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Western Journal of Emergency Medicine:

Integrating Emergency Care with Population Health

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Emergency medicine is a specialty which closely reflects societal challenges and consequences of public policy decisions. The emergency department specifically deals with social injustice, health and economic disparities, violence, substance abuse, and disaster preparedness and response. This journal focuses on how emergency care affects the health of the community and population, and conversely, how these societal challenges affect the composition of the patient population who seek care in the emergency department. The development of better systems to provide emergency care, including technology solutions, is critical to enhancing population health.

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Perceptions of Emergency Department Crowding in the Commonwealth of Pennsylvania

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Introduction: The state of emergency department (ED) crowding in Pennsylvania has not previously been reported.

Methods: We assessed perceptions of ED crowding by surveying medical directors/chairs from Pennsylvania EDs in the spring of 2008.

Results: A total of 106 completed the questionnaire (68% response rate). A total of 83% (86/104) agreed that ED crowding was a problem; 26% (27/105) reported that at least half of admitted patients boarded for more than 4 hours. Ninety-eight percent (102/104) agreed that patient satisfaction suffers during crowding and 79% (84/106) stated that quality suffers. Sixty-five percent (68/105) reported that crowding had worsened during the past 2 years. Several hospital interventions were used to alleviate crowding: expediting discharges, 81% (86/106); prioritizing ED patients for inpatient beds, 79% (84/106); and ambulance diversion, 55% (57/105). Almost all respondents who had improved ED operations reported that it had reduced crowding.

Conclusion: ED crowding is a common problem in Pennsylvania and is worsening in the majority of hospitals, despite the implementation of a variety of interventions. [West J Emerg Med. 2013;14(1):1–10.]

INTRODUCTION

Emergency department (ED) crowding is a major public health problem in the United States.[1] National surveys report a very high prevalence of ED crowding—as high as 91% in 2001.[2] Several causes for ED crowding have been proposed; however, the underlying problem is a fundamental mismatch between demand by patients for care and ED and hospital capacity.[3–5] This supply-demand mismatch has also been shown to have several adverse effects on patients during times of ED crowding. These include long waiting times, poorer satisfaction and pain control, treatment in hallways, a reduced ability to deliver time-sensitive interventions, such as antibiotics in cases of pneumonia and percutaneous intervention in acute myocardial infarction, and poorer survival and complication rates.[6–12]

Several recent reports have proposed solutions to the crowding problem.[13–15] In addition, many interventions to alleviate crowding have been deployed in individual hospitals and in state-level policy. For example, the Department of Health in New York has allowed hospitals to move admitted patients to inpatient hallways when the ED is at full capacity.[16] However, there are few studies that have detailed the results of interventions. There is also little published information on which interventions have been implemented, which have been difficult to implement, and which have the highest impact on improving overall patient flow.

The measurement of ED crowding has been a challenge. Several measures, such as ED occupancy and other measures, have been proposed. Prolonged ED length of stay has been associated with ED crowding and is one of the measures used to measure ED crowding retrospectively.[17] In 2013, the Centers for Medicare and Medicaid Services will provide incentive

payments for specific measures of ED length of stay.[18] However, there are no states that explicitly require hospitals to report patient flow indicators, nor have there been any statewide assessments of the feasibility of reporting systems. In the absence of any national and state-specific reporting requirement and before hospitals start reporting in 2013, there is little information outside of investigator-initiated research to assess the prevalence of crowding. There is currently no way for patients to assess expected or actual wait times when seeking emergency services, outside of EDs who report these times publicly to the local community.

We sought to assess perceptions of ED crowding at the level of ED administration across Pennsylvania by surveying ED medical directors with the goal of (1) determining perceptions on the prevalence of and trends in ED crowding and boarding across the state and (2) assessing the reported use of various interventions aimed at alleviating ED crowding.

METHODS

Study Design and Participants

We performed a cross-sectional survey of department chairs and medical directors in EDs in Pennsylvania focused on ED crowding. Hospitals were included if they were located in Pennsylvania and had a hospital-based ED that was open during the study period. Urgent care centers and veterans hospitals were excluded because crowding issues are different in those hospitals and they are not subject to the Emergency Medical Treatment and Labor Act rules. The initial list of hospitals and contact information was obtained from the Pennsylvania Chapter of the American College of Emergency Physicians (PaACEP).

Data Collection and Processing

Data were collected in the spring of 2008 by a series of e-mail announcements, postage surveys, and follow-up telephone calls. The initial e-mail announcement with a hyperlink to the online survey was sent 4 times. After the initial e-mail announcements, in cases of nonresponse or nonfunctional e-mail, PaACEP sent a paper survey by mail up to 3 times. Remaining nonresponders were contacted by telephone to direct participants to the online survey. A response was determined as being any of the data filled out in the online or paper surveys, or by telephone. Aside from aiding with the initial list of hospitals and with survey mailing, PaACEP was not directly involved in this study.

Data were collected by using an online survey package (http://www.surveymonkey.com; SurveyMonkey, Portland, Oregon). Questions with multiple possible choices were placed in random order to minimize bias. The survey software allowed respondents to skip specific questions and still submit the survey.

The survey was designed to ask specific questions about the level of crowding, boarding, and interventions that had been implemented to alleviate crowding. At the outset of the survey, ED crowding was defined as, "... the functional state of an ED where demand for services exceeds resource supply." Hospitals were asked to identify the name of their hospital in the survey for tracking purposes and they were reassured that hospital-specific information would not be reported. The purpose of this was to ensure more accurate data reporting and to increase the likelihood of reporting potentially sensitive information. We used the following language to introduce participants to the survey: "To protect your confidentiality and to encourage your most honest answers, please be assured that we will be de-identifying the data for the analysis. Hospital-specific information will NOT be reported to the state." Accordingly, no hospital-specific information is published in this report. The survey instrument was developed and refined in 2 separate research conferences in the Departments of Emergency Medicine at the University of Pennsylvania and Albert Einstein Medical Center. The survey was then piloted locally among the emergency physician faculty at both centers to ensure that the survey was easy to understand. For some questions, write-in answers were allowed.

Additional data on the EDs were obtained to assess for nonresponse bias, including Level I trauma designation (http://www.amtrauma.org), PA region (http://www.phc4.org)—including Southeastern PA, Central PA, and Western PA—and the presence of an emergency medicine residency training program (http://www.saem.org/saemdnn/). The institutional review boards at the University of Pennsylvania and Albert Einstein Medical Center, both of which are located in Philadelphia, Pennsylvania, approved the study.

Data Analysis

The primary data were tabulated from answers to survey questions. We compared responders to nonresponders by using Fisher exact tests. A P value of 0.05 or less was considered significantly different. Stata 10 (Stata Corporation, College Station, Texas) was used for the data analysis.

RESULTS

Assessment of Response Rate, Nonresponse Bias, and Characteristics of Participant Hospitals

Among the 156 EDs meeting our inclusion criteria in Pennsylvania, 106 separate EDs responded (response rate = 68%). Of the 106 hospitals, 100 (94%) identified the name of their hospital, permitting an assessment of nonresponse bias. A total of 11 (11%) respondents had emergency medicine residency programs; 44 (44%) were in Southeastern PA; 32 (32%), in Western PA; and 24 (24%), in Central PA; 20 (20%) were trauma centers. Respondent hospitals were more likely to have EM residencies (11% versus 0%, $P = 0.01$) and be trauma centers (20% versus 8%, $P = 0.07$). There was no statistical difference in Pennsylvania region across respondent hospitals ($P = 0.65$). Of the 106 hospitals, 101 answered questions on hospital demographics. (Table 1) Most hospital respondents

Table 1. Characteristics of hospital emergency departments (ED) in Pennsylvania that participated in the survey (n = 106).

	n (%)
Academic/community status (n = 101)	
Academic with ED residency program	11 (11)
Academic without ED residency	19 (19)
Community hospital	71 (70)
ED type (n = 101)	
Rural	28 (28)
Suburban	45 (45)
Urban	28 (28)
Annual ED census per year (n = 102)	
<10,000	4 (4)
10,000–25,000	29 (28)
25,001–50,000	48 (47)
50,001–75,000	15 (15)
>75,000	6 (6)
Total inpatient bed capacity (n = 102)	
<50	14 (14)
50–100	18 (18)
101–250	36 (35)
251–500	22 (22)
>500	12 (12)
Diversion hours in the last calendar year (n = 100)	
0	23 (23)
1–100	31 (31)
101–300	10 (10)
301–500	10 (10)
501-1000	4 (4)
>1000	3 (3)
No diversion policy	19 (19)
ED capacity (n = 102)	Mean (SD, range)
No. of ED rooms	20 (12, 2–81)
No. of hallway treatment spaces	5 (4, 0–23)
Fast-track rooms	4 (4, 0–17)
ED holding area treatment spaces	1 (3, 0–21)

SD, standard deviation.

were nonurban hospitals with between 100 to 500 beds, with a census of 10,000 to 50,000 patients.

The Importance of ED Crowding Compared to Other Issues Facing EDs

Emergency department directors across Pennsylvania rated ED crowding as the most important issue affecting their ED, with 30 directors ranking crowding as the number 1 issue; 22, as the number 2 issue; and 13, as the number 3 issue. Other important issues included quality of ED care, with 21 ranking it as the number 1 issue; reimbursement for ED care, with 10 ranking it as the number 1 issue; and physician and nurse retention, which were ranked the number 1 issue by 9 and 8 directors, respectively (Table 2)

Prevalence of ED Crowding and Boarding

In all, 84% (n = 87) of ED directors agreed or strongly agreed that crowding was a problem in their hospital. The highest percentage of EDs (37% [n = 39]) reported that they were crowded 11% to 25% of the time, while 24% (n = 25) reported that their EDs were crowded 26% to 50% of the time. The highest percentage of EDs (33% [n = 35]) reported that boarding (defined as transfer to an inpatient bed > 4 hours after request) occurred for 1% to 10% of admitted patients (Figure 1).

Consequences of ED Crowding

The most frequently cited adverse consequence of crowding was patient and staff dissatisfaction, with 98% and 95% of ED directors agreeing or strongly agreeing, respectively, that this occurred in their hospital when the ED was crowded. Other adverse consequences included a high proportion of EDs reporting that patients leave without being seen (84%) and that quality of care suffers (79%) during crowded times. A high percentage (73%) agreed or strongly agreed that when crowding occurred, admitted patients were boarded for long periods. However, only 32% of ED directors agreed or strongly agreed that their hospital devoted more resources to the ED during times of crowding and 30% reported going on diversion (Table 3).

Trends in ED Crowding, On-Call Specialists, and Primary Care Access

Within the past 2 years, 65% of ED directors reported that crowding had become worse or much worse in their hospital, while 61% reported that primary care access was worse or much worse in their community. In addition, 53% reported that on-call specialist availability had worsened (Figure 2).

Strategies Used by Hospitals When the ED Becomes Crowded

A total of 81% of EDs reported that their hospitals sometimes or always expedite inpatient discharges, while 61% reported that their hospitals sometimes rapidly transfer ED patients to inpatient beds. Several strategies were never used during crowded times. For example, 82% of hospitals report never triaging patients to other acute settings, 81% never cancel elective surgeries, 77% never move admitted patients to inpatient hallways, and 76% never use a hospital-wide disaster plan (Table 4).

Factors Affecting Crowding

Several factors were reported to affect crowding, the most frequent being delayed bed placement for admitted patients (63%). Other important factors that strongly affected crowding

Table 2. Major issues affecting Pennsylvania emergency departments (ED) (n = 106).

Please rate the importance of the following issues to your ED (rank the top 3, with 1 being most important)	Ranked as No. 1 issue	Ranked as No. 2 issue	Ranked as No. 3 issue	Total*
ED crowding	30	22	13	65
Quality of ED care	21	14	6	41
Reimbursement for ED care	10	14	21	45
Physician retention	9	8	7	24
Nurse retention	8	11	17	36
Malpractice	7	10	10	27
Access to primary care in community	7	9	7	23
Relationships with inpatient services	7	6	7	20
Nurse:patient ratios	4	10	5	19
Hospital-acquired infections	2	2	3	7
Violence in the ED	1	1	1	3

* Total reflects the number of respondents that ranked the issue as No. 1, No. 2, or No. 3.

were an increase in ED volume (41%), insufficient ED space (40%), and an increase in patient acuity (36%) (Table 5).

Recent, Future, and Failed Interventions to Alleviate Crowding and Which Have Been Successful at Reducing Crowding

All hospitals reported interventions that had been implemented in the last 2 years to help alleviate crowding in their hospitals. The most frequent interventions were improving ED operations (40%), hiring more ED nurses (37%) and physician extenders (33%), and implementing the emergency severity index triage (33%). Almost all (98%) who tried to improve ED operations reported that it improved the crowding situation. Of those EDs that hired physician extenders, 71% found this to be useful to alleviate crowding. Several EDs tried to implement interventions, but were not successful. The most frequent failed interventions were attempts at boarding admitted ED patients in inpatient hallways (40%) and at implementing surgical schedule smoothing (21%). Interestingly, while 4 of 6 (67%) hospitals that implemented surgical smoothing found this to be helpful in alleviating crowding, only 1 of 5 (20%) hospitals that used inpatient hallways to board ED patients reported that it reduced crowding. (Table 6).

Major Barriers for Alleviating Crowding

The most frequent barrier to improving ED crowding was hospital administration (52%), followed by insufficient ED human resources (48%), and ED financial resources (45%) (Table 7).

DISCUSSION

Consistent with national reports, we found perceptions of a very high prevalence of ED crowding in Pennsylvania.[1,2] This is also consistent with previous state-level reports demonstrating a high level of ED crowding in California, Florida, Texas, and New York.[19,20] In Pennsylvania, while crowding is the largest issue facing EDs, it does not appear to occur all the time in most hospitals. This reflects the cyclical nature of ED demand, where crowding may be present at certain times of the day, week, month, or year.[21] The supply-demand mismatch is present in most EDs some of the time, but the proportion of time for which there are insufficient resources to handle ED patients is highly variable, depending upon the hospital. Few EDs report a supply-demand mismatch all the time, but most report it part of the time. We found a similar pattern in the rates of ED boarding, where only a small proportion of EDs report that more than 50% of EDs admitted patients board for more than 4 hours and most report that somewhere between 1% to 10% board for more than 4 hours.

During episodes of crowding, there was clear consensus that crowding lowers patient and staff satisfaction. The effect of ED crowding on patient satisfaction has been reported recently, with ED crowding, hallway bed placement, and long boarding times resulting in lower patient satisfaction.[6] Quality of care was also reported to be a major issue, which is confirmed by reports that have shown an association between ED crowding and process measures, such as time to antibiotics in cases of pneumonia and the timing and provision of pain control.[7,8,22,23] In addition, a recent report found that crowding lengthens the overall time in the ED, even for high-acuity patients.[17] There was also general agreement that patients leave without being seen, which is a known consequence of long waits.[24,25] However, only a minority of hospitals reported using ambulance diversion during times of crowding, which may reflect local or regional policies.

Most medical directors reported that crowding had worsened across the state during the pat 2 years. While the Emergency Medicine Transfer and Active Labor Act requires that all patients presenting to the ED have a screening

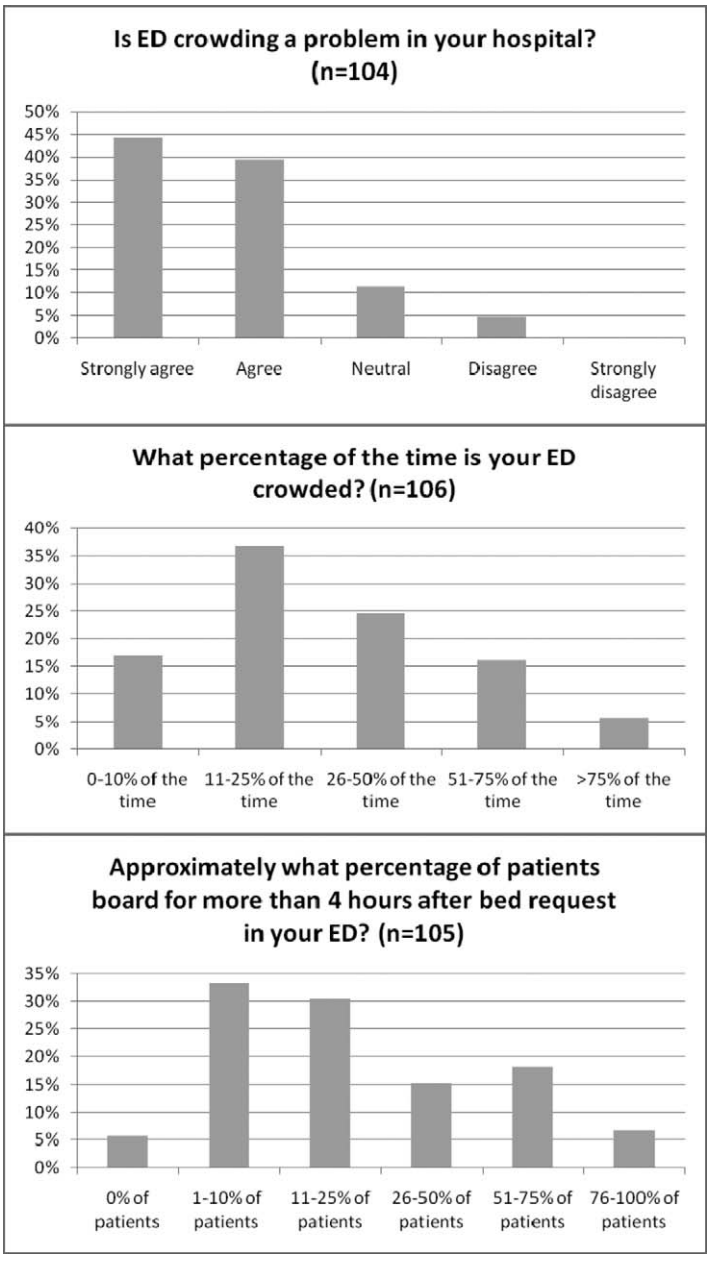

Figure 1. The prevalence of emergency department (ED) crowding and boarding in Pennsylvania hospitals.

examination, there have been few state or national policies that require hospitals to provide timely emergency care. In addition, because more than half of ED directors report that primary care access is worse, ED volume may be increasing to make up for the shortfall of urgent primary care services in Pennsylvania.[26]

Most hospitals report a change in operations during crowded times. These changes most frequently include expediting inpatient discharges, prioritizing ED patients for inpatient beds, and rapidly transferring ED patients to inpatient beds. Because boarding is a central cause for crowding, it would make sense that hospitals would attempt to rapidly move admitted patients out of the ED in response to crowding.[27] Several strategies were used by a minority of hospitals,

Table 3. Consequences of emergency department (ED) crowding in Pennsylvania hospitals.

What happens when your ED becomes crowded?	n (%)
Admitted patients are boarded for long periods (n = 106)	
Strongly agree	42 (40)
Agree	35 (33)
Neutral	10 (9)
Disagree	17 (16)
Strongly disagree	2 (2)
Quality of care suffers (n = 106)	
Strongly agree	37 (35)
Agree	47 (44)
Neutral	10 (9)
Disagree	10 (9)
Strongly disagree	2 (2)
Patient satisfaction suffers (n = 104)	
Strongly agree	74 (71)
Agree	28 (27)
Neutral	1 (1)
Disagree	. . .*
Strongly disagree	1 (1)
Patients leave without being seen (n = 104)	
Strongly agree	50 (42)
Agree	44 (42)
Neutral	7 (6)
Disagree	1 (1)
Strongly disagree	3 (3)
Staff satisfaction suffers (n = 105)	
Strongly agree	72 (69)
Agree	26 (25)
Neutral	3 (3)
Disagree	1 (1)
Strongly disagree	2 (2)
The hospital devotes more resources to the ED (n = 106)	
Strongly agree	4 (4)
Agree	30 (28)
Neutral	27 (25)
Disagree	33 (31)
Strongly disagree	12 (11)
My ED does not become crowded (n = 103)	
Strongly agree	1 (1)
Agree	7 (7)
Neutral	10 (10)
Disagree	38 (37)
Strongly disagree	47 (46)

* Indicates there were no responses for this.

