA	Parity	PMH/comorbidities	Symptoms	Outcome
1	37	13	G6P2122	None	Urinary retention, bilateral costo-vertebral tenderness and thick white discharge on speculum exam	Self-catheterization, Pessary
2	42	13	G5P3013	Infertility, LEEP, salpingectomy	Urinary retention	Self-catheterization, pessary placement
3	22	21	G15P5009	Multiple spontaneous abortions, clotting disorder	Urinary retention, LUQ pain, nausea	Pessary placement

EGA, estimated gestational age; *PMH*, past medical history; *LEEP*, look electrosurgical excision procedure; *LUQ*, left upper quadrant

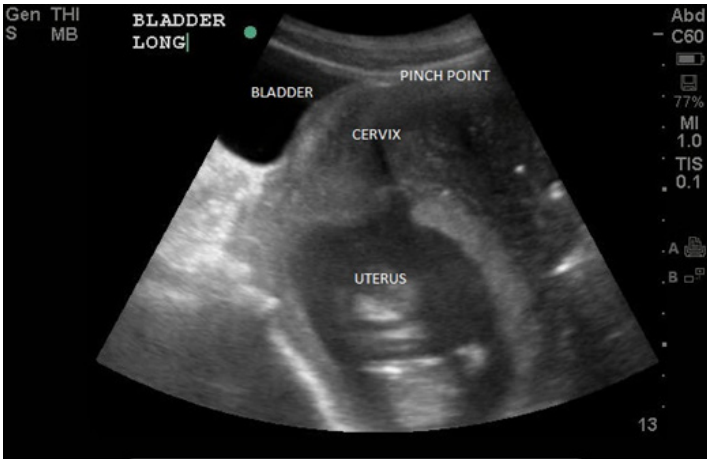

Figure. Inferior bladder, containing significant volume of urine, entrapped by gravid uterus.

similar manner to patients #1 and #2 with the only abnormal finding being bacterial vaginosis. Her bedside ultrasound showed a retroflexed uterus and a significant amount of urine in the bladder. Because of her symptoms she was sent for a formal pelvic ultrasound in the ED, which confirmed the diagnosis of uterine incarceration and showed >600mL in the bladder. She underwent straight catheterization with return of 400mL urine.

All three patients received formal ultrasounds confirming compression of the inferior pole of the bladder. OBGYN was consulted and examined the patients in the ED, ultimately deciding to discharge the patients with close follow up the next day. The patients were given instruction on self-catheterization, and return precautions should their condition worsen.

They were seen the next day in the OBGYN clinic and underwent a trial of pessary placement with successful alleviation of their symptoms. Three weeks later the patients' symptoms had improved to the point where they no longer required use of the pessary.

DISCUSSION

The exact mechanism of GUI is believed to be due to trapping of the uterine fundus in a retroverted position, which leads to a progressively elongated cervix that becomes displaced anteriorly and leads to obstructive bladder symptoms.[2] Risk factors for this condition include post-surgical adhesions, pelvic inflammatory disease, fibroids, and laxity of supporting tissues.[3] The most typical presentation occurs between 14 and 16 weeks of gestation with a variety of symptoms mimicking common gastrointestinal, genitourinary, and musculoskeletal conditions. Physical findings include anterior displacement of the uterus, anterior angulation of the vaginal angle, retroverted uterus, cervical displacement toward cephalad and a low-lying fundal height for gestational age.[4]

Though urinary tract infections (UTI) are by far the most common cause of dysuria in pregnant patients, a patient with a GUI can easily be misdiagnosed as a UTI even by experienced clinicians. Though these patients' particular presentations did not appear alarming, they could have easily been disregarded as normal pregnancy pain or Braxton-Hicks contractions if careful attention to detail was not made. The complications of a missed GUI are rare, but could be potentially disastrous and life threatening. These complications include hydronephrosis, UTI, bladder rupture, sepsis, peritonitis, miscarriage, oligohydramnios, fetal growth restriction, and fetal demise.[5-7] Even if these immediate complications are not present, delayed complications can include a pregnancy loss of up to 33% in the second trimester.[8,9] Because of the potential of these serious complications, this is a diagnosis that should be considered more frequently in the ED, especially in community care settings such as ours, where obstetric patients make up a large portion of the ED census per year.