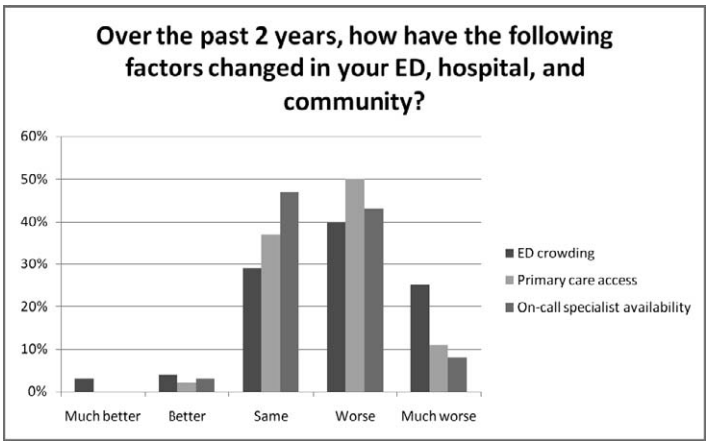

Figure 2. Changes in emergency department (ED) crowding, primary care access, and on-call specialist availability in Pennsylvania (n = 105).

including cancelling elective surgeries, stopping intrahospital transfers, and moving ED patients to inpatient hallways. Because non-ED admissions generate higher revenues, it would make sense that from a purely economic perspective, hospitals would be hesitant to cancel transfers for profitable patients compared to the less profitable ED patients waiting for inpatient beds.[28]

Emergency department directors named delays in inpatient bed placement as having the strongest effect on crowding. Boarding as a central cause for crowding has been confirmed in several reports.[22,29,30] Increased volume, increased acuity, and insufficient ED space were also named as strong contributors to crowding across Pennsylvania. These factors are also known causes for crowding and capacity issues. Efficiency issues were reported to have a moderate effect on crowding, such as delays in radiology and delays in consultation. A similar finding was noted in a report that detailed systematic delays in time to antibiotic administration for patients with pneumonia where one component, a delay in radiology, was a significant factor in delayed antibiotic administration.[31]

When asked which interventions had been performed to alleviate crowding during the previous 2 years, only 40% of EDs reported there had been an active intervention. The most common intervention was improving ED efficiency, which was also reported by nearly all medical directors to help alleviate crowding. About one third to one fourth of EDs reported that they had hired more staff (physicians, physician extenders, and nurses), increased ED space, or hired a bed manager. Of those interventions, hiring physician extenders seemed to have the greatest effect on reducing crowding, with more than 70% reporting an improvement. Hiring physician extenders may improve crowding by expediting care for low severity cases. Implementation of 2 interventions that involve support outside the ED was reported to be largely unsuccessful. More than 40% of EDs reported the inability to use inpatient hallways for admitted patients. In addition, 20% reported attempting to implement surgical schedule smoothing but had met with failure. Surgical schedule smoothing is the process of balancing surgery loads throughout the week (ie, an equal number of surgeries every day), as opposed to what is commonly done in hospitals, which is to schedule elective surgeries during weekdays.[32,33] Respondents did not detail why surgical smoothing and the use of inpatient floors, successful solutions to ED crowding in other states, had not been implemented in their EDs in Pennsylvania. However, of the few hospitals that had been able to implement smoothing, 4 of 6 reported that it had reduced crowding. Given these preliminary results, surgical schedule smoothing appears to be a promising intervention to reduce ED crowding. By contrast, only 1 of 5 hospitals that use inpatient floors for admitted patients reported that it has successfully reduced crowding. This may indicate that the use of inpatient floors for admitted patients as a strategy to reduce crowding may have less impact than expected.[34]

However, these data do suggest that certain strategies to reduce crowding may have greater impact than others. Given the fact that, by itself, improving ED operations seems to universally improve ED crowding, it is unclear whether hospitals should look to their ED to improve throughput, or

Table 4. Specific strategies used when emergency departments (ED) become crowded in Pennsylvania hospitals.

Which mechanisms are used when your ED is crowded?	Always, n (%)	Sometimes, n (%)	Never, n (%)
Expedite inpatient discharges (n = 106)	6 (6)	79 (75)	21 (20)
Rapid transfer of admitted patients to inpatient beds (n = 105)	8 (8)	64 (61)	33 (32)
Move ED patients to inpatient hallways (n = 106)	9 (8)	20 (19)	77 (73)
Hospital-wide disaster plan (n = 105)	3 (3)	22 (21)	80 (76)
Cancel elective surgeries (n = 100)	. . .*	19 (19)	81 (81)
Ambulance diversion (n = 105)	5 (5)	52 (50)	48 (46)
Triage patients to other acute care settings (n = 105)	1 (1)	18 (17)	86 (82)
Prioritize ED patients for inpatient bed assignments (n = 106)	13 (12)	71 (67)	22 (12)
Stop accepting hospital-to-hospital transfers (n = 101)	6 (6)	41 (41)	54 (53)

* Indicates there were no responses for this.

Table 5. Factors affecting emergency department (ED) crowding in Pennsylvania hospitals.

For each of the following, please indicate the degree to which it contributes to ED crowding in your ED?	Strongly affects crowding, n (%)	Moderately affects crowding, n (%)	Minimally affects crowding, n (%)	Does not affect crowding, n (%)	This is not a problem, n (%)
Nursing shortage (n = 104)	30 (29)	36 (35)	23 (22)	7 (7)	8 (8)
Increased ED volume (n = 106)	43 (41)	44 (42)	16 (15)	1 (1)	2 (2)
Increased patient acuity (n = 106)	38 (36)	55 (51)	12 (11)	1 (1)	1 (1)
Insufficient ED space (n = 106)	43 (40)	26 (24)	25 (23)	8 (8)	5 (5)
Physician shortage (n = 106)	12 (11)	13 (12)	34 (32)	26 (25)	21 (20)
Radiology delays (n = 105)	24 (23)	36 (34)	33 (32)	6 (6)	6 (6)
Delays in consultation (n = 104)	21 (20)	36 (35)	32 (31)	11 (11)	4 (4)
Delays in bed placement (n = 106)	67 (63)	24 (23)	9 (9)	5 (5)	1 (1)
ED inefficiency (n = 104)	9 (9)	35 (33)	41 (39)	8 (12)	13 (12)

look more to non-ED interventions, such as surgical smoothing, which seem similarly useful, but much more difficult to implement. Comparative studies aimed at determining which interventions are most effective at reducing crowding and the logistics of implementing them (ie, the buy-in needed to achieve an intervention) will be helpful in guiding hospitals to improve ED flow.

Several barriers to improving ED crowding were listed. Approximately one half of ED directors reported that hospital administration was a major barrier. The difficulty associated with effecting change in hospitals, as well as the varied priorities of stakeholders, may contribute to this negative perception of hospital administrators. Similarly, approximately half of ED directors reported that they did not have sufficient human or financial resources to improve crowding. A reluctance of hospital administration to provide support or resources to ED crowding may be due to the way in which crowding is prioritized by hospitals and perceptions that crowding is more of an ED problem than a hospital-wide problem.

LIMITATIONS

There are several limitations to this study. The greatest limitation of this study was that we did not verify any of the answers, so it is possible that some of the survey responses may not be accurate. For example, it is unknown whether the medical directors used real data for many of the quantitative questions or whether they used estimates. In addition, these data may represent a biased sampled because we did not sample 100% of Pennsylvania EDs and because those EDs responding were more likely to have ED residency programs. Because residency programs tend to be in more populated areas, the data may overestimate the level of crowding across Pennsylvania EDs. It may be more difficult to generalize these data to community hospitals that did not answer the survey. It is also possible that respondent hospitals differed on factors that we did not report, such as ED volume. We attempted to reduce nonresponse bias by trying to maximize our response rate through using several survey requests and multiple modalities (e-mail, paper mail, and phone calls). Another limitation is that these data were obtained from medical directors, who may have their own crowding bias, affecting how they responded to survey questions. Even though we explicitly communicated that we would not publicly release the individual results from their hospitals, the fact that they identified their hospital may have influenced how they estimated the level of crowding and reported data. However, medical directors likely are in the best position to provide accurate data on this issue. We were also limited by our survey instrument, which was developed and piloted locally, but was not rigorously validated. Finally, for this study, we defined boarding as occurring 4 hours or more after a bed request. Since a recent report has defined boarding as a shorter time interval from the bed request (2 hours), our definition may have underestimated the level of boarding across the state.[35]

CONCLUSION

According to ED medical directors across Pennsylvania, crowding is currently the number one issue facing their EDs in the state. Most directors report that crowding and boarding occur some of the time, while few report it occurs all the time. There appears to be consensus that crowding has a negative impact on patient and staff satisfaction, and in most EDs, quality of care. However, a minority report that greater resources are devoted to the ED during episodes of crowding. Several factors affecting ED crowding were identified in this report, but boarding of ED-admitted patients appears to be the most common. Many interventions have been implemented and the most successful ones include improving ED operations, hiring physician extenders, and smoothing of surgical schedule. Improving ED operations may include ED-specific interventions such as bedside registration or improvements in

Table 6. Interventions to alleviate emergency department (ED) crowding in the past 2 years (2006–2007) in Pennsylvania hospitals.

What has been done to alleviate crowding in your ED in the past 2 years, has it worked, and what are the plans for the future? (n = 106)	n (%)	Reportedly effective in reducing ED crowding, No. (%)
ED staffing		
Hired more physician extenders	35 (33)	25 of 35 (71%)
Plans to hire more physician extenders	16 (15)	
Tried to hire more physician extenders, but unable	10 (9)	
Hired more nurses	39 (37)	20 of 39 (51%)
Plans to hire more nurses	12 (11)	
Tried to hire more nurses, but unable to	21 (20)	
Hired more ED physicians	27 (25)	11 of 27 (41%)
Plans to hire more physicians	21 (20)	
Tried to hire more physicians, but unable	15 (14)	
Hired a bed manager	31 (29)	11 of 31 (35%)
Plans to hire a bed manager in the future	9 (8)	
Tried to hire a bed manager, but unable	8 (8)	
Capacity issues		
Increased ED size	25 (24)	12 of 25 (48%)
Plans to increase ED size in the future	16 (15)	
Tried to increase ED size, but unable	9 (9)	
Increased hospital size	15 (14)	7 of 15 (47%)
Plans to increase hospital size in the future	25 (24)	
Tried to increase hospital size, but unable	17 (16)	
Opened observation unit	8 (8)	2 of 8 (25%)
Plans to open an observation unit in the future	19 (18)	
Tried to open an observation unit, but unable	17 (16)	
ED and hospital efficiency		
Improved ED operations	42 (40)	41 of 42 (98%)
Plans to improve ED operations in the future	1 (1)	
Tried to improve operations, but unable	3 (3)	
Implemented surgical schedule smoothing	6 (6)	4 of 6 (67%)
Plans to implement smoothing in the future	9 (9)	
Tried to implement smoothing, but unable	22 (21)	
Boarded ED patients on inpatient hallways	5 (5)	1 of 5 (20%)
Plans to use inpatient hallways in the future	1 (1)	
Tried to use inpatient hallways, but unable	42 (40)	
Triage		
Implement ESI triage	35 (33)	8 of 35 (33%)
Plans to implement ESI in the future	8 (8)	
Tried to implement ESI, but unable	4 (4)	

ESI, emergency severity index.

Table 7. Major barriers to alleviating emergency department (ED) crowding in Pennsylvania hospitals.

What are the major barriers to alleviating crowding in your hospital? (n = 78)	n (%)
Hospital administration	41 (52)
The ED does not have suitable human resources to improve crowding (ie, staff)	38 (49)
ED does not have suitable financial resources to improve crowding	35 (45)
There are no barriers	8 (10)

the way the ED itself functions. Interventions that involve collaboration outside the ED, such as moving patients to inpatient hallways and surgical schedule smoothing, have been difficult to implement in many hospitals. Hospital administration is reported to be a barrier in approximately half of hospitals, as is having suitable financial and human resources to improve crowding.

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REFERENCES

1. Institute Of Medicine. IOM report: the future of emergency care in the United States health system. *Acad Emerg Med*. 2006;13:1081–1085.
2. Derlet R, Richards J, Kravitz R. Frequent overcrowding in U.S. emergency departments. *Acad Emerg Med*. 2001;8:151–155.
3. Eitel DR, Rudkin SE, Malvehy MA, et al. Improving service quality by understanding emergency department flow: a white paper and position statement prepared for the American Academy of Emergency Medicine. *J Emerg Med*. 2010;38:70–79.
4. Burt CW, McCaig LF. Trends in hospital emergency department utilization: United States, 1992–99. *Vital Health Stat 13*. 2001;(150):1–34.
5. American College of Emergency Physicians 1998–1999 Safety Net Task Force. *Defending America's Safety Net*. Dallas, TX: American College of Emergency Physicians; 1999.
6. Pines JM, Iyer S, Disbot M, et al. The effect of emergency department crowding on patient satisfaction for admitted patients. *Acad Emerg Med*. 2008;9:825–831.
7. Pines JM, Hollander JE. Emergency department crowding is associated with poor care for patients with severe pain. *Ann Emerg Med*. 2008;51:1–5.
8. Pines JM, Localio AR, Hollander JE, et al. The impact of emergency department crowding measures on time to antibiotics for patients with community-acquired pneumonia. *Ann Emerg Med*. 2007;50:510–516.
9. Chalfin DB, Trzeciak S, Likourezos A, et al. Impact of delayed transfer of critically ill patients from the emergency department to the intensive care unit. *Crit Care Med*. 2007;35:1477–1483.
10. Carr BG, Kaye AJ, Wiebe DJ, et al. Emergency department length of stay: a major risk factor for pneumonia in intubated blunt trauma patients. *J Trauma*. 2007;63:9–12.
11. Pines JM, Pollack CV Jr, Diercks DB, et al. The association between emergency department crowding and adverse cardiovascular outcomes in patients with chest pain. *Acad Emerg Med*. 2009;16:617–625.
12. Kulstad EB, Kelley KM. Overcrowding is associated with delays in percutaneous coronary intervention for acute myocardial infarction. *Int J Emerg Med*. 2009;2:149–154.
13. Bernstein SL, Asplin BR. Emergency department crowding: old problem, new solutions. *Emerg Med Clin North Am*. 2006;24:821–837.
14. Olshaker JS, Rathlev NK. Emergency Department overcrowding and ambulance diversion: the impact and potential solutions of extended boarding of admitted patients in the Emergency Department. *J Emerg Med*. 2006;30:351–356.
15. American College of Emergency Physicians. Emergency department crowding: high-impact solutions. American College of Emergency Physicians Web site. Available at: www.acep.org/workarea/showcontent.aspx?id=37960. Accessed December 22, 2008.
16. Garson C, Hollander JE, Rhodes KV, et al. Emergency department patient preferences for boarding locations when hospitals are at full capacity. *Ann Emerg Med*. 2008;51:9–12.
17. McCarthy ML, Zeger SL, Ding R, et al. Crowding delays treatment and lengthens emergency department length of stay, even among high-acuity patients. *Ann Emerg Med*. 2009;54:492–503.
18. US Department of Health and Human Services. Proposed changes to the hospital outpatient prospective payment system and CY 2012 payment rates. Centers for Medicare and Medicaid Services Web site. Available at: http://www.cms.gov/HospitalOutpatientPPS/HORD/itemdetail.asp?itemID=CMS1240960&. Accessed April 8, 2011.
19. Richards JR, Navarro ML, Derlet RW. Survey of directors of emergency departments in California on overcrowding. *West J Med*. 2000;172:385–388.
20. Derlet RW, Richards JR. Emergency department overcrowding in Florida, New York, and Texas. *South Med J*. 2002;95:846–849.
21. Asplin BR, Flottemesch TJ, Gordon BD. Developing models for patient flow and daily surge capacity research. *Acad Emerg Med*. 2006;13:1109–1113.
22. Fee C, Weber EJ, Maak CA, et al. Effect of emergency department crowding on time to antibiotics in patients admitted with community-acquired pneumonia. *Ann Emerg Med*. 2007;50:501–509.
23. Hwang U, Richardson L, Livote E, et al. Emergency department crowding and decreased quality of pain care. *Acad Emerg Med*. 2008;15:1248–1255.
24. Monzon J, Friedman SM, Clarke C, et al. Patients who leave the

emergency department without being seen by a physician: a control-matched study. *CJEM*. 2005;7:107–113.

25. Kulstad EB, Hart KM, Waghchoure S. Occupancy rates and emergency department work index scores correlate with leaving without being seen. *West J Emerg Med*. 2010;11:324–328.
26. Rust G, Ye J, Baltrus P, et al. Practical barriers to timely primary care access: impact on adult use of emergency department services. *Arch Intern Med*. 2008;168:1705–1710.
27. Schull MJ, Lazier K, Vermeulen M, et al. Emergency department contributors to ambulance diversion: a quantitative analysis. *Ann Emerg Med*. 2003;41:467–476.
28. McHugh M, Regenstein M, Siegel B. The profitability of Medicare admissions based on source of admission. *Acad Emerg Med*. 2008;15: 900–907.
29. Bond K, Ospina MB, Blitz S, et al. Frequency, determinants and impact of overcrowding in emergency departments in Canada: a national survey. *Healthc Q*. 2007;10:32–40.
30. Yancer DA, Foshee D, Cole H, et al. Managing capacity to reduce emergency department overcrowding and ambulance diversions. *Jt Comm J Qual Patient Saf*. 2006;32:239–245.
31. Pines JM, Morton MJ, Datner EM, et al. Systematic delays in antibiotic administration in the emergency department for adult patients admitted with pneumonia. *Acad Emerg Med*. 2006;13:939–945.
32. McManus ML, Long MC, Cooper A, et al. Variability in surgical caseload and access to intensive care services. *Anesthesiology*. 2003;98:1491–1496.
33. Litvak E, Buerhaus PI, Davidoff F, et al. Managing unnecessary variability in patient demand to reduce nursing stress and improve patient safety. *Jt Comm J Qual Patient Saf*. 2005;31:330–338.
34. Viccellio A, Santora C, Singer AJ, et al. The association between transfer of emergency department boarders to inpatient hallways and mortality: a 4-year experience. *Ann Emerg Med*. 2009;54:487–491.
35. Welch S, Augustine J, Camargo CA Jr, et al. Emergency department performance measures and benchmarking summit. *Acad Emerg Med*. 2006;13:1074–1080.

Emergency Department Crowding is Associated with Reduced Satisfaction Scores in Patients Discharged from the Emergency Department

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Introduction: Emergency department (ED) crowding has been shown to negatively impact patient outcomes. Few studies have addressed the effect of ED crowding on patient satisfaction. Our objective was to evaluate the impact of ED crowding on patient satisfaction in patients discharged from the ED.

Methods: We measured patient satisfaction using Press-Ganey surveys returned by patients that visited our ED between August 1, 2007 and March 31, 2008. We recorded all mean satisfaction scores and obtained mean ED occupancy rate, mean emergency department work index (EDWIN) score and hospital diversion status over each 8-hour shift from data archived in our electronic tracking board. Univariate and multivariate logistic regression analysis was calculated to determine the effect of ED crowding and hospital diversion status on the odds of achieving a mean satisfaction score ≥ 85, which was the patient satisfaction goal set forth by our ED administration.

Results: A total of 1591 surveys were returned over the study period. Mean satisfaction score was 77.6 (standard deviation [SD] ±16) and mean occupancy rate was 1.23 (SD ± 0.31). The likelihood of failure to meet patient satisfaction goals was associated with an increase in average ED occupancy rate (odds ratio [OR] 0.32, 95% confidence interval [CI] 0.17 to 0.59, $P < 0.001$) and an increase in EDWIN score (OR 0.05, 95% CI 0.004 to 0.55, $P = 0.015$). Hospital diversion resulted in lower mean satisfaction scores, but this was not statistically significant (OR 0.62, 95% CI 0.36 to 1.05). In multivariable analysis controlling for hospital diversion status and time of shift, ED occupancy rate remained a significant predictor of failure to meet patient satisfaction goals (OR 0.34, 95% CI 0.18 to 0.66, $P = 0.001$).

Conclusion: Increased crowding, as measured by ED occupancy rate and EDWIN score, was significantly associated with reduced patient satisfaction. Although causative attribution was limited, our study suggested yet another negative impact resulting from ED crowding. [West J Emerg Med. 2013;14(1):11-15.]

INTRODUCTION

Emergency department (ED) crowding is a major issue facing many of the nation's emergency departments.[1-5] The etiology of crowding is believed to be multifactorial, with the following key elements contributing to its cause: a decrease in hospital capacity, an increase in closures of a significant number of EDs, an increase in ED patient volumes, a shortage in nursing staff, an increase in the complexity of patient management and the inability to transfer patients from the ED to inpatient units.[4] ED crowding has been associated with adverse medical outcomes and substandard patient care, including delays in door-to-needle time for patients with acute myocardial infarction, increased death after admission and poor performance on pneumonia quality of care measures.[6-11]

A recent meta-analysis found crowding to be associated with an increase in transport delays, ambulance diversion and patients leaving the ED without being seen.[12] A recent study focusing on patients who were admitted to the ED suggested that poor ED service, as indicated by ED hallway use and prolonged boarding time, was not only associated with a decreased satisfaction in the ED, but also predicted a lower satisfaction with the entire hospitalization.[13] Patient satisfaction is an important issue for EDs and has been recognized as a measure of quality of healthcare.[14]

Determining the correlation between ED crowding and patient satisfaction could have substantial impact, as patient satisfaction can play a key role in physician evaluations, compensation, medico-legal action and improvement in patient care. No studies, to our knowledge, have evaluated the effect of ED crowding on patient satisfaction in patients discharged directly from the ED.

The purpose of our study was to investigate the association between patient satisfaction, as measured using Press-Ganey surveys (www.pressganey.com), and ED crowding, as measured by the ED occupancy rate, emergency department work index (EDWIN) score and hospital diversion status. We hypothesized that there would be an inverse relationship between patient satisfaction and ED crowding in patients discharged directly from the ED.

MATERIALS AND METHODS

Study Design and Setting

We conducted a retrospective, cohort study of all patients who were discharged from the ED and completed Press-Ganey patient satisfaction surveys between August 1, 2007 and March 31, 2008. The study was performed in a large, tertiary care, suburban, teaching hospital ED. Our ED has an annual census of greater than 85,000 patients, with an average of 230 patients seen in the ED on a daily basis. This study was approved by our local institutional review committee.

Methods of Measurement

Crowding was measured using the following 3 metrics: ED occupancy rate, modified EDWIN score and hospital diversion status. The ED occupancy rate was defined as the total number of patients in the ED divided by the total number of ED licensed beds.[15] We determined the EDWIN score by calculating patient number and acuity, number of attending physicians on duty and total bed availability.[11, 16, 17] The higher the EDWIN score the more crowded the ED. We measured patient satisfaction using the Press-Ganey survey, a commonly used measure of patient satisfaction in the ED.

Press-Ganey surveys were distributed, at random, to both adult and pediatric patients discharged from the ED over an 8-month period. Press-Ganey selects patients randomly to distribute surveys, using a read-skip methodology, as follows: The system reads the first patient record, then skips the next 7 records, then reads the next record, then skips the next 7 records. This method is continued until the maximum number of patients is reached. A maximum of 2000 patients were provided with a survey each month, which translated to approximately 40% of the patients discharged from the ED in a given month. The surveys were collected by Press-Ganey, with an average response rate of 10-12%.

Patients were instructed to complete the survey by scoring questions within the following categories: arrival, tests, nurses, doctors, family or friends, personal issues, overall assessment and personal/insurance information. Each question was scored on a 5-point Likert scale, with a score of 1 corresponding to "very poor" and a score of 5 corresponding to "very good." Each score on the Likert scale was then converted to a mean satisfaction score (1=0, 2=25, 3= 50, 4=75, 5=100). Each patient was also asked to designate his or her time of arrival, which corresponded to one of 3 8-hour shifts: 7:00AM–3:00PM, 3:00PM–11:00PM and 11:00PM–7:00AM.

We recorded all mean satisfaction scores and obtained mean ED occupancy rate, mean EDWIN score and hospital diversion status over each 8-hour shift. These data were archived in our electronic tracking board. We considered hospital diversion status positive if our ED was on diversion at any point during the 8-hour shift. Our hospital went on diversion when there was no available monitored bed to take a new patient admitted from the ED.

We calculated the original EDWIN score using the following formula: $\sum n_i t_i / N_a(B_T - B_A)$, where n_i was the number of patients in the ED in triage category *i*, t_i was the triage category, N_a was the number of attending physicians on duty, B_T was the number of treatment bays and B_A was the number of admitted patients in the ED. The triage category (t_i) was defined by the Emergency Severity Index (ESI), a measure commonly used in North America to stratify patients into 5 groups based on their acuity, required resources and timeliness.[18] To assign higher numerical values to higher severity patients, the EDWIN score reverses the standard ordinal ranking of triage categories so that ESI-1 patients (highest acuity) are assigned a value of 5, ESI-2 patients a value of 4, ESI-3 patients a value of 3, ESI-4 patients a value of 2 and ESI-5 patients (lowest acuity) a value of 1. In the original derivation of the EDWIN score, the authors found "an active but manageable ED has an EDWIN score less than 1.5, a busy ED has an EDWIN between 1.5 and 2, and a crowded ED has a score greater than 2."[16]

Our ED information system and electronic tracking board (Picis ED PulseCheck, Wakefield, Mass.) automatically calculated and provided a "modified" EDWIN score in real-time. To avoid "divide by zero" computational errors, the EDWIN score available on our electronic tracking board varied from the standard EDWIN score in the following 2 ways: 1) admitted patients were not removed from the variable n_i in the numerator (standard calculation of EDWIN score excludes admitted patients from variable n_i); and 2)

the number of treatment bays, B_T, denoted all beds available for patient care in the ED, including hallway beds (standard calculation only includes licensed treatment bays). In our study, B_T was 117, rather than the 50 licensed beds for our ED. The result of these modifications was a lowering of the numerical value of our score when compared to the original description of the EDWIN score, but it still varied by a full order of magnitude between lowest and highest value. Given that we used this modified EDWIN score that involved changes to both the numerator and the denominator of the original EDWIN score, there is no proportional correlation to the original EDWIN score; therefore, it is difficult to draw conclusions about the score at which a "busy" and "crowded" ED would occur.

Primary Data Analysis

We calculated Spearman correlation (ρ) to determine the association between ED crowding and patient satisfaction scores (with Spearman correlation coefficients ranging from -1 to 1, with values closest to -1 indicating a strong inverse association and values closest to 1 indicating a strong positive association). We calculated univariate and multivariate logistic regression analysis to determine the effect of ED crowding and hospital diversion status on the odds of achieving a mean satisfaction score ≥ 85, which was the patient satisfaction goal set forth by our ED administration. Model parameters were specified and input as forced predictors into our model. We performed statistical analyses using SPSS version 16.0 (SPSS Inc., Chicago, IL). For all analyses, $P \leq 0.05$ denoted statistical significance, with no adjustment for multiple comparisons.

RESULTS

A total of 1591 surveys were returned over the course of our study period, encompassing 497 8-hour shifts. Our analysis revealed a mean patient satisfaction score of 77.6, with a standard deviation of 16.5. The mean occupancy rate was 1.23 (SD ± 0.31), and the mean EDWIN score was 0.30 (SD ± 0.08). Occupancy rate was inversely correlated with patient satisfaction (Spearman's ρ = -0.16, $P < 0.001$). The EDWIN score was inversely correlated with patient satisfaction (Spearman's ρ = -0.11, $P = 0.02$). We also found a statistically significant decrease in the likelihood of meeting patient satisfaction goals (mean satisfaction score ≥ 85) with an increase in average ED occupancy rate (odds ratio [OR] 0.32, 95% confidence interval [CI] 0.17 to 0.59, $P < 0.001$). Likewise, we noted a significant decrease in the likelihood of meeting patient satisfaction goals (mean satisfaction score ≥ 85) with an increase in the EDWIN score (OR 0.05, 95% CI 0.004 to 0.55, $P = 0.015$). Analysis of the effect of hospital diversion on patient satisfaction goals revealed slightly lower mean satisfaction scores when the ED was on diversion, but this difference was not statistically significant (OR 0.62, 95% CI 0.36 to 1.05). In multivariable analysis controlling for hospital diversion status and time of shift, ED occupancy rate remained a significant predictor of failure to meet patient satisfaction goals (OR 0.34, 95% CI 0.18 to 0.66, $P = 0.001$).

To evaluate the characteristics of the occupancy rate and EDWIN score as instruments predictive of ED satisfaction, we plotted receiver operating characteristic (ROC) curves using the binary outcome of meeting patient satisfaction goals as set by our ED administration (mean satisfaction score ≥ 85). The area under the curve (AUC) for occupancy rate was 0.59 (95% CI 0.54 to 0.65, $P \leq 0.001$) as seen in Figure 1. The AUC for the EDWIN score was 0.57 (95% CI 0.52 to 0.62, $P = 0.012$) as seen in Figure 2. The AUC values obtained were small, which limited our ability to use a single cutoff value to obtain high sensitivity and specificity. That said, an ED occupancy rate < 90% suggested approximately 90% sensitivity for meeting a mean satisfaction score ≥ 85, while and ED occupancy rate > 151% provided approximately 90% specificity for failure to meet a mean satisfaction score ≥ 85.

DISCUSSION

ED crowding is a phenomenon that continues to burden the healthcare system. The number of patients passing through EDs in the United States continues to increase, along with

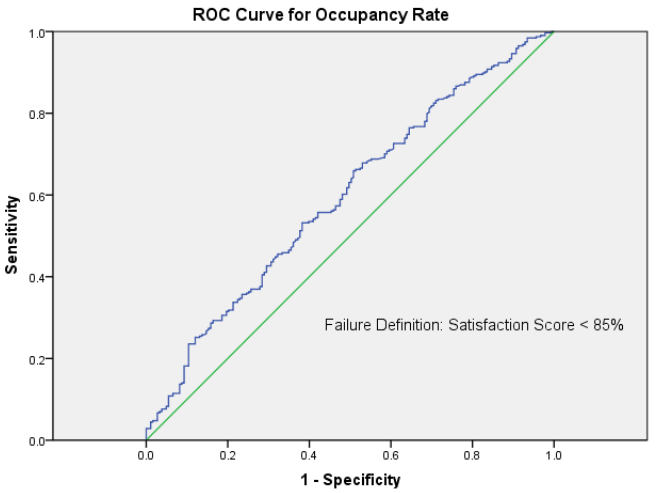

Figure 1. Receiver operating characterstic (ROC) curve for occupancy rate.

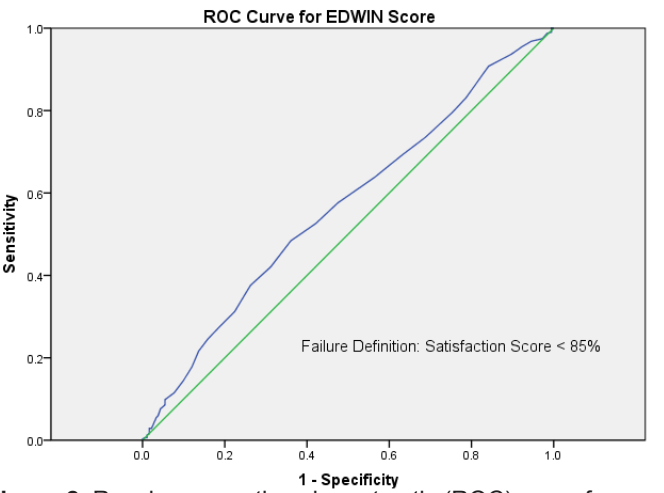

Figure 2. Receiver operating characterstic (ROC) curve for emergency department work index (EDWIN) score.

a decrease in the number of EDs available for their care.[4] An increase in patient volume, with a concomitant decrease in available facilities to treat these patients, will further complicate the issue of ED crowding. This issue goes beyond a patient's contentment with his or her visit to the ED; it has been associated with unfavorable medical outcomes and poor patient care.[6-11, 19, 20] ED crowding may also impact hospital revenue and has even been shown to impact physician job satisfaction.[21-23] Needless to say, ED crowding is a complex issue affecting many aspects of patient care.

Interestingly, at least 1 recent study did not find an association between ED crowding and adverse outcomes. This study measured time to percutaneous coronary intervention for patients with ST-segment elevation myocardial infarction (STEMI). As suggested in that study, higher acuity conditions, such as STEMI, may result in a diversion of resources away from other lower acuity conditions, which can lead to unfavorable outcomes overall.[24]

What makes our study different from other studies evaluating patient satisfaction was that we evaluated patients discharged directly from the ED. We used ED crowding metrics to show that the more crowded the ED, the more dissatisfied the patient. Our analysis revealed a statistically significant decrease in patient satisfaction goals with an increase in both occupancy rate and EDWIN score. Although hospital diversion status was correlated with a slight decrease in patient satisfaction goals, this was not clinically significant.

LIMITATIONS

This study was non-randomized and took place at a single institution. Those individuals who returned the Press-Ganey survey may not have been representative of all patients. Furthermore, our response rate was uncertain and likely low, as is common for patient satisfaction surveys. As a result, this study might have been subject to selection bias. The scale of our EDWIN score differed from that described in the original literature, which potentially limited the generalizability of our results. Avoidance of a divide by zero error in the implementation of electronic real-time calculation of the EDWIN score resulted in a larger denominator than would have otherwise existed. As such, our EDWIN score calculation resulted in a lower value than would normally have been calculated. Despite the lower numerical value of our EDWIN score, the range of our score was wide (almost a full order of magnitude existed between the lowest and highest values), which may have served to maintain the sensitivity of the score at the expense of transferability between different sites. Nevertheless, the validity of the EDWIN score had been inconsistent in studies published since its original description.[17, 25]

Another consideration was that patient satisfaction survey data obtained from Press-Ganey were only available in 8-hour shift increments, which may have limited the sensitivity of our analysis. Individual patient data were not available. As such, it was plausible that greater crowding variability existed within each distinct 8-hour period.

CONCLUSION

Increased crowding, as measured by ED occupancy rate and EDWIN score, was significantly associated with reduced patient satisfaction. Although causative attribution was limited, our study suggested yet another negative impact resulting from ED crowding.

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REFERENCES

1. American College of Emergency Physicians. Crowding. *Ann Emerg Med*. 2006; 47:585.
2. Instite of Medicine. The future of emergency care in the United States health system. *Ann Emerg Med*. 2006; 48:115-120.
3. Gibbs N. "Do you want to die?" The crisis in emergency care is taking its toll on doctors, nurses--and patients. *Time*. 1990; 135:58-60, 62-55.
4. Kellermann AL. Crisis in the emergency department. *N Engl J Med.* 2006; 355:1300-1303.
5. Moskop JC, Sklar DP, Geiderman JM, et al. Emergency department crowding, part 1--concept, causes, and moral consequences. *Ann Emerg Med*. 2009; 53:605-611.
6. Derlet RW, Richards JR. Emergency department overcrowding in Florida, New York, and Texas. *South Med J*. 2002; 95:846-849.
7. Miro O, Antonio MT, Jimenez S, et al. Decreased health care quality associated with emergency department overcrowding. *Eur J Emerg Med*. 1999; 6:105-107.
8. Pines JM, Hollander JE, Localio AR, et al. The association between emergency department crowding and hospital performance on antibiotic timing for pneumonia and percutaneous intervention for myocardial infarction. *Acad Emerg Med.* 2006; 13:873-878.
9. Schull MJ, Vermeulen M, Slaughter G, et al. Emergency department crowding and thrombolysis delays in acute myocardial infarction. *Ann Emerg Med.* 2004; 44:577-585.
10. Sprivulis PC, Da Silva JA, Jacobs IG, et al. The association between hospital overcrowding and mortality among patients admitted via Western Australian emergency departments. *Med J Aust*. 2006; 184:208-212.
11. Trzeciak S, Rivers EP. Emergency department overcrowding in the United States: an emerging threat to patient safety and public health. Emerg Med J. 2003; 20:402-405.
12. Hoot NR, Aronsky D. Systematic review of emergency department crowding:

causes, effects, and solutions. *Ann Emerg Med.* 2008; 52:126-136.

13. Pines JM, Iyer S, Disbot M, et al. The effect of emergency department crowding on patient satisfaction for admitted patients. *Acad Emerg Med*. 2008; 15:825-831.
14. Ross CK, Steward CA, Sinacore JM. A comparative study of seven measures of patient satisfaction. *Med Care*. 1995; 33:392-406.
15. McCarthy ML, Aronsky D, Jones ID, et al. The emergency department occupancy rate: a simple measure of emergency department crowding? *Ann Emerg Med*. 2008; 51:15-24, 24 e11-12.
16. Bernstein SL, Verghese V, Leung W, et al. Development and validation of a new index to measure emergency department crowding. *Acad Emerg Med*. 2003; 10:938-942.
17. Weiss SJ, Ernst AA, Nick TG. Comparison of the National Emergency Department Overcrowding Scale and the Emergency Department Work Index for quantifying emergency department crowding. *Acad Emerg Med.* 2006; 13:513-518.
18. Wuerz RC, Milne LW, Eitel DR, et al. Reliability and validity of a new five-level triage instrument. *Acad Emerg Med.* 2000; 7:236-242.
19. Begley CE, Chang Y, Wood RC, et al. Emergency department diversion and trauma mortality: evidence from houston, Texas. *J Trauma.* 2004; 57:1260-1265.
20. Johnson KD, Winkelman C. The effect of emergency department crowding on patient outcomes: a literature review. *Adv Emerg Nurs J.* 2011; 33:39-54.
21. Bayley MD, Schwartz JS, Shofer FS, et al. The financial burden of emergency department congestion and hospital crowding for chest pain patients awaiting admission. *Ann Emerg Med.* 2005; 45:110-117.
22. Krochmal P, Riley TA. Increased health care costs associated with ED overcrowding. *Am J Emerg Med.* 1994; 12:265-266.
23. Rondeau KV, Francescutti LH. Emergency department overcrowding: the impact of resource scarcity on physician job satisfaction. J *Healthc Manag*. 2005; 50:327-340; discussion 341-322.
24. Harris B, Bai JC, Kulstad EB. Crowding Does Not Adversely Affect Time to Percutaneous Coronary Intervention for Acute Myocardial Infarction in a Community Emergency Department, *Ann Emerg Med*, 2011.
25. Jones SS, Allen TL, Flottemesch TJ, et al. An independent evaluation of four quantitative emergency department crowding scales. *Acad Emerg Med*. 2006; 13:1204-1211.

The Impact of Emergency Physician Turnover on Planning for Prospective Clinical Trials

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Introduction: Emergency physician (EP) turnover is a significant issue that can have strong economic impact on hospital systems, as well as implications on research efforts to test and improve clinical practice. This work is particularly important to researchers planning randomized trials directed toward EPs because a large degree of turnover within a physician group would attenuate the effectiveness of the desired intervention. We sought to determine the incidence and factors associated with EP workforce changes.