Though GUI has been extensively described in the literature, there are few reports of its actual diagnosis in the ED setting. During a literature search we did find one case report where an ED noted that a patient had a clinically incarcerated uterus; however, there was no ultrasonographic evidence of bladder obstruction in this particular case.[10] We believe that our case series is the first known series of GUI diagnosis in the ED using bedside ultrasonography. Although there are no established gold standard tests for GUI, both ultrasound and magnetic resonance imaging seem to be acceptable modalities for confirming the diagnosis.[11,12] This case demonstrates one of the many utilities of ultrasound in the ED setting, particularly in experienced operators. While no conclusions about statistical significance of testing for GUI can be drawn from this particular test, we emphasize two main points from our experience.

The first is that GUI is a rare, potentially fatal, but possible diagnosis in all pregnant women with symptoms of UTI and/or bladder obstruction that should be in the differential diagnosis for emergency physicians. Second, we believe that when used in conjunction with clinical findings, bedside emergency ultrasound is an excellent adjunct to aid in the diagnosis of GUI.

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Severe Hemorrhage from Cervical Cancer Managed with Foley Catheter Balloon Tamponade

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CASE

A 67-year-old woman complaining of continuous fresh vaginal hemorrhage came to our emergency department in a pre-shock state. Examinations revealed an irregularly shaped mass in the uterus and active arterial bleeding. Emergent hysterectomy and interventional radiology were not immediately available. Foley catheter with 20mL water was inserted into the uterine cavity, then the balloon was pulled to obstruct the uterus output (Figure). Her vital signs became stabilized, and she was transferred to another hospital two days later.

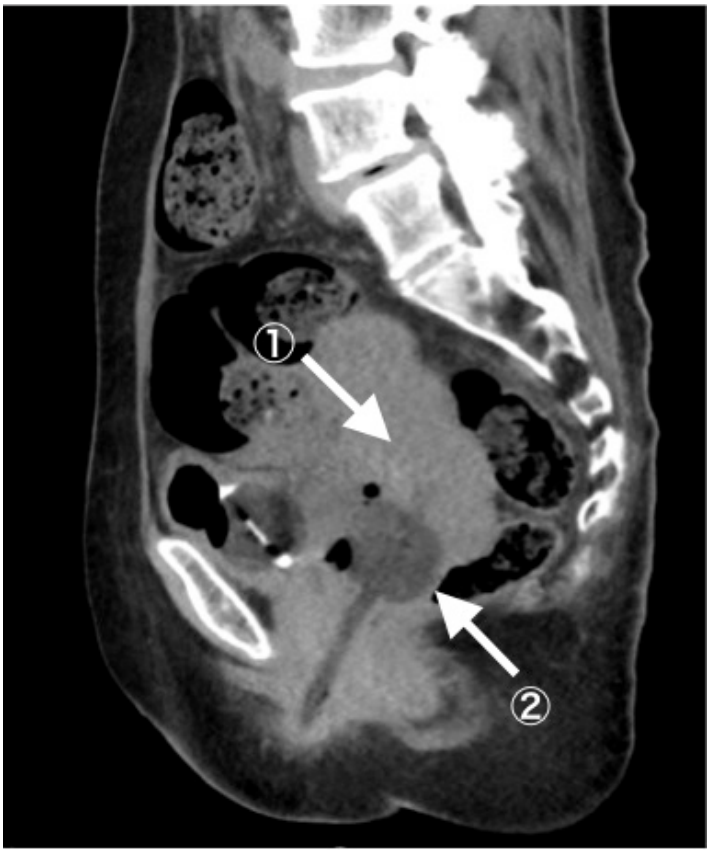

Figure. Successful balloon tamponade from the intrauterine mass using Foley catheter. Arrow 1: mass and coagulated blood filling the uterine cavity. Arrow 2: foley catheter balloon put at the uterine cervix.

DIAGNOSIS AND DISCUSSION

A 67-year-old patient was diagnosed as Stage IIb cervical carcinoma. In this case, we controlled active bleeding from cervical cancer by balloon tamponade technique, which is frequently used in obstetric postpartum hemorrhage as a noninvasive and fertility-sparing procedure.[1] Although devices specially made for obstetric hemorrhages are frequently used, less expensive and more easily accessible devices such as Foley catheters and condom catheters are also used.[2,3] Only one case has ever been reported with this procedure used for hemorrhage from gynecologic malignancies.[4] In this case, we were able to achieve sufficient tamponade effect using a single quite-small volume balloon, probably because the tumor itself and coagulated blood almost filled the uterine cavity.