Methods: In an attempt to determine EP turnover and workforce change, data from the INSTINCT (INcreasing Stroke Treatment through INterventional behavior Change Tactics) trial were used. The INSTINCT trial is a prospective, cluster-randomized, controlled trial evaluating a targeted behavioral intervention to increase appropriate use of tissue plasminogen activator in acute ischemic stroke. Individual EPs staffing each of the study hospitals were identified at baseline and 18 months. Surveys were sent to EPs at both intervals. Models were constructed to investigate relationships between physician/hospital characteristics and workforce change.

Results: A total of 278 EPs were identified at baseline. Surveys were sent to all EPs at baseline and 18 months with a response rate of 72% and 74%, respectively. At 18 months, 37 (15.8%) had left their baseline hospital and 66 (26.3%) new EPs were working. Seven EPs switched hospitals within the sample. The total number of EPs at 18 months was 307, a 10.8% overall increase. Among the 24 hospitals, 6 had no EP departures and 5 had no new arrivals. The median proportion of EP workforce departing by hospital was 16% (interquartile range [IQR] = 4%–25%; range = 0%–73%), and the median proportion added was 21% (IQR = 7%–41%; range = 0%–120%). None of the evaluated covariates investigating relationships between physician/hospital characteristics and workforce change were significant.

Conclusion: EP workforce changes over an 18-month period were common. This has implications for emergency department directors, researchers, and individual EPs. Those planning research involving interventions upon EPs should account for turnover as it may have an impact when designing clinical trials to improve performance on healthcare delivery metrics for time-sensitive medical conditions such as stroke, acute myocardial infarction, or trauma. [West J Emerg Med. 2013;14(1):16–22.]

INTRODUCTION

Emergency physician (EP) turnover is a considerable issue throughout the country. While there is very limited information available on turnover rates of EPs, current estimates suggest that about 9% of physicians from all specialties leave their practice each year.[1] An EP may choose to leave his/her hospital group for one of a variety of reasons, including lack of job satisfaction, desire for geographical change, spousal employment opportunity, or a combination of such factors.[2] In addition, the EP may belong to a group or contract organization that loses its contract with a hospital. Turnover significantly impacts hospitals through lost productivity and recruiting and relocation costs; remaining faculty may have decreased morale.[3,4]

An EP departure from a practice can have multiple effects. As well as having an immediate economic impact on the hospital system,[5] departures can also affect efforts to study and improve clinical practice through quality improvement efforts and knowledge translation initiatives. Accounting for EP turnover is important when designing clinical trials to improve performance on healthcare delivery metrics for time-sensitive medical conditions such as stroke, acute myocardial infarction, or trauma. Past work has little information regarding hospital level EP workforce change, with most prior investigations focused on EP decisions to leave the specialty.[6,7]

Given the importance of estimating EP turnover rates, we have analyzed prospectively collected data on emergency department (ED) practices within the INSTINCT (INcreasing Stroke Treatment through INterventional behavior Change Tactics) trial—a prospective, cluster-randomized, controlled trial evaluating an intervention to increase appropriate use of tissue plasminogen activator (tPA) in acute ischemic stroke. Our primary objective was to estimate and describe EP turnover within Michigan; our secondary objective was to identify provider and hospital level factors which were associated with EP workforce changes.

METHODS

Study Design

This study is based on data collected in the INSTINCT trial. This multi-center, cluster-randomized trial was designed to test the ability of targeted educational interventions to increase the appropriate use of tPA for the treatment of ischemic stroke. Data for this study were obtained from 2 surveys administered to emergency physicians associated with the participating hospitals at times separated by approximately 18 months. These surveys were designed to assess emergency physician attitudes, beliefs, and behavior regarding acute stroke treatment as part of the overall trial protocol, but also provided data over time allowing us to analyze EP turnover during the study period. The design and reporting of this study was facilitated by the recommendations of the STROBE statement, a reporting guideline considered essential for good reporting of observational studies.[8]

Human Subjects Protection

The University of Michigan Institutional Review Board (IRBMED) and local IRBs approved the INSTINCT trial and the surveys.

Study Setting and Population

Emergency physicians in practice at hospitals participating in the INSTINCT trial were included. Physicians were determined to be in practice by the local principal investigator and were included if they were in a permanent position at the participating site. Residents were not included. The intervention within INSTINCT was randomized at the hospital level. Hospitals were selected from the population of acute care hospitals in Michigan. Hospitals were excluded if they were affiliated with the INSTINCT emergency medicine residency, self-identified as an academic comprehensive stroke center, experienced more than 100,000 annual ED visits, or experienced fewer than 100 annual inpatient stroke discharges. These design elements were used to facilitate matched pairs of hospitals to serve as control and intervention sites within the overall trial.

Study Protocol

Within Michigan, each participating hospital had a local principal investigator. The local principal investigator provided the clinical coordinating center with a list of names and contact information for all emergency physicians in practice at the site and their relevant contact information at 2 time points: prior to any educational intervention within Michigan, and again 18 months later after all interventions had occurred. This contact information was used to solicit participation in the INSTINCT trial survey. In addition, the local principal investigator annually provided information regarding the hospital ED volume, teaching status, and other institutional level variables. Each physician identified was assigned a unique identifier by the data management center. Physicians who migrated between sites were accounted for in this process.

Measurements

The emergency physicians present for the baseline survey were categorized based on their location at 18 months. The following categories were used: "stayed at hospital," "left all Michigan hospitals (departure)," or "transferred to a different Michigan hospital." Obversely, physicians present within the hospitals at 18 months were categorized as follows: present at the same hospital as at first survey, new (not previously working at the Michigan hospital), or transferred from a different Michigan hospital. Age, gender, years in practice, and other physician level factors were self reported by the survey respondents.

Statistical Analysis

Descriptive statistics regarding hospital and survey respondent characteristics were calculated as means or

proportions as appropriate, and absolute counts and proportions of each type of physician disposition over the course of the study were obtained. The medians and interquartile ranges for the proportions of each type of event (physician loss, physician addition, and overall physician change) were calculated at the hospital level.

We constructed several models to investigate the relationships between physician/hospital characteristics and turnover. Since we expected physicians within hospitals to be more alike than physicians across hospitals (clustering or within hospital correlation), we used methods which accounted for these different types of variability. In general, the uncertainty (or standard error) for parameter estimation in a model should increase in these situations.[9] Logistic regression models were used to explore the following relationships:

Model 1: The outcome was physician departure and the model covariates were age, gender, hospital teaching status, hospital treatment/control allocation within INSTINCT, and the total number of emergency physicians practicing at that hospital, again with adjustment for within hospital correlation.

We used Poisson regression to examine factors associated with changes in overall number of physicians within each ED.

Model 2: The outcome variable was the total number of physicians at the 18-month survey and the offset (denominator) was the number of physicians at baseline; therefore, the modeled outcome can be considered the proportion of original physicians who were still practicing at 18 months. We included the following hospital level covariates: mean age, proportion female, proportion responding to survey, teaching status, and treatment/control allocation within INSTINCT. Since this model was at the hospital level, we adjusted for within pair correlation.

Model 3: We used logistic regression to investigate the association between treatment/control allocations within INSTINCT and the odds of a physician returning at 18 months from baseline with a weight variable proportional to the number of physicians in each hospital at 18 months.

Statistical analyses were performed using SAS version 9.2 (SAS Corporation, Cary, North Carolina).

RESULTS

The hospital characteristics and demographic characteristics of physicians responding to the surveys are given in Table 1. While some internal characteristics of these hospitals changed during the course of the study, there was no addition or removal of hospitals from the trial throughout its course.

At baseline, 278 emergency physicians were identified at the 24 Michigan hospitals, of which 199 (72%) returned the baseline survey. At 18 months, 307 physicians were identified within the INSTINCT sample and 344 surveys were sent (included physicians present at baseline who left), and 255 (74%) responded. Complete information regarding the population of physicians working at all sites at both time points was captured from the INSTINCT trial site principal investigators.

At 18 months, 37 (15.8%) had left their baseline hospital and 66 (26.3%) new EPs were working. Seven EPs switched hospitals within the sample. The total number of EPs at 18 months was 307, a 10.8% overall increase. Among the 24 hospitals, 6 had no EP departures and 5 had no new arrivals. The median proportion of EP workforce departing by hospital was 16% (interquartile range [IQR] = 3.8%–25%; range = 0%–73%), and the median proportion added was 21% (IQR = 7%–41%; range = 0%–120%).

The disposition of physicians by hospital is given in Table 2, along with the proportion of physicians remaining at 18 months (accounting for physician loss) and the proportion of physicians at 18 months who were present at baseline (accounting for proportion of physicians at the later time point who likely had opportunity to receive intervention but may have moved to a different hospital within the trial). Six of the 24 hospitals (25%) experienced no physician loss. At 18 months, 5 hospitals (20.8%) were staffed entirely by physicians who were present at baseline, although 4 of these hospitals (16.6%) reported a lower total number of physicians.

The results of the models are presented in Table 3. None of the evaluated predictor variables in the models achieved statistical significance. In assessing whether hospital or physician level variables are predictive of the propensity for physicians to move, we used methods that allowed for the possibility of intraclass (intrahospital) correlation (ICC), a measure that estimates how alike members within a cluster (ED) behave with respect to an outcome (leaving their position). There was no evidence of such correlation, and an analysis based on independence gives essentially equivalent results. Therefore, one could ignore the number of hospitals (clusters) when trying to estimate how much emergency physician turnover one could expect when planning future studies (ie, reasonable to assume ICC = 0).

DISCUSSION

In this investigation, we found that changes in emergency physician workforce were common. The overall incidence of physician departure was higher than we anticipated when initially planning the INSTINCT trial. We did not find any specific factors that were strongly predictive of physician turnover at either the hospital or provider levels. We observed substantial variability between sites, as several sites had no turnover and some sites had near complete turnover. A major strength of our work is that our methodology allowed us to have migration information even on those who did not respond to our survey via the site principal investigators.

This work has important implications for several groups, including emergency department directors, researchers, and emergency physicians in practice. While it is likely that many groups providing staffing to emergency departments have data on the workforce changes within their sites, we believe this is

Table 1. Hospital and physician characteristics at baseline and 18 months.

	Baseline		18 Months	
Characteristics	n	(%)	n	(%)
Hospital level				
Inpatient beds				
< 100	4	(17)	4	(17)
101–250	12	(50)	11	(46)
251–500	5	(21)	6	(25)
> 500	3	(13)	3	(13)
Annual ED volume (adult)				
< 20,000	7	(29)	7	(29)
20,001–40,000	8	(33)	8	(33)
40,001–60,000	7	(29)	8	(33)
60,001–80,000	2	(8)	1	(4)
> 80,000	0	(0)	0	0
Teaching hospital	9	(38)	11	(46)
Physician level				
Female	46/199	(23)	59/254	(23)
	Median	42	Median	44
Age (years)	Minimum	28	Minimum	30
	Maximum	65	Maximum	67
Race or ethnic group				
White	171/192	(89)	216/239	(90)
Non-white	21/192	(11)	23/239	(10)
Black	6/192	(3)	7/239	(3)
Asian	5/192	(3)	5/239	(2)
Hispanic	4/192	(2)	7/239	(3)
Other	5/192	(3)	4/239	(2)
Education				
EM residency training	160/199	(80)	220/255	(86)
Specialty board certification				
EM	170/199	(85)	231/255	(91)
Internal medicine	8/199	(4)	1/255	(0)
Family practice	8/199	(4)	8/255	(3)
Pediatrics	1/199	(1)	0/255	
None	12/199	(6)	9/255	(4)
Other	11/199	(6)	6/255	(2)
Year of medical school graduation				
1997–2006	62/198	(31)	92/254	(36)
1987–1996	72/198	(36)	94/254	(37)
1977–1986	51/198	(26)	56/254	(22)
1957–1976	13/198	(7)	12/254	(5)
Year of EM residency completion				
1977–1986	15/160	(9)	14/193	(7)
1987–1996	58/160	(36)	80/193	(41)
1997–2006	87/160	(54)	99/193	(51)

ED, emergency department; *EM*, emergency medicine.

Table 2. Disposition of physician workforce by center.

Center	Present in center at baseline	Present at baseline and 18 months	Left INSTINCT sample	Transferred to different Michigan hospital	Percent of total physicians remaining within center at 18 months	New to INSTINCT sample	Transferred in from different Michigan hospital	Total present at 18 months	Percent of total physicians at 18 months who were also present at baseline	Net change in workforce	Net change as a percent of baseline
1	6	6	0	0	100	0	0	6	100	0	0
2	5	4	1	0	80	6	0	10	40	5	100
3	4	4	0	0	100	1	0	5	80	1	25
4	9	6	3	0	67	3	0	9	67	0	0
5	20	15	3	2	75	9	4	28	54	8	40
6	11	3	4	4	27	7	1	11	27	0	0
7	18	16	2	0	89	1	1	18	89	0	0
8	11	11	0	0	100	6	0	17	65	6	55
9	15	14	1	0	93	1	0	15	93	0	0
10	14	14	0	0	100	6	0	20	70	6	43
11	20	19	1	0	95	7	0	26	73	6	30
12	5	3	2	0	60	2	0	5	60	0	0
13	6	4	2	0	67	0	0	4	100	−2	−33
14	11	9	1	1	82	1	0	10	90	−1	−9
15	14	14	0	0	100	1	0	15	93	1	7
16	7	6	1	0	86	0	0	6	100	−1	−14
17	6	5	1	0	83	0	0	5	100	−1	−17
18	9	9	0	0	100	1	0	10	90	1	11
19	8	6	2	0	75	0	0	6	100	−2	−25
20	27	22	5	0	81	2	0	24	92	−3	−11
21	9	7	2	0	78	2	0	9	78	0	0
22	13	11	2	0	85	3	0	14	79	1	8
23	5	3	2	0	60	2	1	6	50	1	20
24	25	23	2	0	92	5	0	28	82	3	12
Total **(Mean)**	278	234	37	7	**84**	66	7	307	**76**	29	**10**
Median					84				81		0
25th Percentile					75				66		−2
75th Percentile					96				93		21

INSTINCT, INcreasing Stroke Treatment through INterventional behavior Change Tactics.

Table 3. Measurements of association between physician turnover and hospital/physician characteristics. Model 1 is with adjustment for within hospital correlation. Model 2 is with adjustment for within hospital pair correlation.*

	Model 1		Model 2 Poisson		Model 3 Binary logistic	
	OR	95% CI	IRR	95% CI	OR	95% CI
Age	1.04	0.98–1.10				
Gender (male vs female)	0.78	0.29–2.10				
INSTINCT (treatment vs control)	0.95	0.39–2.30	1.04	0.87–1.25	0.66	0.07–6.16
Teaching status (yes vs no)	1.30	0.41–4.17	1.10	0.95–1.28	0.98	0.04–22
EP count at hospital	0.94	0.86–1.02				
Hospital mean EP Age			0.99	0.97–1.01	1.0	0.70–1.43
Hospital EP proportion male			1.18	0.66–2.12	5.5	0.001–26,142

INSTINCT, INcreasing Stroke Treatment through INterventional behavior Change Tactics; *EP*, emergency physician; *OR*, odds ratio; *CI*, confidence interval; *IRR*, incident rate ratio.
* Model 1: Type: Binary Logistic, Outcome: Physician departure; Model 2: Type: Poisson, Outcome: Count of physicians at 18 months; Model 3: Type: Binary Logistic, Outcome: Physician return at 18 months.

the first report of specific provider level changes within a geographic sampling of emergency departments. In addition, it is likely that private emergency physician groups or contract organizations consider this type of information to be proprietary, and perhaps as a consequence it has not been disseminated in the peer-reviewed literature. The importance of this work to researchers planning cluster-randomized trials directed at emergency physicians in practice is clear. It is plausible that a large degree of turnover within a site would attenuate the effectiveness of intervention with the actual intended audience for the intervention becoming a moving target. This could occur either from the loss of many physicians or the addition of a large number of physicians due to expansion. From the perspective of the individual emergency physician in practice, this work provides a description of the amount of turnover that may be expected within a community emergency department. When considering employment at a site, one could use our report as an estimate of a baseline expected rate of turnover.

Our findings raise additional questions that will be useful areas of future research. We have hypothesized that increased physician turnover may adversely affect the benefit seen from targeted behavior change interventions. In this study, we have quantified the degree of physician turnover within our sites. Upon the primary analysis of the main INSTINCT outcomes (the improvements in the proportion of patients who were appropriately receiving intravenous tPA for stroke and the degree of knowledge change among ED physicians regarding thrombolytic use), we plan to measure the association between turnover and the efficacy of the main INSTINCT trial educational intervention. While it is intuitive that an association will be found between these factors of turnover and effectiveness of the intervention, it is also possible that the intervention may be resistant to turnover and may exert its main effect at the hospital level. Additional research with larger cohorts of emergency physicians with a more diverse geographic and demographic distribution that includes smaller hospitals and academic health centers may provide additional insight into emergency physician migration patterns.

LIMITATIONS

This investigation has several important limitations. The sampling frame for INSTINCT was at the hospital level. Only community hospitals with more than 100 stroke diagnoses were included. In addition, hospitals with formal comprehensive stroke programs were excluded. On the other hand, this investigation does provide a sample of hospitals that might be expected to be reflective of many community hospitals throughout the United States. It should be noted, however that all the included hospitals were within the lower peninsula of Michigan, and our findings in this investigation may not be generalizable to other settings. The state of Michigan has experienced economic challenges during the period in which this study was performed. This may lead to additional turnover due to economic stresses and migration to other states, although it may also lead to fewer turnovers due to difficulty finding alternative employment opportunities. Physician turnover rates were determined as a secondary analysis within a clinical trial with broader specific aims. We did not collect data on the longevity of physicians within their positions or the reasons that physicians ultimately left their positions. Finally, we did not observe enough physician departure events to draw any strong inferences relating hospital and physician level factors and their influence on turnover.

CONCLUSIONS

In summary, the incidence of emergency physician turnover is relatively common in our hospital sample. Further research is needed to better describe emergency physician

turnover in more varied geographic settings. This has a significant impact on decisions made by emergency department directors, researchers, and individual level EPs. Planners of research efforts that involve targeted educational interventions upon emergency physicians to test and improve their clinical practice should take workforce changes into account in the modeling of their investigations.

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REFERENCES

1. Turck JE. *Caring for the Country: Physician Retention at Cortland Regional Medical Center* [thesis]. Cortland, NY: State University of New York; 2009.
2. Pathman DE, Williams ES, Konrad TR. Rural physician satisfaction: its sources and relationship to retention. *J Rural Health*. 1996;12:366–377.
3. Misra-Hebert AD, Kay R, Stoller JK. A review of physician turnover: rates, causes, and consequences. *Am J Med Qual*. 2004;19:56–66.
4. Demmy TL, Kivlahan C, Stone TT, et al. Physicians' perceptions of institutional and leadership factors influencing their job satisfaction at one academic medical center. *Acad Med*. 2002;77:1235–1240.
5. Buchbinder S, Wilson M, Melick C. Estimates of costs of primary care physician turnover. *Am J Manag Care*. 1999;5:1431–1438.
6. Reinhart MA, Munger BS, Rund DA. American Board of Emergency Medicine Longitudinal Study of Emergency Physicians. *Ann Emerg Med*. 1999;33:22–32.
7. Hall KN, Wakeman MA. Residency-trained emergency physicians: their demographics, practice evolution, and attrition from emergency medicine. *J Emerg Med*. 1999;17:7–15.
8. von Elm E, Altman DG, Egger M, et al. The strengthening the reporting of observational studies in epidemiology (strobe) statement: guidelines for reporting observational studies. *J Clin Epidemiol*. 2008;61:344–349.
9. Wears RL. Advanced statistics: statistical methods for analyzing cluster and cluster-randomized data. *Acad Emerg Med*. 2002;9:330–341.

The Treatment of Cutaneous Abscesses: Comparison of Emergency Medicine Providers' Practice Patterns

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Introduction: Cutaneous abscesses are commonly treated in the emergency department (ED). Although incision and drainage (I&D) remains the standard treatment, there is little high-quality evidence to support additional interventions such as pain control, type of incision, and use of irrigation, wound cultures, and packing. Although guidelines exist to support clinician management of abscesses, they do not clearly specify these additional interventions. This study sought to describe the ED treatments administered to adults with uncomplicated superficial cutaneous abscesses, defined as purulent lesions requiring incision and drainage that could be managed in an ED or outpatient setting.

Methods: Four hundred and seventy-four surveys were distributed to 15 EDs across the United States. Participants were queried about their level of training and practice environment as well as specific questions regarding their management of cutaneous abscesses in the ED.

Results: In total, 350 providers responded to the survey (74%). One hundred eighty-nine respondents (54%) were attending physicians, 135 (39%) were residents, and 26 (7%) were midlevel providers. Most providers (76%) used narcotics for pain management, 71% used local anesthetic over the roof of the abscess, and 60% used local anesthetic in a field block for pain control. More than 48% of responders routinely used irrigation after (I&D). Eighty-five percent of responders used a linear incision to drain the abscess and 91% used packing in the wound cavity. Thirty-two percent routinely sent wound cultures and 17% of providers routinely prescribed antibiotics. Most providers (73%) only prescribed antibiotics if certain historical factors or physical findings were present on examination. Antibiotic treatment, if used, favored a combination of 2 or more drugs to cover both *Streptococcus* and methicillin-resistant *Staphylococcus aureus* (47%). Follow-up visits were most frequently recommended at 48 hours unless wound was concerning and required closer evaluation.

Conclusion: Variability exists in the treatment strategies for abscess care. Most providers used narcotic analgesics in addition to local anesthetic, linear incisions, and packing. Most providers did not irrigate, order wound cultures, or routinely prescribe oral antibiotics unless specific risk factors or physical signs were present. Limited evidence is available at this time to guide these treatment strategies. [West J Emerg Med. 2013;14(1):23–28.]

INTRODUCTION

Skin and soft tissue infections, particularly those caused by community-acquired methicillin resistant *Staphylococcus aureus* (MRSA) are common presentations to the emergency department (ED).[1–3] Multiple consensus documents and textbooks offer procedure guidelines for management of simple cutaneous abscesses, yet there is little evidence to support these practices (Table 1).[4–10] The only consensus on treatment is incision and drainage (I&D), but specific recommendations regarding incision type, irrigation, packing, pain management, wound cultures, and timing for follow-up visits vary widely. One study demonstrated variation by provider type and experience, suggesting practice patterns for I&D technique are not standardized, even within a single institution.[11] Our objective was to determine variability of practice patterns nationwide for treatment of uncomplicated superficial abscesses.

METHODS

Study Design and Population

This was a cross-sectional survey of ED providers, including resident physicians, attending physicians, and midlevel providers (physician assistants and nurse practitioners). Surveys were distributed to a convenience sample of 474 ED providers from 15 EDs across the United States. Study sites were selected from home institutions of a network of researchers across the country who had previously studied or published articles on abscess care. Surveys were distributed to all full-time physicians and residents rotating in the ED during the study period. The 9 sites, comprising 15 EDs, were chosen from academic centers, community teaching departments, and military EDs from different parts of the country, including urban and suburban locations, to optimize generalizability. Surveys were distributed in either paper or electronic format to all ED providers working in their department at each site during the study period. This study received an exempt status from the local institutional review committee.

Survey Content and Administration

The survey was designed to examine practice patterns of ED providers for the management of uncomplicated superficial cutaneous abscesses. The questionnaire, developed by members of the research team, was based upon a literature review of current recommendations for abscess management and was reviewed and revised by a research committee at Washington Hospital Center. The final survey consisted of 15 questions in total to determine provider demographics and the 4 categories of management strategies: pain management, irrigation, I&D/packing, and culture/antibiotic use. Questions were close-ended and consisted of categorical and yes/no responses. For some questions, participants could select more than 1 answer, if appropriate. The survey used an encrypted Internet-based survey tool (SurveyMonkey; http://www.surveymonkey.com) to collect and analyze responses. Each survey site had a unique identifier to determine the site response rate.

Between October 1 to 31, 2010, surveys were distributed to each provider working in the ED of participating institutions. Participants had the option of either answering the survey online or completing a hard copy, but were limited to 1 submission per responder. To preserve anonymity while preventing multiple entries by 1 individual and allow tracking by each study site, we enabled a tool on SurveyMonkey that assigned tracking codes to participants at each site. Results from paper surveys were entered online by a study investigator. Participation was voluntary and a small incentive in the form of a drawing for a small prize was offered. All responses were anonymous, though participants were asked to provide an e-mail address if they wished to participate in the prize drawing.

We collected the background demographics of the survey participants, including provider type (midlevel provider, resident, fellow, or attending physician) and type of practice setting (academic, community, military, rural, urban). We measured use of specific interventions for abscess management: pain control, irrigation, packing, wound cultures, antibiotic use, and follow-up instructions.

Data Analysis

Responses were analyzed by using standardized tabulations. Descriptive statistics were used to describe demographic variables and percentages were used to summarize categorical data. Comparison of responses by provider type was completed by using the chi-square test; Fisher exact test was used when appropriate. Results were calculated on the basis of the number of respondents to a particular question.

To identify the association between provider type and management strategies, unadjusted and adjusted odds ratios and 95% confidence intervals were calculated by using logistic regression with StatXact, version 9.0.0 (March 17, 2010; Cytel Corporation, Cambridge, Massachusetts).

RESULTS

Demographics

Of the 474 eligible participants, 350 providers (74%) responded to the survey (Appendix; online only). Of the respondents, 189 (54%) were attending physicians, 135 (39%) were residents, and 26 (7%) were midlevel providers. Respondents were asked about the type of environment in which they practiced and were allowed to indicate more than 1 if they worked at multiple different hospitals. Two hundred and seventy-three (78%) worked at a university-affiliated hospital; 66 (19%), at a community hospital; 65 (19%), at a military hospital; 64 (18%), only in an urban environment; and 3 (<1%), only in a rural environment.

Table 1. Current procedural guidelines for incision and drainage of simple cutaneous abscesses.

Source	Pain management	I & D with cavity probing	Irrigation	Packing	Culture	Antibiotics
Roberts & Hedges[4]	Local infiltration and systemic*	Yes	Mentions, but states no evidence exists for benefit	Gentle packing, mentions no evidence exists	Not discussed	Not discussed
Rosen's Emergency Medicine[5]	Local infiltration and systemic	Yes	Yes, no endpoint recommended	Gentle packing	Not recommended	Not recommended
Tintinalli's Textbook of Emergency Medicine[6]	Local infiltration, systemic, and mentions regional/ field block	Yes	Yes, no endpoint recommended	Gentle packing	Not discussed	Advocates clinical judgment, generally not needed
Rakel Textbook of Family Medicine[7]	Ring or field block, lack of effectiveness of local anesthesia mentioned	Yes	Yes, no endpoint recommended	Gentle packing	Routine culture in immunocompetent patients not recommended	Not recommended
UpToDate[8]	Advocates local with field block/regional block	Yes	Yes, until all visible pus removed	Gentle packing for larger abscesses	Yes, for those receiving antibiotics	Discussed in separate article
NEJM[9]	Local, mentions field/ regional and systemic for comfort	Yes	Yes, until effluent is clear	Gentle packing	Optional	Based on community pathogens, generally not recommended
2011 IDSA Guidelines[10]	Not discussed	Yes	Not discussed	Not discussed	Useful in certain circumstances*	Recommended under certain circumstances†

I&D, incision and drainage; *NEJM*, New England Journal of Medicine; *IDSA*, Infectious Diseases Society of America.

* Patients treated with antibiotic therapy, patients with severe local infection or signs of systemic illness, and patients who have not responded adequately to initial treatment, or concern for a cluster or outbreak.

† Severe or extensive disease, rapid progression in presence of associated signs and symptoms of systemic illness–associated comorbidities or immunosuppression, extremes of age, abscess in an area difficult to drain (eg, face, hand, and genitalia), associated septic phlebitis, or lack of response to incision and drainage alone.

Pain Management

Overall, most respondents (76%) provided narcotics in addition to local anesthesia. There was no significant difference between midlevel providers and physicians providing oral or intravenous analgesia before incision and drainage (Table 2). Seventy-one percent of all responders administered local anesthetic over the roof of the abscess and 60% used a field block, with no significant difference between provider type.

Irrigation

As a group, ED providers were about equally likely to use irrigation versus no irrigation after incision and drainage: 48% versus 52%, respectively. Midlevel providers were significantly more likely to use irrigation than residents and attending physicians: 84% versus 45%, respectively, (Table 2). Of those who reported using irrigation, almost all (94%) used saline, 4% used tap water, and 1% used betadine. Additionally, of the providers using irrigation, most irrigated under high pressure (66%), with either a splash guard or angiocatheter, and 34% rinsed out the wound cavity without high pressure. There was no clear consensus on the amount of irrigation to use. Forty-eight percent of irrigators used 50 cc or less, or enough to rinse out the wound until only irrigation fluid returned. Only 36% used 100 cc per centimeter of abscess size and 16% indicated there was no specific volume they routinely used.

Incision and Drainage/Packing/Follow-Up Instructions

The most common type of incision was linear among attending physicians (87%), residents (88%), and midlevel providers (56%). Elliptical incisions were less common for attending physicians (7%), residents (7%), and midlevel providers (36%). Cruciate incisions were rarely reported (6%). No providers indicated that they used needle aspiration as treatment of abscesses.

Most providers used packing in the wound cavity (91%) and this was consistent for attending physicians (94%), residents (86%), and midlevel providers (100%). Seventy-five percent of all providers filled the wound with packing, while 24% used only a small wick to keep the cavity open. Patients were instructed to return in 24 hours by 15% of providers, at 48 hours by 32% of providers, and at "48 hours unless wound is concerning and needs closer evaluation" by 47% of providers.

Table 2. Reported routine management of abscess by provider type.

Abscess management	Midlevel provider, % (n = 26)	Physician, % (n = 324)	OR (95% CI)
IV narcotics	92	74	4.01 (0.925–17.365)
Irrigation	84	45	6.33 (2.125–18.852)
Antibiotics	33	15	2.65 (1.085–6.479)
Wound cultures	86	28	16.11 (4.154–55.759)
Packing*	100	90	

CI, confidence interval; *IV*, intravenous; *OR*, odds ratio.

* OR not estimable; the 2 proportions (physician: 0.90, midlevel: 1.0) were not significantly different ($P = 0.10$; 95% CI, −0.137 to 0.058).

Culture/Antibiotic Use

Most providers (68%) do not routinely culture the wound cavity. There were significantly more midlevel providers who routinely ordered wound cultures than attending physicians and residents: 86% versus 28%, respectively, (Table 2), The routine use of antibiotics after every incision and drainage in healthy patients with uncomplicated abscesses was rare (17%). Antibiotics were reserved for use if the patient was diabetic or immunocompromised (58%), had a history of MRSA (24%), or surrounding cellulitis (74%).

If antibiotics were used, 33% of all providers used trimethoprim-sulfamethaxole alone, 8% used cephalexin alone, 8% used clindamycin alone, and 47% used a combination of 2 or more drugs for MRSA and *Streptococcus* coverage. Midlevel providers were more likely to use a combination of 2 different antibiotics. Virtually all respondents (99%) allowed wounds to heal by secondary intention rather than primary closure after incision and drainage (drainage followed by immediate suture repair).

DISCUSSION

Most texts and guidelines suggest incision and drainage as the treatment for uncomplicated superficial cutaneous abscesses; however, there is no standard definition of the procedure and little evidence to support the additional steps involved. This survey is unique in that it evaluated previously unaddressed issues including use of pain control, irrigation, wound cultures, and packing. Significant variation exists with regard to the management of cutaneous abscesses. Our study attempted to describe variability in clinical practice to establish a basic understanding of the current management of emergency providers nationwide and compare management strategies to existing guidelines.

Incision and drainage has been considered to be one of the more painful procedures performed in the ED, second only to nasogastric tube insertion.[12] Providing adequate pain management is a challenge, as the lower pH of the infected tissue reduces the effectiveness of local anesthetic. Our study demonstrated that most providers treat pain associated with I&D with local lidocaine and often with additional oral or intravenous narcotics. Although most references recommend at least local anesthesia, there is some discrepancy regarding the need for additional systemic pain management.[4–10] The difference in abscess size, location, and patient's pain threshold may account for this variability in practice. No randomized controlled trials to date have compared the effectiveness in pain reduction of these various techniques, and additional research

in this area will likely yield improved patient care and satisfaction.

Irrigation, though recommended by most textbooks and cited guidelines,[4–10] is routinely done by only about half of respondents. There is little consensus on the type and volume of fluid that should be used to irrigate the cavity. Although 1 single-site study found that physician assistants were less likely to use irrigation than attending physicians and residents, our study demonstrated the opposite.[11] In fact, less than half of the physicians surveyed routinely used irrigation after I&D, compared with 84% of midlevel providers. This is possibly because of the additional time required to irrigate, the undesired effect of purulent discharge splashing under high pressure, and lack of evidence to support its routine use. No randomized controlled trials have investigated the theoretical benefit of reducing the bacterial load in abscesses through copious irrigation.

Most texts and guidelines recommend a wide incision and often cite insufficient drainage as the cause of treatment failure. Continuing the incision over the entire length of the abscess theoretically allows for adequate room to probe loculations, facilitates subsequent packing changes, and allows for adequate drainage. However, a recent study in a pediatric population calls this standard practice into question. In a study with 115 patients, using 2 small incisions (4–5 mm) far apart on the abscess and a loop drain tied on top of the skin, the success rate was 94.5%, as measured by need for additional intervention.[13] Large incisions produce large scars, and cosmetic outcome may be an important factor for patient satisfaction. Although it has not been studied in ED patients, primary closure has been used in the operating room under general anesthesia and has been shown to reduce cost, reduce time for wound healing, and improve cosmetic appearance.[14–16] Although no studies have compared outcome with incision type, needle aspiration alone is commonly associated with higher rates of treatment failure.[17] Our study demonstrates that most providers use linear incisions and very few perform needle aspirations unless it is used diagnostically to determine if a lesion contains purulent discharge. Primary closure of abscess cavities was rarely reported.

The use of gentle packing is generally recommended by current guidelines to prevent premature wound closure and allow continuous drainage after I&D.[9] However, the theory behind wound packing is based on consensus guidelines rather than evidence-based data and is performed at the discretion of the provider.[18] Furthermore, a small pilot study challenged this mantra by demonstrating that packing may cause increased pain and is not associated with improved outcome.[19] Our study demonstrated that almost all providers routinely used packing and frequent wound repacking visits despite the lack of supporting evidence and increased pain and inconvenience to the patient. Further randomized controlled trials are needed to determine the effects of packing on clinical outcomes.

Although the 2011 Infectious Diseases Society of America guidelines recommend wound cultures in certain circumstances, the routine use of wound cultures in uncomplicated abscesses in otherwise healthy individuals is often unnecessary in the ED.[20] While the prevalence of MRSA is variable geographically, it has become the most common cause of skin and soft tissue infections and is often treated empirically. Our study reflects the fact that although most physicians do not routinely order wound cultures, many midlevel providers still attempt to identify an organism. Wound cultures are costly and results are neither available immediately nor likely to change management. Although cultures may be needed in some instances, it is unclear why this was more routine practice among midlevel providers.[10]

Perhaps the most surprising result of our study is that only 17% of providers indicated that they routinely give oral antibiotics after I&D. While this practice follows guidelines (Clinical Infectious Disease, Center of Disease Control), textbooks,[4–10] and recommendations from recent studies,[21,22] it is significantly less than the antibiotic use of 53% to 80% reported in previous studies.[1,11] This survey suggests that physicians are perhaps now reserving the routine use of antibiotics for specific cases. Most providers stated that they would select antibiotics with MRSA coverage, but would not routinely prescribe them unless there were certain risk factors such as a history of MRSA, immunodeficiency, or surrounding cellulitis. The variability in the number and types of antibiotic coverage may be influenced by local susceptibilities and desire to cover both MRSA and other bacteria.

As we continue to improve our practice as emergency care providers and move toward more evidence-based care, many of these practices will likely be challenged, and perhaps what has been "standard" will be replaced by less invasive, less painful, and more effective treatment of even our most routine patient presentations.

LIMITATIONS

The study was limited by its survey design, predominantly closed-answer format and sampling strategy. Some of the survey questions were not stratified by patient or wound factors and it is possible that provider management may vary on the basis of specific variables (ie, abscess location) that were not queried. The survey relies on self-reported practices and thus, the accuracy of actual practice patterns cannot be assured. Attempts were made to include various practice settings nationwide, but the sampling technique introduces some selection bias. While the response rate of 74% is higher than that of most survey studies,[23,24] the 26% who did not respond may also represent a source of selection bias.

CONCLUSION

Current guidelines recommend incision and drainage without defining a standard treatment method. This study shows a large variation of practice patterns for the management

of uncomplicated superficial abscesses in the ED. Despite this variability in clinical practice, certain trends were identified. Most providers used oral or intravenous analgesia in addition to local anesthetic, linear incisions, and packing. Most physicians did not use irrigation, order wound cultures, or routinely prescribe oral antibiotics unless specific risk factors or physical signs were present. Further research into ideal management of uncomplicated superficial abscesses is needed to create evidence-based guidelines and optimize treatment in the ED.