Similar tamponade techniques are commonly used by emergency physicians for several emergency hemorrhages, such as vaginal, nasal, esophageal, or urethral hemorrhage, which usually require procedures performed by each specialty physician afterwards. Such balloon tamponade techniques are valuable as a bridge to specialty treatment because they can be conducted easily by emergency physicians using easily accessible devices.

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Conflicts of Interest: By the *West*JEM article submission agreement, all authors are required to disclose all affiliations, funding sources and financial or management relationships that could be perceived as potential sources of bias. The authors disclosed none.

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Comments on "High Altitude Pulmonary Edema in an Experienced Mountaineer. Possible Genetic Predisposition"

DOI: 10.5811/westjem.2015.6.27505
Whitlow K and Davis B. High Altitude Pulmonary Edema in an Experienced Mountaineer. Possible Genetic Predisposition. *West J Emerg Med.* 2014;15(7):849–851.

To the Editor:

I read with interest the case report by Whitlow and Davis in the November 2014 issue of the Western Journal of Emergency Medicine regarding management of high altitude pulmonary edema (HAPE) in an experienced mountaineer.[1] The authors have appropriately highlighted the need of descent and supplemental oxygen for treating HAPE, a potentially fatal disease if left untreated. The patient in this study, a 25-year-old sea-level resident, was diagnosed as a case of HAPE on the basis of history of acute ascent to 3200m and onset of symptoms and signs suggestive of HAPE within 72 hours of high altitude exposure. He was treated with 100% oxygen, albuterol and ipratropium nebulizers, inhaled and intravenous dexamethasone, intravenous hydralazine, and intravenous furosemide. Subsequently, with improvement of symptoms, he was continued on intravenous dexamethasone. However, as per the Wilderness Medical Society (WMS) evidence-based guidelines of 2009 for clinicians for prevention and treatment of acute altitude illness, diuretics have no role to play in the treatment of HAPE, as these patients are likely to have co-existing intra-vascular volume depletion.[2] Moreover, dexamethasone is not recommended for treatment of all cases of HAPE and it has only a preventive role in HAPE-susceptible individuals.[2] Analysis of the history and examination of this patient reveals that a differential diagnosis of asthma was considered along with HAPE. As a reader, I was inquisitive to know if an X-ray facility was available at the community academic emergency department, and if so, an X-ray chest of the patient on arrival would have helped in confirming the diagnosis of HAPE.

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Conflicts of Interest: By the *West*JEM article submission agreement, all authors are required to disclose all affiliations, funding sources and financial or management relationships that could be perceived as potential sources of bias. The authors disclosed none.

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1. Whitlow KS and Davis BW. High altitude pulmonary edema in an experienced mountaineer. Possible genetic predisposition. W*est J Emerg Med.* 2014;15(7):849-851.
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DOI: 10.5811/westjem.2015.7.28039

In reply:

We appreciate the letter to the editor and are pleased to respond regarding our recent case study regarding high altitude pulmonary edema in an experienced mountaineer. The letter raises some valid questions regarding our treatment decisions. With this, as with most emergency department (ED) patients, it must be understood that the initial treatment reflected the breadth of our differential diagnosis. The patient was receiving nebulizers as he was wheeled into the department for evaluation for a possible asthmatic condition. An initial chest x-ray in the ED revealed "multiple nodular opacities" and our bedside read could not exclude bilateral pulmonary edema of unknown etiology. Although retrospectively the patient's history is consistent with High-altitude pulmonary edema (HAPE), for a patient with continued low oxygen saturation despite supplemental oxygen, diffusely coarse breath sounds, and a broad differential it seemed appropriate for a trial of Furosemide for hypervolemic causes of his apparent pulmonary overload as he was not hypotensive. Regarding his continued treatment outside of our department, we are unable to comment specifically given that we were his emergency providers, but again, continuing Dexamethasone for the possibility that he may have been experiencing some degree of reactive airway or an asthmatic response seems relatively low risk with significant potential gains. Given the patient's rapid response to treatment during his very brief stay his differential was readily narrowed and he was discharged home in excellent condition after a very short stay. This case report was focused on the possible familial or genetic predisposition to HAPE and not intended as a complete review of the prevention and treatment of altitude related illnesses. Perhaps this was a limitation of our manuscript. We are pleased that our case report was read with such interest and welcome further discussion at any time.