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REFERENCES

1. Moran GJ, Krishnadasan A, Gorwitz RJ, et al. Methicillin-resistant *S. aureus* infections among patients in the emergency department. *N Engl J Med*. 2006;355:666–674.
2. Pallin DJ, Egan DJ, Pelletier AJ, et al. Increased US emergency department visits for skin and soft tissue infections, and changes in antibiotic choices during the emergence of community-acquired methicillin-resistant *Staphylococcus aureus*. *Ann Emerg Med*. 2008;51: 291–298.
3. Woolard R, Degutis LC, Mello M, et al. Public health in the emergency department: surveillance, screening, and intervention—funding and sustainability. *Acad Emerg Med*. 2009;16:1138–1142.
4. Butler K. Incision and drainage. In: Roberts J, Hedges J, eds. *Clinical Procedures in Emergency Medicine*. 5th ed. Philadelphia, PA: Elsevier, Inc; 2010:657–691.
5. Meislin H, Guisto J. Soft tissue infections, simple cutaneous abscesses. In: Marks J, Hockberger R, Walls R, eds. *Rosen's Emergency Medicine: Concepts and Clinical Practice*. 7th ed. Philadelphia, PA: Mosby Elsevier, Inc; 2010:1836–1847.
6. Folstad S. Soft tissue infections. In: Tintinalli JE, Ruiz E, Krome RL, eds. *Emergency Medicine: A Comprehensive Study Guide*. 6th ed. New York, NY: McGraw-Hill; 2004:985–986.
7. Beard JM, Osborn J. Common office procedures. In: Rakel R, ed. *Textbook of Family Medicine*. 8th ed. Philadelphia, PA: Elsevier, Inc; 2011:564.
8. Kronfol R, Downey K. Technique of incision and drainage for skin abscess. *UpToDate* Web site. Available at: http://www.uptodate.com/contents/technique-of-incision-and-drainage-for-skin-abscess. Accessed December 30, 2010.
9. Hammond SP, Baden LR. Management of skin and soft-tissue infection—polling results. *New Engl J Med*. 2008;359:e20.
10. Liu C, Bayer A, Cosgrove S, et al. Clinical practice guidelines by the Infectious Diseases Society of America for the treatment of methicillin-resistant *Staphylococcus aureus* infections in adults and children. *Clin Infect Dis*. 2011;52:e18–55.
11. May L, Harter K, Yadav K, et al. Practice patterns and management strategies for purulent skin and soft-tissue infections in an urban academic ED [published online ahead of print January 27, 2011]. *Am J Emerg Med*. DOI: 10.1016/j.ajem.2010.11.033.
12. Singer AJ, Richman PB, Kowalkska A. Comparison of patient and practitioner assessments of pain from commonly performed emergency department procedures. *Ann Emerg Med*. 1999;33:652–658.
13. Freedman S, Sivabalasundaram V, Bohn V, et al. The treatment of pediatric gastroenteritis: A comparative analysis of pediatric emergency physicians' practice patterns. *Acad Emerg Med*. 2011;18:38–45.
14. Abraham N, Doudle M, Carson P. Open versus closed surgical treatment of abscesses: a controlled clinical trial. *Aust N Z J Surg*. 1997; 67:173–176.
15. Stewart MP, Laing MR, Krukowski ZH. Treatment of acute abscesses by incision, curettage and primary suture without antibiotics: a controlled clinical trial. *Br J Surg*. 1985;72:66–67.
16. Edino ST, Ihezue CH, Obekpaa PO. Outcome of primary closure of incised acute soft-tissue abscesses. *Niger Postgrad Med J*. 2001;8:32–36.
17. Gaspari RJ, Resop D, Mendoza M, et al. A randomized controlled trial of incision and drainage versus ultrasonographically guided needle aspiration for skin abscesses and the effect of methicillin-resistant *Staphylococcus aureus*. *Ann Emerg Med*. 2011;57:483–491.
18. Stevens DL, Bisno AL, Chambers HF, et al. Practice guidelines for the diagnosis and management of skin and soft-tissue infections. *Clin Infect Dis*. 2005;41:1373–1406.
19. Gerald F, Dominici P, Giraldo P, et al. Routine packing of simple cutaneous abscesses is painful and probably unnecessary. *Acad Emerg Med*. 2008;16:470–473.
20. Schmitz G. How do you treat an abscess in the era of increased community associated methicillin-resistant *Staphylococcus aureus* (MRSA)? *J Emerg Med*. 2011;41:276–281.
21. Schmitz GR, Bruner D, Pitotti R, et al. Randomized controlled trial of trimethoprim-sulfamethoxazole for uncomplicated skin abscesses in patients at risk for community-associated methicillin-resistant *Staphylococcus aureus* infection. *Ann Emerg Med*. 2010;56:283–287.
22. Duong MD, Markwell S, Peter J, et al. Randomized, controlled trial of antibiotics in the management of community-acquired skin abscesses in the pediatric patient. *Ann Emerg Med*. 2010;55:401–407.
23. Asch D, Jedrziewski K, Christakis N. Response rates to surveys published in medical journals. *J Clin Epidemiol*. 1997;10:1229–1236.
24. Cummings S, Savitz L, Konrad T. Reported response rates to mailed physician questionnaires. *Health Serv Res*. 2001;35:1347–1355.

Variation in Specialists' Reported Hospitalization Practices of Children Sustaining Blunt Head Trauma

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Introduction: Questions surround the appropriate emergency department (ED) disposition of children who have sustained blunt head trauma (BHT). Our objective was to identify physician disposition preferences of children with blunt head trauma (BHT) and varying computed tomography (CT) findings.

Methods: We surveyed pediatric and general emergency physicians (EP), pediatric neurosurgeons (PNSurg), general neurosurgeons (GNSurg), pediatric surgeons (PSurg) and trauma surgeons regarding care of two hypothetical patients: Case 1: a 9-year-old who fell 10 feet and Case 2: an 11-month-old who fell 5 feet. We presented various CT findings and asked physicians about disposition preferences. We evaluated predictors of patient discharge using multivariable regression analysis adjusting for hospital and ED characteristics and clinician experience. Pediatric EPs served as the reference group.

Results: Of 2,341 eligible surveyed, 715 (31%) responded. Most would discharge children with linear skull fractures (Case 1, 71%; Case 2, 62%). Neurosurgeons were more likely to discharge children with small subarachnoid hemorrhages (Case 1 PNSurg OR 6.87, 95% CI 3.60, 13.10; GNSurg OR 6.54, 95% CI 2.38, 17.98; Case 2 PNSurg OR 5.38, 95% CI 2.64, 10.99; GNSurg OR 6.07, 95% CI 2.08, 17.76). PSurg were least likely to discharge children with any CT finding, even linear skull fractures (Case 1 OR 0.14, 95% CI 0.08, 0.23; Case 2 OR 0.18, 95% CI 0.11, 0.30). Few respondents (<6%) would discharge children with small intraventricular, subdural, or epidural bleeds.

Conclusion: Substantial variation exists between specialties in reported hospitalization practices of neurologically-normal children with BHT and traumatic CT findings. [West J Emerg Med. 2013;14(1):29-36.]

INTRODUCTION

Traumatic brain injury (TBI) is a leading cause of death in children older than 1 year of age and a significant cause of morbidity. Between 2002 and 2006 the estimated annual number of TBIs in children less than 15 years of age in the U.S. was approximately 511,000, including approximately 2,200 deaths, 35,000 hospitalizations, and 474,000 emergency department (ED) visits.[1] Cranial computed tomography (CT) is the diagnostic test of choice for evaluating children with blunt head trauma in the ED. Fewer than 10% of these CTs, however, are diagnostic of TBI.[2-9] Furthermore, the implications of small traumatic findings on CT are not clear.[10-12] Therefore, CT should ideally be selectively used with the goal of identifying clinically-important findings.

Several large studies have suggested that the presence or absence of certain clinical signs and symptoms are predictive of a TBI requiring acute intervention, such as hospitalization, neurological surgery, or on-going anti-epileptic pharmacotherapy.[3, 8, 9, 13,14] Studies such as these have caused investigators to question the necessity of identifying children with TBIs that are not clinically important.[10, 11] With newer generation helical CT scanners, TBIs not identified

Table 1. Characteristics of survey respondents.

Demographic	n=636	%
Physician characteristics		
Practice specialty		
Pediatric emergency medicine	336	47
General emergency medicine	161	22
Pediatric neurosurgery	58	8
General neurosurgery	21	3
Pediatric surgery	76	11
Trauma surgery	48	7
Other	15	2
Years in practice		
0-5 years	173	24
6-10 years	167	24
11-15 years	144	20
> 15 years	231	32
Percentage of patients that are children		
0-10%	83	12
11%-30%	151	21
31%-50%	25	3
51%-95%	51	7
> 95%	405	57
Hospital characteristics		
Annual ED pediatric volume		
< 20,000	166	23
20,000-40,000	190	27
40,000-60,000	177	25
> 60,000	182	25
Practice setting*		
Children's hospital	416	58
General hospital	220	31
Private hospital	143	20
Academic hospital	481	67
Geographic location		
Urban (> 50,000 pop)	651	91
Non-urban (< 50,000 pop)	64	9

ED, emergency department
*Total greater than 100% as some respondents indicated multiple practice settings

20 years ago are now being more readily visualized. Furthermore, with more sensitive neuroimaging tools, such as magnetic resonance imaging (MRI) and single-photon emission computed tomography (SPECT) brain perfusion imaging, TBIs not visible on cranial CT are also being identified.[15,16] Considering this rapid pace of technological developments in neuroimaging, future modalities will likely identify even smaller, more subtle TBIs, and challenge current neuroimaging decision rules that focus on TBI identified on cranial CT.

Current clinical practice patterns result in a number of neurologically-normal children with small TBIs undergoing cranial CT and hospitalization for observation despite the lack of need for acute intervention.[3, 9] The potential inefficiency in this practice prompted us to seek the opinion of specialists on what constitutes a clinically-significant TBI on CT scan for the purposes of hospitalization and acute management. Our objective was to identify variations and factors associated with ED disposition of neurologically-normal children with blunt head trauma and different traumatic cranial CT findings. We hypothesized that substantial variation in practice exists among physicians caring for neurologically-normal children with TBIs on CT and that factors associated with this variation can be identified.

METHODS

Study Design and Population

We surveyed by electronic and regular mail, physicians caring for children with blunt head trauma practicing in all U.S. pediatric Level I and Level II trauma centers, children's hospitals, and trauma centers with a pediatric commitment between July 2006 and May 2007. We compiled a mailing list from information obtained through the American College of Surgeons (ACS), the National Association of Children's Hospitals and Related Institutions (NACHRI), and websites of verified ACS and NACHRI member institutions. We surveyed all physicians trained in pediatric emergency medicine (PEM),

Table 2. Overall emergency department discharge rates by isolated cranial computed tomography (CT) finding.

CT finding	Case 1	Case 2
Linear nondisplaced skull fracture	71%	62%
Diastatic (widened) skull fracture	26%	22%
Depressed skull fracture	19%	17%
Basilar skull fracture	23%	17%
Pneumocephalus	9%	7%
Small intracerebral hemorrhage	10%	6%
Small subarachnoid hemorrhage	9%	7%
Small intraventricular hemorrhage	4%	3%
Subdural hematoma	6%	4%
Epidural hematoma	2%	2%

general emergency medicine (GEM), pediatric neurosurgery (PNSurg), general neurosurgery (GNSurg), pediatric surgery (PSurg) and trauma surgery (TSurg) practicing in these centers identified by the methods listed above. The local institutional review committee approved this study.

Survey Content and Administration

In the survey we presented case studies of 2 hypothetical neurologically-normal children with blunt head trauma: Case 1, a 9-year-old boy who fell 10 feet from a tree landing on dirt with unknown history of loss of consciousness; and Case 2, an 11-month-old girl crying vigorously and attempting to crawl after falling 5 feet from the sibling's bunk bed with an unknown history of loss of consciousness. Both patients were further described as being asymptomatic and having normal neurological examinations after 4 hours of ED observation. Survey participants were asked whether they would be willing to discharge the patients home to reliable parents with good follow up, given any of the following 10 differing *isolated*, traumatic cranial CT findings: linear nondisplaced skull fracture, diastatic (widened) skull fracture, depressed skull fracture (less than the table width of the skull), basilar skull fracture, pneumocephalus, very small subarachnoid hemorrhage, very small intraventricular hemorrhage, subdural hematoma without midline shift, epidural hematoma without midline shift, and small intracerebral hemorrhage. The survey instrument also included 7 items pertaining to participants' demographic characteristics.

We contacted participants via electronic mail in July 2006 and invited them to participate in the web-based survey. Each participant was provided with a hyperlink text to gain access to the questionnaire. For physicians with undeliverable e-mail addresses, we sent the survey via U.S. Postal Service in August 2006. Non-responders to the initial e-mail survey were sent a second e-mail request for participation in September 2006 with the survey attached as an electronic PDF document. We sent physicians who did not respond to the web-based or electronic surveys a cover letter and survey by U.S. Postal Service in December 2006. A final mailing to non-responders was distributed by U.S. Postal Service in February 2007.

Data Analysis

We entered data into a Microsoft Access database (Microsoft Corp., Redmond, WA) and analyzed it using

Table 3. Case 1 emergency department discharge rates by practice specialty.

	PEM (n=336)	GEM (n=161)	PNSG (n=58)	GNSG (n=21)	PS (n=76)	TS (n=48)
†Linear nondisplaced skull fracture***	86%	63%	64%	55%	39%	55%
‡Diastatic (widened) skull fracture***	33%	16%	29%	29%	12%	26%
§Depressed skull fracture**	25%	14%	22%	29%	5%	15%
‖Basilar skull fracture***	28%	22%	33%	33%	0%	11%
¶Pneumocephalus*	10%	8%	16%	20%	1%	4%
††Small intracerebral hemorrhage***	9%	11%	21%	33%	2%	2%
‡‡Small subarachnoid hemorrhage***	7%	6%	31%	30%	1%	6%
§§Small intraventricular hemorrhage**	5%	2%	10%	20%	1%	2%
Subdural hematoma	6%	6%	7%	15%	1%	2%
‖‖Epidural hematoma***	1%	1%	13%	7%	0%	2%

PEM, pediatric emergency medicine; *GEM*, general emergency medicine; *PNSG,* pediatric neurosurgery; *GNSG,* general neurosurgery; *PS*, pediatric surgery; *TS,* trauma surgery

Overall significant differences (by Chi-square test of homogeneity of proportions, with 5 degrees of freedom):

* $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$

Two-way significant differences (using Holm correction for Bonferroni multiple test procedure):

†PEM v. GEM, PNSG, GNSG, PS, and TS; GEM v. PS; PNSG v. PS

‡PEM v. GEM and PS

§PEM v. GEM and PS; PNSG v. PS; GNSG v. PS

‖PEM v. PS; GEM v. PS; PNSG v. PS; GNSG v. PS; PS v. TS

¶PNSG v. PS; GNSG v. PS

††PNSG v. PS; GNSG v. PS and TS

‡‡PEM v. PNSG and GNSG; GEM v. PNSG and GNSG; PNSG v. PS and TS; GNSG v. PS

§§GEM v. GNSG; GNSG v. PS

‖‖PEM v. PNSG; GEM v. PNSG

Table 4. Case 2 emergency department discharge rates by practice specialty.

	PEM (n=336)	GEM (n=161)	PNSG (n=58)	GNSG (n=21)	PS (n=76)	TS (n=48)
†Linear nondisplaced skull fracture***	78%	48%	60%	52%	37%	45%
‡Diastatic (widened) skull fracture***	29%	14%	29%	33%	7%	15%
§Depressed skull fracture***	23%	9%	26%	33%	4%	11%
‖Basilar skull fracture***	20%	13%	26%	29%	1%	15%
Pneumocephalus	9%	5%	11%	15%	1%	2%
¶Small intracerebral hemorrhage*	6%	5%	13%	20%	2%	2%
††Small subarachnoid hemorrhage***	6%	5%	23%	25%	3%	4%
‡‡Small intraventricular hemorrhage***	3%	1%	11%	15%	1%	2%
Subdural hematoma	5%	3%	9%	5%	1%	2%
Epidural hematoma	1%	2%	4%	0%	0%	2%

PEM, pediatric emergency medicine; *GEM*, general emergency medicine; *PNSG*, pediatric neurosurgery; *GNSG*, general neurosurgery; *PS*, pediatric surgery; *TS*, trauma surgery

Overall significant differences (by Chi-square test of homogeneity of proportions, with 5 degrees of freedom): * $P < 0.05$; *** $P < 0.001$

Two-way significant differences (using Holm correction for Bonferroni multiple test procedure):

†PEM v. GEM, PNSG, PS, and TS

‡PEM v. GEM and PS; PNSG v. PS; GNSG v. PS

§PEM v. GEM and PS; GEM v. PNSG and GNSG; PNSG v. PS; GNSG v. PS

‖PEM v. PS; PNSG v. PS; GNSG v. PS; PS v. TS

¶Signifcant on overall chi-square, but no pairwise significant differences.

††PEM v. PNSG and GNSG; GEM v. PNSG and GNSG; PNSG v. PS; GNSG v. PS

‡‡PEM v. PNSG and GNSG; GEM v. PNSG and GNSG

Stata/SE 8.2 for Windows (Version 8. StataCorp LP, College Station, TX). We assessed overall significant differences between practice specialties and disposition with chi-square tests. Post hoc testing was conducted using Holm's correction for Bonferroni multiple test procedure.[17] Because there were so few (15) surveys returned from practitioners in the "other" practice specialty group, we removed these from further analysis. We then performed backward stepwise multivariable logistic regression to examine the impact of physician characteristics (practice specialty, years in practice, and percentage of patients in their practices who are children) and hospital characteristics (annual ED pediatric patient volume, practice setting, and geographic location) on disposition decision-making for each hypothetical patient with any of the 10 cranial CT findings. Pediatric EPs, > 15 years of practice, and > 95% pediatric patients were selected as reference standards for data analysis because they were the most populous subgroups. We also selected pediatric ED volume of > 60,000 as the reference standard group, as the frequency of all ED volume categories were nearly equivalent. Results are presented with odds ratios (OR) with 95% confidence intervals (CI).

RESULTS

We distributed 2,799 surveys. Three hundred sixty-seven were ultimately undeliverable. Ninety-one respondents were ineligible to participate in the survey (90 did not care for children younger than 18 years with trauma and one was a nurse practitioner). In total, 715 (31%) of 2,341 eligible participants responded to the survey. Response rates within subspecialty were pediatric emergency medicine 336/878 (38%), general emergency medicine 161/645 (25%), pediatric neurosurgery 58/135 (43%), general neurosurgery 21/203 (10%), pediatric surgery 76/387 (20%), and trauma surgery 48/93 (52%).

Physician and hospital characteristics of respondents are shown in Table 1. Nearly one-half of all participants specialize in PEM. One-third have more than 15 years of practice experience. Most respondents care almost exclusively for pediatric patients. Participants were evenly distributed across the 4 categories representing annual pediatric patient volume. Most respondents practice in urban areas.

Overall patient discharge rates by isolated CT finding for Case 1 and Case 2 are shown in Table 2. Most respondents would discharge patients having isolated linear, non-displaced skull fractures. Up to 1 quarter of respondents would discharge patients with diastatic (widened) skull fractures, depressed skull fractures, or basilar skull fractures. Few respondents would discharge patients with pneumocephalus, small intracerebral hemorrhage, subarachnoid or very small intraventricular hemorrhages, subdural or epidural hematomas. Discharge rates by practice specialty for both cases are reported in Tables 3 and 4.

The statistically significant results of the multivariable analyses for the 2 cases are shown in Tables 5 and 6, respectively. Pediatric surgeons were least likely to discharge

Table 5. Case 1 physician and hospital predictors of patient discharge on multivariate analysis.

	Odds ratios (95% confidence intervals)									
	Linear nondisplaced skull fracture	Diastatic (widened) skull fracture	Depressed skull fracture	Basilar skull fracture	Pneumo-cephalus	Small intracerebral hemorrhage	Small subarachnoid hemorrhage	Small intraventricular hemorrhage	Subdural hematoma	Epidural hematoma
Practice specialty										
Pediatric EM	ref	ref	ref	ref	ref	ref	ref	ref	ref	ref
General EM	ns	0.41 (0.26,0.65)	ns	ns	ns	ns	ns	ns	ns	ns
Pediatric neurosurgery	0.41 (0.22,0.75)	ns	ns	ns	ns	2.53 (1.17,5.48)	6.87 (3.60,13.10)	ns	ns	9.31 (2.99,28.96)
General neurosurgery	ns	ns	ns	ns	ns	5.95 (1.88,18.85)	6.54 (2.38,17.98)	ns	ns	ns
Pediatric surgery	0.14 (0.08,0.23)	0.32 (0.16, 0.62)	0.25 (0.11,0.60)	ns	0.09 (0.01,0.67)	0.13 (0.02,0.97)	ns	ns	ns	ns
Trauma surgery	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
Years in practice										
0-5 years	ns	ns	0.52 (0.32,0.86)	0.58 (0.37,0.92)	ns	ns	ns	ns	ns	ns
6-10 years	ns	ns	ns	ns	2.26 (1.31,3.91)	ns	ns	ns	ns	ns
11-15 years	1.83 (1.13,2.95)	ns	ns	ns	ns	ns	ns	ns	ns	ns
> 15 years	ref	ref	ref	ref	ref	ref	ref	ref	ref	ref
Percentage of patients who are children										
0-10%	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
11%-30%	ns	ns	0.57 (0.35,0.94)	ns	ns	ns	ns	ns	ns	ns
31%-50%	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
51%-95%	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
> 95%	ref	ref	ref	ref	ref	ref	ref	ref	ref	ref
Annual ED peds volume										
< 20,000	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
20,000-40,000	ns	ns	ns	ns	0.45 (0.22,0.91)	0.45 (0.21,0.96)	ns	ns	ns	ns
40,000-60,000	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
> 60,000	ref	ref	ref	ref	ref	ref	ref	ref	ref	ref
Practice setting										
Children's hospital	3.11 (2.10,4.59)	ns	ns	ns	ns	ns	ns	ns	ns	ns
General hospital	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
Private hospital	ns	ns	2.04 (1.31,3.18)	ns	ns	ns	ns	ns	ns	ns
Academic hospital	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
Geographic location										
Urban (> 50,000 pop)	ns	ns	ns	2.22 (1.02,4.81)	ns	ns	ns	ns	ns	ns

EM, emergency medicine; *ns,* not significant; *ref,* reference group

Table 6. Case 2 physician and hospital predictors of patient discharge on multivariate analysis.