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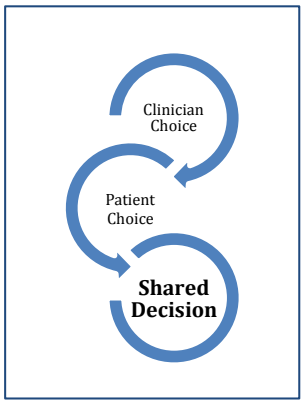
Conflicts of Interest: By the *West*JEM article submission agreement, all authors are required to disclose all affiliations, funding sources and financial or management relationships that could be perceived as potential sources of bias. The authors disclosed none.



Call for Papers

2016 *Academic Emergency Medicine* Consensus Conference

Shared Decision Making in the Emergency Department: Development of a Policy-Relevant Patient-Centered Research Agenda

The 2016 *Academic Emergency Medicine* (*AEM*) consensus conference, "**Shared Decision Making in the Emergency Department: Development of a Policy-Relevant Patient-Centered Research Agenda,**" will be held on May 10, 2016, immediately preceding the SAEM Annual Meeting in New Orleans, LA. Original research papers on this topic, if accepted, will be published together with the conference proceedings in the December 2016 issue of *AEM*.

The consensus conference will convene major thought leaders and necessary stakeholders on shared decision making in acute care. Specifically, the conference will include patients, patient representatives from national advocacy organizations, emergency physicians, mid-level providers, emergency nurses, and researchers with expertise in shared decision making and patient-centered outcomes research, comparative effectiveness research, and health information technology. There will be clinicians across various disciplines such as emergency medicine, health services research, psychology, and quality improvement. Finally, the conference will include national policy makers, payer representatives, and other stakeholders with the expressed goal of developing a multidisciplinary, consensus-based, high-priority research agenda to improve and optimize shared decision making in the emergency department.

Consensus Objectives:

1. Critically examine the state of science on shared decision making in emergency medicine, and identify opportunities, limitations, and gaps in knowledge and methodology;
2. Develop a consensus statement that prioritizes opportunities for research in shared decision making that will result in practice changes, and identifies effective methodological approaches;
3. Identify and build collaborative research networks to study the use of shared decision making and patient-centered outcomes research in emergency medicine that will be competitive for federal funding.

Accepted manuscripts will present original, high-quality research in shared decision making in the ED, such as clinical decision rules, shared decision making, knowledge translation, comparative effectiveness research, and multidisciplinary collaboration. They may include work in clinical, translational, health systems, policy, or basic science research. Papers will be considered for publication in the December 2016 issue of *AEM* if received by April 17, 2016. All submissions will undergo peer review and publication cannot be guaranteed.

For queries, please contact the conference chair, Corita R. Grudzen, MD, MSHS (corita.grudzen@nyumc.org), or the co-chairs Christopher R. Carpenter, MD, MSc (carpenterc@wusm.wustl.edu) and Erik Hess, MD (Hess.Erik@mayo.edu). Information and updates will be regularly posted in *AEM* and the SAEM Newsletter, and on the journal and SAEM websites.

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Emergency Medicine Fellowship Opportunities

UC Irvine Department of Emergency Medicine is seeking HS Clinical Instructors for fellowships starting July 1, 2016. UC Irvine Medical Center is rated among the nation's best hospitals by U.S. News & World report 14 years in a row and is a 412-bed tertiary and quaternary care hospital with a nationally recognized three-year EM residency program since 1989. The progressive 35-bed ED sees more than 50,000 patients/year and serves as a Level I adult and Level II Pediatric Trauma Center with more than 3,800 annual trauma runs.

The hospital is also a Comprehensive Stroke & Cerebrovascular Center, Comprehensive Cancer Center, Cardiovascular receiving center and regional Burn centers, with Observation and an After Hours clinic in urban Orange County. Completion of an ACGME accredited EM Residency is required. Salary is commensurate with qualifications and proportion of clinical effort. For more information visit: http://www.emergencymed.uci.edu/fellowships.asp (To apply: https://recruit.ap.uci.edu).

1. **Disaster Medicine Fellowship (JPF03020)**
2. **EM Education and Faculty Development (JPF03026)**
3. **Medical Simulation Fellowship (JPF03023)**
4. **Multimedia Design Education Technology Fellowship (JPF03051)**
5. **Point-of-Care Ultrasound Fellowship (JPF03018)**

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University of California Irvine, Department of Emergency Medicine is seeking applicants for the fellowship in Disaster Medical Sciences for July 1, 2016. UCI Medical Center is a Level I Trauma Center with 3,800 runs/year and a 50,000 ED census. Fellows serve as HS Clinical Instructors. The program combines the disciplines of emergency management/disaster medicine and public health with traditional emphasis on systems research including mass casualty management, scarce resource allocation, and triage.