	Odds ratios (95% confidence intervals)									
	Linear nondisplaced skull fracture	Diastatic (widened) skull fracture	Depressed skull fracture	Basilar skull fracture	Pneumo-cephalus	Small intracerebral hemorrhage	Small subarachnoid hemorrhage	Small intraventricular hemorrhage	Subdural hematoma	Epidural hematoma
Practice specialty										
Pediatric EM	ref	ref	ref	ref	ref	ref	ref	ref	ref	ref
General EM	ns	ns	0.33 (0.18,0.58)	0.54 (0.32,0.90)	ns	ns	ns	ns	ns	ns
Pediatric neurosurgery	0.55 (0.30,1.00)	ns	ns	ns	ns	ns	5.38 (2.64,10.99)	4.39 (1.64,11.74)	ns	ns
General neurosurgery	ns	ns	ns	ns	ns	ns	6.07 (2.08,17.76)	ns	ns	ns
Pediatric surgery	0.18 (0.11,0.30)	0.24 (0.11,0.54)	0.21 (0.08,0.55)	0.04 (0.01,0.31)	ns	ns	ns	ns	ns	ns
Trauma surgery	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
Years in practice										
0-5 years	ns	0.55 (0.34,0.87)	0.34 (0.19,0.61)	0.58 (0.35,0.98)	ns	ns	ns	ns	ns	ns
6-10 years	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
11-15 years	1.70 (1.10,2.63)	ns	ns	ns	ns	ns	ns	ns	ns	ns
>15 years	ref	ref	ref	ref	ref	ref	ref	ref	ref	ref
Percentage of patients who are children										
0-10%	0.20 (0.12,0.35)	ns	ns	ns	ns	ns	ns	ns	ns	ns
11%-30%	0.22 (0.14,0.34)	ns	ns	ns	ns	ns	ns	ns	ns	ns
31%-50%	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
51%-95%	ns	1.89 (1.00,3.54)	ns	ns	ns	ns	ns	ns	ns	ns
>95%	ref	ref	ref	ref	ref	ref	ref	ref	ref	ref
Annual ED peds volume										
<20,000	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
20,000-40,000	0.57 (0.38,0.85)	ns	ns	ns	ns	ns	ns	ns	0.20 (0.05,0.87)	ns
40,000-60,000	0.61 (0.39,0.95)	ns	ns	ns	ns	ns	ns	ns	ns	ns
>60,000	ref	ref	ref	ref	ref	ref	ref	ref	ref	ref
Practice setting										
Children's hospital	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
General hospital	ns	0.47 (0.30,0.73)	ns	ns	ns	ns	ns	ns	ns	ns
Private hospital	ns	ns	1.87 (1.17,2.99)	ns	ns	ns	ns	ns	ns	ns
Academic hospital	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
Geographic location										
Urban (>50,000 pop)	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns

EM, emergency medicine; *ns*, not significant; *ref*, reference group.

either patient with various types of skull fractures, and physicians working in children's hospitals were more likely to discharge Case 1 with a linear skull fracture. In both cases, pediatric neurosurgeons and general neurosurgeons were more likely to discharge patients with small subarachnoid hemorrhages, and for Case 1, they were more likely to discharge patients with small intracerebral hemorrhages. Of note, pediatric neurosurgeons were also substantially more likely to discharge Case 1 with a small epidural hematoma. In general, physicians with fewer than 5 years of experience also had a lower odds ratio of patient discharge with several of the CT findings.

DISCUSSION

Management of children with minor head trauma remains controversial, and there is no clear standard of care. Not only is there debate on which children require imaging, but the appropriate subsequent disposition of these children once the CT results are known is also unclear as there are no specific guidelines. In our survey of specialists caring for these children, we found substantial variation in the reported hospitalization practices of neurologically-normal children with traumatic findings on cranial CT following blunt head trauma, despite the fact that many TBIs identified on CT do not need acute intervention.[8,9,18-20] In fact, TBIs needing neurosurgery in children with Glasgow Coma Scale scores of 14-15 are very uncommon.[3,5,8,9] If medical or surgical intervention is not needed, hospitalization may in fact not be necessary, assuming the neurologically-normal child has reliable parents, no suspicion of inflicted injuries (i.e., abuse) and acceptable follow-up.

In the case scenarios presented, while almost two-thirds of the specialists would discharge patients with a linear skull fracture, a substantial number indicated that they would still admit these children for inpatient observation. Several previous studies have suggested that neither an isolated linear skull fracture nor a basilar skull fracture is, by itself, an indication for hospital admission.[21,22] Children with isolated skull fractures in the study by Beaudin et al[23] were discharged from the ED or the pediatric ward without complications and could have easily been managed at home after a period of ED observation.

All surveyed specialty groups reported that they were less likely to discharge patients with intracranial hemorrhages (subarachnoid, intraventricular, subdural, epidural or intracerebral hemorrhages) as opposed to those with isolated skull fractures. Although the reasons for this were not elicited in this study, it is known that certain regions of the brain, especially the medial temporal lobe and the posterior fossa, tolerate mass effect poorly. Potential concern for enlargement of even small hemorrhages in the subacute phase of injury probably influences the decision to admit these patients for observation. Interestingly, pediatric EPs were the most likely of all the specialties to discharge patients with traumatic findings on cranial CT from the ED. Neurosurgeons also indicated their willingness to discharge patients with certain CT findings. In previous research, neurosurgeons have suggested that neurosurgical consultation is not necessary in patients with minor TBI findings and normal neurologic status.[24]

LIMITATIONS

The study has several limitations. We achieved a 31% response rate to our survey. While this compares favorably to many recent surveys, it is unclear to what degree the practice patterns of non-respondents may have differed from those that responded.[25-27] We also cannot be certain that the responses to the hypothetical cases reflect the actual practice patterns of those caring for children with blunt head trauma. Respondents may be more willing to discharge home a theoretical patient than an actual patient. We also surveyed only those specialists working in major pediatric trauma centers and children's hospitals because we assumed that they care for a large portion of these types of patients and considered these clinicians to be the most knowledgeable about this issue. It is possible that there are other clinicians who care for children with these injuries that did not have the opportunity to respond to our survey, and their practice patterns may differ.

CONCLUSION

Substantial variation exists between specialties in reported hospitalization practices of neurologically-normal children with blunt head trauma and traumatic cranial CT findings. Pediatric neurosurgeons and general neurosurgeons are more willing to discharge patients than are pediatric surgeons, and other important specialty differences are evident as well. Better evidence is needed to guide disposition decision-making in neurologically-normal children with minor, traumatic cranial CT findings.

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REFERENCES

1. Faul M, Xu L, Wald MW, et al. Traumatic brain injury in the united states: emergency department visits, hospitalization and deaths, 2002-2006. Atlanta (GA): Centers for Disease Control and Prevention, National Center for Injury Prevention and Control; 2010.
2. Homer CJ, Kleinman L. Technical report: minor head injury in children. *Pediatrics*. 1999; 104:e78.
3. Palchak MJ, Holmes JF, Vance CW, et al. A decision rule for identifying

children at low risk for brain injuries after blunt head trauma. *Ann Emerg Med*. 2003; 42:492-506.
4. Schunk JE, Rodgerson JD, Woodward GA. The utility of head computed tomographic scanning in pediatric patients with normal neurologic examination in the emergency department. *Pediatr Emerg Care*. 1996; 12:160-5.
5. Quayle KS, Jaffe DM, Kuppermann N, et al. Diagnostic testing for acute head injury in children: when are head computed tomography and skull radiographs indicated? *Pediatrics*. 1997; 99:e11.
6. Gruskin KD, Schutzman SA. Head trauma in children younger than 2 years: are there predictors for complications? *Arch Pediatr Adolesc Med*. 1999; 153:15-20.
7. Greenes DS, Schutzman SA. Clinical indicators of intracranial injury in head-injured infants. *Pediatrics*. 1999; 104:861-7.
8. Osmond MH, Klassen TP, Wells GA, et al. Catch: a clinical decision rule for the use of computed tomography in children with minor head injury. *CMAJ*. 2010; 182:341-8.
9. Kuppermann N, Holmes JF, Dayan PS, et al. Identification of children at very low risk of clinically-important brain injuries after head trauma: a prospective cohort study. *Lancet*. 2009; 374:1160-70.
10. Oman JA, Cooper RJ, Holmes JF, et al. Performance of a decision rule to predict need for computed tomography among children with blunt head trauma. *Pediatrics*. 2006; 117:e238-46.
11. Atzema C, Mower WR, Hoffman JR, et al. Defining "clinically unimportant" ct findings in patients with blunt head trauma. *Acad Emerg Med*. 2002; 9:451.
12. Atzema C, Mower WR, Hoffman JR, et al. Defining "therapeutically inconsequential" head computed tomographic findings in patients with blunt head trauma. *Ann Emerg Med*. 2004; 44:47-56.
13. Haydel MJ, Shembekar AD. Prediction of intracranial injury in children aged five years and older with loss of consciousness after minor head injury due to nontrivial mechanisms. *Ann Emerg Med*. 2003; 42:507-14.
14. Dunning J, Daly JP, Lomas JP, et al. Derivation of the children's head injury algorithm for the prediction of important clinical events decision rule for head injury in children. *Arch Dis Child*. 2006; 91:885-91.
15. Belanger HG, Vanderploeg RD, Curtiss G, et al. Recent neuroimaging techniques in mild traumatic brain injury. *J Neuropsychiatry Clin Neurosci*. 2007; 19:5-20.
16. Wilde EA, McCauley SR, Hunter JV, et al. Diffusion tensor imaging of acute mild traumatic brain injury in adolescents. *Neurology*. 2008; 70:948-55.
17. Holm S. A simple sequentially rejective multiple test procedure. *Scand J Statist*. 1979; 6:65-70.
18. Jeret JS, Mandell M, Anziska B, et al. Clinical predictors of abnormality disclosed by computed tomography after mild head trauma. *Neurosurgery*. 1993; 32:9-16.
19. Miller EC, Holmes JF, Derlet RW. Utilizing clinical factors to reduce head ct scan ordering for minor head trauma patients. *J Emerg Med*. 1997; 15:453-7.
20. Dunham CM, Coates S, Cooper C. Compelling evidence for discretionary brain computed tomographic imaging in those patients with mild cognitive impairment after blunt trauma. *J Trauma*. 1996; 41:679-86.
21. Kadish HA, Schunk JE. Pediatric basilar skull fracture: do children with normal neurologic findings and no intracranial injury require hospitalization? *Ann Emerg Med*. 1995; 26:37-41.
22. Greenes DS, Schutzman SA. Infants with isolated skull fracture: what are their clinical characteristics, and do they require hospitalization? *Ann Emerg Med*. 1997; 30:253-9.
23. Beaudin M, Saint-Vil D, Ouimet A, et al. Clinical algorithm and resource use in the management of children with minor head trauma. *Journal of Pediatric Surgery*. 2007; 42:849-52.
24. Huynh T, Jacobs D, Dix S. Utility of neurosurgical consultation for mild traumatic brain injury. *The American Surgeon*. 2006; 72:1162-7.
25. Kristal SL, Randall-Kristal KA, Thompson BM. The society for academic emergency medicine's 2004-2005 emergency medicine faculty salary and benefit survey. *Acad Emerg Med*. 2006; 13:548-58.
26. Thurman RJ, Katz E, Carter W, et al. Emergency medicine residency applicant perception of unethical recruiting practices and illegal questioning in the match. *Acad Emerg Med*. 2009; 16: 550-7.
27. Zonfrillo MR, Nelson KA, Durbin DR. Emergency physicians' knowledge and provision of child passenger safety information. *Acad Emerg Med*. 2011; 18:145-51.

Variation in Specialists' Reported Hospitalization Practices of Children Sustaining Blunt Abdominal Trauma

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Introduction: Children with blunt abdominal trauma (BAT) are often hospitalized despite no intervention. We identified factors associated with emergency department (ED) disposition of children with BAT and differing computed tomography (CT) findings.

Methods: We surveyed pediatric and general emergency physicians (EPs), pediatric and trauma surgeons regarding care of 2 hypothetical asymptomatic patients: a 9-year-old struck by a slow-moving car (Case 1) and an 11-month-old who fell 10 feet (Case 2). We presented various abdominal CT findings and asked physicians about disposition preferences. We evaluated predictors of patient discharge using multivariable regression analysis, adjusting for hospital and ED characteristics, and clinician experience. Pediatric EPs served as the reference group.

Results: Of 2,003 eligible surveyed, 636 (32%) responded. For normal CTs, 99% would discharge in Case 1 and 88% in Case 2. Prominent specialty differences included: for trace intraperitoneal fluid (TIF), 68% would discharge in Case 1 and 57% in Case 2. Patients with TIF were less likely to be discharged by pediatric surgeons (Case 1: OR 0.52, 95% CI 0.32, 0.82; Case 2: OR 0.49, 95% CI 0.30, 0.79). Patients with renal contusions were less likely to be discharged by pediatric surgeons (Case 1: OR 0.55, 95% CI 0.32, 0.95) and more likely by general EPs (Case 1: OR 1.83, 95% CI 1.25, 2.69; Case 2: OR 2.37, 95% CI 1.14, 4.89).

Conclusion: Substantial variation exists between specialties in reported hospitalization practices of asymptomatic children after abdominal trauma with minor CT findings. Better evidence is needed to guide disposition decisions. [West J Emerg Med. 2013;14(1):37-46.]

INTRODUCTION

Intra-abdominal injury (IAI) is a leading cause of morbidity and mortality in children older than 1 year of age. More than 600,000 children with blunt abdominal trauma are evaluated annually in United States (U.S.) emergency departments (EDs), many of whom undergo abdominal imaging. When abdominal imaging is performed after blunt trauma, computed tomography (CT) is the test of choice.[1,2] However, IAIs are identified in fewer than 20% of children imaged after blunt abdominal trauma.[3]

Controversy remains regarding disposition of the child after blunt traumatic injury. It remains unclear whether hospitalization is necessary when a minor IAI has been identified, as relatively few patients with IAIs require acute, specific therapy.[4,5] The great majority of children with solid organ injuries are managed non-operatively. For injuries

to the liver or spleen, non-operative success rates of 90% to 95% have been reported, and for isolated Grade I or II injuries to the solid organs, surgical interventions or blood transfusions are uncommon.[6]

To best develop and evaluate clinical decision rules for identifying "clinically important" IAIs for purposes of imaging and patient disposition, one needs to understand how various physician groups currently manage children with minor IAIs after blunt trauma. Furthermore, trauma care is optimized when the care provided is standardized based on scientific evidence.[7] Substantial variability in ED disposition of injured patients suggests an area of clinical inefficiency. Our objective was to identify: 1) variation in imaging and disposition decisions among clinicians who care for pediatric trauma patients; and 2) factors associated with disposition decisions of children with blunt abdominal trauma and differing abdominal CT findings. We suspected that substantial variation in practice patterns exists among physicians caring for children with normal abdominal examinations and minor IAIs on CT, and that factors associated with this variation can be identified. Specifically, we hypothesized that as a group, surgeons are more likely to hospitalize these children than are emergency physicians (EPs).

METHODS

Study Design and Population

We conducted a self-administered, electronic and paper mail survey of pediatric EPs, general EPs, pediatric surgeons, and trauma surgeons practicing in all U.S. pediatric Level I and Level II trauma centers, children's hospitals, and trauma centers with a pediatric commitment between July 2006 and May 2007. We identified these institutions and physicians using information obtained through the American College of Surgeons (ACS), the National Association of Children's Hospitals and Related Institutions (NACHRI), and from institutional websites of verified ACS and NACHRI members. Surveys were sent to the entire group of physicians identified. The local institutional review committee approved this study.

Survey Content and Administration

In our survey we asked about participants' demographic characteristics and then presented 2 hypothetical patient scenarios involving children with blunt abdominal trauma: Case 1, a 9-year-old girl struck by a car traveling 10 mph while riding her bicycle with laboratory measurements notable only for an elevated ALT level of 135 U/L; and Case 2, an 11-month-old boy who fell 10 feet from a balcony and landed in dirt with laboratory measurements notable only for microscopic hematuria of 25 rbc/hpf. Both patients were described as being otherwise asymptomatic and having normal abdominal examinations after 4 hours of ED observation. Survey participants were asked whether they would be willing to discharge the patients home to reliable parents with good follow up given any of the following 8 isolated abdominal CT findings: normal CT, trace intraperitoneal fluid, small splenic contusion, Grade 1 subcapsular splenic hematoma, small liver contusion,

Table 1. Characteristics of survey respondents.

Demographic	n=636	%
Physician characteristics		
Practice specialty		
Pediatric emergency medicine	336	53
General emergency medicine	161	25
Pediatric surgery	76	12
Trauma surgery	48	8
Other	15	2
Years in practice		
0-5 years	155	24
6-10 years	152	24
11-15 years	138	22
> 15 years	191	30
Percentage of patients that are children		
0-10%	67	11
11%-30%	138	22
31%-50%	22	3
51%-95%	41	6
> 95%	368	58
Hospital characteristics		
Annual ED pediatric volume		
< 20,000	147	23
20,000-40,000	169	27
40,000-60,000	157	25
> 60,000	163	26
Practice setting*		
Children's hospital	369	58
General hospital	201	32
Private hospital	129	20
Academic hospital	431	68
Geographic location		
Urban (> 50,000 pop)	575	90
Non-urban (< 50,000 pop)	61	10

ED, emergency department
*Total greater than 100% as some respondents indicated multiple practice settings

Table 2. Overall emergency department discharge rates by isolated abdominal computed tomography (CT) finding.

CT Finding	Case 1	Case 2
Normal CT	99%	88%
Trace intraperitoneal fluid	68%	57%
Small splenic contusion	25%	21%
Grade 1 subcapsular splenic hematoma	5%	5%
Small liver contusion	25%	19%
Grade 1 subcapsular liver hematoma	4%	3%
Intraparenchymal liver hematoma	7%	6%
Grade 1 renal contusion	37%	27%

Grade 1 subcapsular liver hematoma, intraparenchymal liver hematoma, and Grade 1 renal contusion.

Survey participants then were asked 2 general questions to assess their opinions regarding the diagnosis and management of children with blunt abdominal trauma: 1) "Should every child with a traumatic intra-abdominal injury identified by CT, no matter how small, be hospitalized even if no acute intervention is needed?" and 2) "Would you accept not identifying a traumatic intra-abdominal injury that would have appeared on CT (if a CT were obtained) in a well-appearing, verbal child if no acute intervention was necessary (e.g. blood transfusion, therapeutic embolization, laparotomy, or IV fluids)?".