Completion of American Council of Graduate Medical Education (ACGME) accredited Emergency Medicine Residency is required prior to start. One or two year positions are available. The two-year program requires a master's degree and tuition is paid for by the department. Salary commensurate with level of clinical work.

Submit CV, statement of interest and three letters of recommendation at:
https://recriut.ap.uci.edu/apply/JPF03020

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UC Irvine Department of Emergency Medicine (EM) is seeking a HS Clinical Instructor- Education and Faculty Development Fellow for July 1, 2016. University of California, Irvine Medical Center is a Level I Trauma center with 3,800 runs/year, 50,000 ED census with a nationally recognized three-year residency program since 1989. Fellowship concentrations include residency and student education with an emphasis on research methodology.

This two-year fellowship requires completion of a Masters degree in Education, Translational Science or Public Health. One-year fellowship is available for those with a Master degree or starting one during the fellowship. Completion of an ACGME accredited EM Residency required. Salary is commensurate with qualifications and proportion of clinical effort.

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See the department of Emergency Medicine's website available at:
http://www.emergencymed.uci.edu/Education/faculty_development.asp for more details.

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University of California, Irvine, Department of Emergency Medicine (EM) is seeking a HS Clinical Instructor- Medical Simulation Fellow for July, 2016. University of California, Irvine Medical Center is a Level I Trauma center with 3,800 runs/year, 50,000 ED census with a nationally recognized three-year residency program since 1989. The UC Irvine Medical Education Simulation Center is a new $40 million, 65,000-square-foot facility that provides telemedicine and simulation-based educational programs and CME courses for thousands of healthcare providers each year. The four-story medical education center includes a full-scale operating room, emergency room, trauma bay, obstetrics suite and critical care unit. The simulation fellow will have the opportunity to educate/train and form cooperative collaborative relationships with medical students, residents, nurses, allied health professionals, EMTs, paramedics, and physicians while developing and delivering innovative simulation curriculum. Our simulation-based content has been implemented in educational courses at the local, regional and international level.

The Medical Simulation Fellowship is a one year mentored fellowship that offers advanced training in simulation teaching, curriculum design, educational program implementation, study design, and research for a graduate of an accredited Emergency Medicine residency program. A two-year track is available for those applicants in pursuit of an advanced degree. Salary is commensurate with qualifications and proportion of clinical effort.

For more information, visit our website at:
http://www.emergencymed.uci.edu/Education/simulation.asp

Submit CV and statement of interest at: https://recruit.ap.uci.edu/apply/JPF03023

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Point-of-Care Ultrasound Fellowship

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Qualified candidates should send a CV with letter of interest to Edmundo Mandac, MD, Chair, Department of Emergency Medicine at: edmundo.mandac@uhhospitals.org or call 216-844-1636.

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- Ketamine and EMS
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- Treatment of Agitation
- Informed consent & Invol Meds
- Quality Improvement
- Applying BETA Guidelines
- Interviewing techniques
- Starting a PES/Psych Ed
- Research Forum

Topics (Tentative)
Friday December 4 (Day 2)

- Improving Efficiency
- Synthetic Cannabinoids
- High Utilizer Management
- HEADS ED
- Excited Delirium
- Violence in the ED/PES
- Neurobehavioral Manifestations of Non-Convulsive Status
- Fellowship
- AMA and other risk issues
- Psych collaborative
- Will I Get Sued
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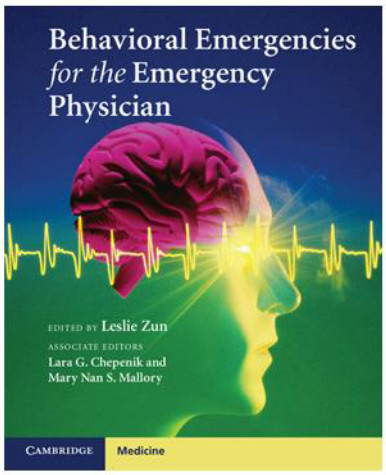

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Complete your application by also submitting a statement on previous and/or past contributions to diversity, equity and inclusion

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7:40-8:20pm Management of the Acutely Agitated Patient — James Hardy, MD
8:20-9:00pm Using Social Media to Teach and Learn — Nikita Joshi, MD

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