Participants initially were contacted by electronic mail in July 2006. They were invited to participate in the web-based survey and given a hypertext link to access the questionnaire. Physicians with undeliverable e-mail addresses were sent the survey via U.S. Postal Service. In September 2006, physicians who had not responded to the initial e-mail survey were sent a second e-mail request to participate, but with the survey attached as an electronic PDF document. In December 2006, we sent a cover letter and survey by mail to physicians who had not responded to either e-mail survey. In February 2007, we sent a final paper mailing to all remaining non-responders.

Data Analysis

We entered data into a Microsoft Access database (Microsoft Corp., Redmond, WA) and analyzed it using Stata/SE 8.2 for Windows (Version 8. StataCorp LP, College Station, TX). We used simple univariate statistics to analyze demographic variables and used Holm's correction for Bonferroni multiple test procedure to conduct post hoc testing.[8] Since there were so few surveys returned from practitioners in the "other" practice specialty group, these were removed from further analysis. We used the chi-square test to determine the association between practice specialty and patient disposition. We then performed backward stepwise logistic regression to examine the impact of physician characteristics (practice specialty, years in practice, and percentage of patients who are children) and hospital characteristics (annual ED pediatric patient volume, practice setting, and geographic location) on disposition decisions for the hypothetical patients with different abdominal CT findings. Reference groups for the analysis were pediatric emergency medicine specialty, > 15 years of clinical practice experience, pediatric ED volume of > 60,000 visits per year, and practices with > 95% pediatric patients. We selected these reference groups because (except for ED volume) they were the most populous of the subgroups. Finally, we performed standard multivariable logistic regression to determine differences between practice specialties for the general opinion questions regarding the diagnosis and management of children with blunt abdominal trauma, adjusting for years in practice, percentage of patients who are children, annual ED pediatric volume, practice setting, and geographic location. Results are presented with odds ratios (OR) with 95% confidence intervals (CI).

Table 3. Case 1 emergency department discharge rates by practice specialty.

	PEM (n=336)	GEM (n=161)	PS (n=76)	TS (n=48)
Normal CT	99%	99%	96%	100%
†Trace intraperitoneal fluid***	75%	65%	55%	48%
‡Small splenic contusion*	25%	33%	15%	19%
§Grade 1 subcapsular splenic hematoma*	4%	9%	3%	4%
Small liver contusion	24%	31%	16%	30%
Grade 1 subcapsular liver hematoma	4%	6%	3%	6%
§Intraparenchymal liver hematoma**	5%	13%	3%	13%
¶Grade 1 renal contusion***	36%	50%	24%	34%

PEM, pediatric emergency medicine; *GEM*, general emergency medicine; *PS*, pediatric surgery; *TS*, trauma surgery; *CT*, computed tomography
Overall significant differences: *$P < 0.05$; **$P < 0.01$; ***$P < 0.001$
Two-way significant differences (using Holm correction for Bonferroni multiple test procedure):
†PEM v. PS and TS
‡GEM v. PS
§PEM v. GEM
¶PEM v. GEM; GEM v. PS

RESULTS

We distributed 2,395 surveys, of which 314 were undeliverable. Seventy-seven respondents did not care for patients younger than 18 years with trauma, and one was a nurse practitioner, giving a total of 78 respondents that were ineligible to participate in the survey analysis. Of the remaining 2,003 eligible participants, 636 (32%) responded to the survey. Practice specialty response rates were pediatric emergency medicine 336/878 (38%), general emergency medicine 161/645 (25%), pediatric surgery 76/387 (20%), and trauma surgery 48/93 (52%).

Physician and hospital characteristics of respondents are shown in Table 1. One-half of all participants (53%) specialize in pediatric emergency medicine. Nearly one-third (30%) have more than 15 years of clinical practice experience. More than one-half (58%) almost exclusively care for pediatric patients. While the participants were evenly distributed across the 4 categories representing annual pediatric patient volumes, most identified their practice setting as an academic or a children's hospital. Most respondents (90%) practice in urban areas.

Overall ED discharge rates by CT finding for Cases 1 and 2 are shown in Table 2. Most respondents would discharge the hypothetical patients in both cases when CT findings were normal (Case 1: 99%, Case 2: 88%), although the number who would discharge patients with trace intraperitoneal fluid on their CT was substantially lower (Case 1: 68%, Case 2: 57%). Approximately one-fourth to one-third would discharge patients with a small splenic contusion (Case 1: 25%, Case 2: 21%), a small liver contusion (Case 1: 25%, Case 2: 19%), or a Grade 1 renal contusion (Case 1: 37%, Case 2: 27%). Few would discharge patients with a Grade 1 subcapsular splenic hematoma (Case 1: 5%, Case 2: 5%), a Grade 1 subcapsular liver hematoma (Case 1: 4%, Case 2: 3%), or an intraparenchymal liver hematoma (Case 1: 7%, Case 2: 6%). ED discharge rates of each practice specialty for the various isolated CT findings are reported in Tables 3 and 4, for Cases 1 and 2 respectively.

Statistically significant results of the multivariable analysis are shown in Tables 5 and 6. Patients with trace intraperitoneal fluid were less likely to be discharged by pediatric surgeons (both cases) and trauma surgeons (Case 1). In Case 2, patients with trace intraperitoneal fluid were also less likely to be discharged by physicians seeing fewer than 30% children in their practices or by those practicing at an academic hospital.

Patients with renal contusions were less likely to be discharged by pediatric surgeons (Case 1), physicians in practice < 10 years (both cases), physicians seeing fewer than 30% children in their practices (Case 2), or physicians practicing at an academic hospital (both cases). Patients with renal contusions were more likely to be discharged by general EPs (both cases).

Patients with intraparenchymal liver hematomas were more likely to be discharged by general EPs (both cases) and trauma surgeons (Case 1).

Table 4. Case 2 emergency department discharge rates by practice specialty.

	PEM (n=336)	GEM (n=161)	PS (n=76)	TS (n=48)
Normal CT	89%	86%	87%	94%
†Trace intraperitoneal fluid**	63%	51%	45%	43%
Small splenic contusion	20%	26%	13%	19%
Grade 1 subcapsular splenic hematoma	3%	8%	3%	6%
Small liver contusion	18%	24%	12%	19%
Grade 1 subcapsular liver hematoma	2%	5%	3%	4%
Intraparenchymal liver hematoma	5%	10%	3%	10%
‡Grade 1 renal contusion*	28%	35%	20%	19%

PEM, pediatric emergency medicine; *GEM*, general emergency medicine; *PS*, pediatric surgery; *TS*, trauma surgery; *CT,* computed tomography
Overall significant differences: *$P < 0.05$; ** $P < 0.01$
Two-way significant differences (using Holm correction for Bonferroni multiple test procedure):
†PEM v. GEM, PS and TS
‡Significant on overall chi-square, but no pairwise significant differences

There were other differences between physician specialty groups regarding ED discharge of patients with various injuries. For example, general EPs were more likely to discharge patients with small splenic contusions (Case 1), while pediatric surgeons were less likely to discharge patients with small liver contusions (Case 1).

For the 2 general opinion questions, 44% (range across specialties 37% - 61%) of participants answered that every child with a traumatic IAI identified by CT, no matter how small, should be hospitalized even if no acute intervention is needed; 74% (range across specialties 53% - 78%) would accept not identifying a traumatic IAI that would have appeared on a CT (if a CT were obtained) in a well appearing, verbal child if no acute intervention was necessary (Table 7). For both questions, pediatric surgeons and trauma surgeons gave the most conservative answers (i.e. were more likely to hospitalize patients and less likely to accept missing CT findings). On multivariate analysis, pediatric surgeons were more likely to believe that children with IAI should always be hospitalized (OR 2.21, 95% CI 1.33, 3.68), and they were less willing to accept not identifying all IAI on CT (OR 0.53, 95% CI 0.30, 0.93).

Table 5. Case 1 physician and hospital predictors of patient discharge on multivariate analysis.

	Odds ratios (95% confidence intervals)							
	Normal CT	Trace intraperitoneal fluid	Small splenic contusion	Grade 1 subcapsular splenic hematoma	Small liver contusion	Grade 1 subcapsular liver hematoma	Intraparenchymal liver hematoma	Grade 1 renal contusion
Practice specialty								
Pediatric EM	ref	ref	ref	ref	ref	ref	ref	ref
General EM	ns	ns	1.62 (1.09,2.41)	ns	ns	ns	3.30 (1.68,6.48)	1.83 (1.25,2.69)
Pediatric surgery	ns	0.52 (0.32,0.82)	ns	ns	0.54 (0.29,0.98)	ns	ns	0.55 (0.32,0.95)
Trauma surgery	ns	0.42 (0.23,0.77)	ns	ns	ns	ns	3.38 (1.26,9.06)	ns
Years in practice								
0-5 years	ns	ns	ns	ns	ns	ns	ns	ns
6-10 years	ns	ns	ns	ns	ns	ns	ns	0.67 (0.45,1.00)
11-15 years	ns	ns	ns	ns	ns	ns	ns	ns
> 15 years	ref	ref	ref	ref	ref	ref	ref	ref
Percentage of patients who are children								
0-10%	ns	ns	ns	ns	ns	ns	ns	ns
11%-30%	ns	ns	ns	2.88 (1.33,6.21)	ns	ns	ns	ns
31%-50%	ns	ns	ns	4.26 (1.14,16.00)	ns	ns	ns	ns
51%-95%	ns	ns	ns	ns	ns	ns	ns	ns
> 95%	ref	ref	ref	ref	ref	ref	ref	ref
Annual ED peds volume								
< 20,000	ns	ns	ns	ns	ns	ns	ns	ns
20,000-40,000	ns	ns	ns	ns	ns	ns	ns	ns
40,000-60,000	ns	ns	ns	ns	ns	ns	ns	ns
> 60,000	ref	ref	ref	ref	ref	ref	ref	ref
Practice setting								
Children's hospital	ns	ns	ns	ns	ns	ns	ns	ns
General hospital	ns	ns	ns	ns	ns	ns	ns	ns
Private hospital	ns	ns	ns	ns	ns	ns	ns	ns
Academic hospital	ns	ns	ns	ns	ns	ns	ns	0.66 (0.46,0.94)
Geographic location								
Urban (> 50,000 pop)	ns	ns	ns	ns	ns	ns	ns	ns

CT, computed tomography; *EM*, emergency medicine; *ns*, not significant; *ref,* reference group; *ED,* emergency department

Table 6. Case 2 physician and hospital predictors of patient discharge on multivariate analysiss.

	Odds ratios (95% confidence intervals)							
	Normal CT	Trace intraperitoneal fluid	Small splenic contusion	Grade 1 subcapsular splenic hematoma	Small liver contusion	Grade 1 subcapsular liver hematoma	Intraparenchymal liver hematoma	Grade 1 renal contusion
Practice specialty								
Pediatric EM	ref	ref	ref	ref	ref	ref	ref	ref
General EM	ns	ns	ns	ns	ns	ns	2.01 (1.04,3.90)	2.37 (1.14 4.89)
Pediatric surgery	ns	0.49 (0.30,0.79)	ns	ns	ns	ns	ns	ns
Trauma surgery	ns	ns	ns	ns	ns	ns	ns	ns
Years in practice								
0-5 years	ns	ns	ns	ns	ns	ns	ns	0.52 (0.33,0.83)
6-10 years	ns	ns	ns	ns	ns	ns	ns	0.58 (0.37 0.92)
11-15 years	ns	ns	ns	ns	ns	ns	ns	ns
> 15 years	ref	ref	ref	ref	ref	ref	ref	ref
Percentage of patients who are children								
0-10%	ns	0.52 (0.31,0.88)	ns	ns	ns	ns	ns	0.39 (0.16,0.95)
11%-30%	ns	0.54 (0.36,0.82)	ns	ns	ns	ns	ns	0.38 (0.17 0.88)
31%-50%	ns	ns	ns	ns	ns	ns	ns	ns
51%-95%	ns	ns	ns	ns	ns	ns	ns	ns
> 95%	ref	ref	ref	ref	ref	ref	ref	ref
Annual ED peds volume								
< 20,000	ns	ns	ns	ns	ns	ns	ns	ns
20,000-40,000	ns	ns	ns	ns	ns	ns	ns	ns
40,000-60,000	ns	ns	0.58 (0.35,0.96)	ns	ns	ns	ns	ns
> 60,000	ref	ref	ref	ref	ref	ref	ref	ref
Practice setting								
Children's hospital	ns	ns	ns	ns	ns	ns	ns	ns
General hospital	ns	ns	ns	ns	ns	2.97 (1.17,7.52)	ns	1.87 (1.06,3.31)
Private hospital	ns	ns	ns	ns	ns	ns	ns	ns
Academic hospital	ns	0.66 (0.47,0.95)	ns	ns	ns	ns	ns	0.67 (0.46,0.97)
Geographic location								
Urban (> 50,000 pop)	ns	ns	ns	ns	ns	ns	ns	ns

CT, computed tomography*; EM*, emergency medicine; *ns*, not significant; *ref,* reference group; *ED*, emergency department.

Table 7. Physician opinions regarding imaging and disposition of children after blunt abdominal trauma.

Characteristic		†Hospitalize every child with IAI on CT	p value	‡Accept not identifying all IAI on CT	p value
All respondents (%)		43.9		73.7	
Practice specialty (%)			0.002		0.001
Pediatric EM (n=336)		41.5		78.0	
General EM (n=161)		37.3		75.8	
Pediatric surgery (n=76)		60.5		62.3	
Trauma surgery (n=48)		56.3		53.3	
Years in practice (%)			0.330		0.233
0-5 years (n=150)		43.9		76.6	
6-10 years (n=149)		48.0		68.8	
11-15 years (n=137)		37.5		78.5	
> 15 years (n=185)		45.6		71.8	
Percentage of patients who are children (%)			0.186		0.827
0-10% (n=67)		41.8		69.8	
11%-30% (n=137)		40.2		71.9	
31%-50% (n=22)		61.9		81.0	
51%-95% (n=40)		56.4		73.0	
> 95% (n=355)		43.4		74.8	
Annual ED pediatric volume (%)			0.868		0.776
< 20,000 (n=145)		46.2		74.7	
20,000 – 40,000 (n=165)		44.2		71.7	
40,000 – 60,000 (n=153)		41.3		72.1	
> 60,000 (n=158)		44.1		76.4	
Practice setting* (%)					
Children's hospital	Yes (n=361)	44.4	0.768	73.2	0.735
	No (n=260)	43.2		74.4	
General hospital	Yes (n=197)	43.7	0.923	73.5	0.958
	No (n=424)	44.1		73.8	
Private hospital	Yes (n=125)	43.2	0.853	72.1	0.662
	No (n=496)	44.1		74.1	
Academic hospital	Yes (n=423)	44.3	0.787	74.2	0.689
	No (n=198)	43.2		72.6	
Geographic location (%)			0.983		0.342
Urban (>50,000 pop) (n=562)		43.9		73.1	
Non-urban (<50,000 pop) (n=59)		44.1		79.0	

*Practicing in specific setting vs. not practicing in that setting
EM, emergency medicine; *IAI*, intra-abdominal injury; *CT*, computed tomography; *ED,* emergency department
Two-way significant differences (using Holm correction for Bonferroni multiple test procedure):
†PEM v. PS; GEM v. PS
‡PEM v. PS and TS; GEM v. TS

DISCUSSION

In our survey we found substantial variation between specialties in reported hospitalization practices of children after blunt abdominal trauma. We also found a number of areas of agreement. In both hypothetical cases, almost all physicians surveyed were willing to discharge patients given normal abdominal CTs . While abdominal CT is not perfectly sensitive for IAI, particularly pancreatic injuries, such injuries are unlikely in patients with normal CTs, normal mental status, and non-tender abdominal examinations.[3, 9-12] In a meta-analysis of nearly 2,600 pediatric blunt trauma patients, the prevalence of IAI after a normal abdominal CT was 0.19% and the negative predictive value of a normal abdominal CT was 99.8%.[13]

Across all specialties, respondents were less likely to discharge an infant with a normal CT (Case 2: 11-month-old who fell 10 feet) than an older child with a normal CT (Case 1: 9-year-old struck by a car). Possible reasons for this difference include that physicians may have less familiarity with evaluating younger children or may practice more conservatively in preverbal children, where the physical examination may be less reliable. In addition, although the survey instructed that there was no concern for physical abuse in these cases, respondents may have had lingering concerns nonetheless.

In both cases, although the majority of physicians were willing to discharge patients with isolated trace intraperitoneal fluid on CT, a substantial percentage would hospitalize such patients. In Case 2, physicians who see fewer than 30% children in their practices were less willing to discharge patients with isolated trace intraperitoneal fluid on CT. It is not surprising that physicians who treat smaller proportions of children are more conservative in their hospitalization practices, as they may feel uncomfortable even with a minor finding on CT that rarely requires an intervention. In one study, isolated intraperitoneal fluid was seen in 14% of hospitalized pediatric patients following blunt abdominal trauma.[14] Of the 94 study patients, 91 (97%) did not require an intervention during hospitalization, while 3 patients developed peritonitis within 12-14 hours of observation. Of note, all 3 had external signs of abdominal trauma and had tenderness on initial abdominal examination. This is consistent with a previous study of children with blunt trauma, in which an IAI was identified in 7/42 (17%) patients with isolated intraperitoneal fluid, all of whom had either abdominal tenderness or a decreased level of consciousness.[15]

Few physicians surveyed in our study would discharge patients with Grade 1 subcapsular splenic hematomas, Grade 1 subcapsular liver hematomas, or intraparenchymal liver hematomas. While general EPs and, in Case 1, trauma surgeons were more likely to discharge patients with intraparenchymal liver hematomas, the vast majority of both groups would still admit children with such injuries. Thus, there appears to be a consensus among these various specialist groups that patients with such injuries warrant hospitalization.

Patients with isolated Grade 1 renal contusions were less likely to be discharged by physicians with less than 10 years of practice experience or practicing at an academic hospital. Such patients were also less likely to be discharged by physicians who see fewer than 30% children in Case 2 and by pediatric surgeons in Case 1. In contrast, such patients were more likely to be discharged by general EPs, and in Case 2, by physicians practicing at a general hospital. It is not surprising that adult practitioners appear to have less concern about renal contusions, as much of the trauma literature discourages evaluation of microscopic hematuria in normotensive, adult blunt trauma patients and there is general acknowledgment that renal contusions will be missed.[16-22] Renal contusions rarely require intervention and have been reported to not result in subsequent renal parenchymal scarring on follow-up CT.[23] In a study of adults with renal injuries, hematomas or contusions were managed non-operatively in 99% of cases, and a more recent study of children with blunt trauma reported that none of the children with Grade 1 renal injuries required surgical intervention.[24,25] While pediatric surgeons may be more conservative as a group, 1 out of 5 would discharge patients with isolated Grade 1 renal contusions.

Ideally, physicians should limit the use of abdominal CT in children to avoid the associated risks from radiation exposure as up to 2% of all cancers in the U.S. may be attributed to CT use.[26] The risk of fatal malignancy from a single abdominal CT is estimated to range from 1/700 – 1/1400, and the risk increases as patient age at time of exposure decreases.[26] While most pediatric and trauma surgeons were willing to accept not identifying injuries when no acute intervention is necessary and no suspicion for abuse exists, they were less willing to do so than pediatric EPs. The reasons for this difference are unclear, but this finding has implications for the implementation of selective imaging protocols, as some groups are likely to be less accepting than others. Overall, 74% of survey respondents were willing to accept not identifying injuries when no acute intervention is necessary and no suspicion for abuse exists, giving hope that successful implementation of validated predictions rules may result in change of clinical practice.

Overall, while we found some areas of agreement, substantial variability exists between specialties in their reported hospitalization practices of children after blunt abdominal trauma. This variation in practice is likely a marker of clinical inefficiency and opportunity for improvement in quality of care. Furthermore, this variability in physician practice patterns may limit full acceptance of selective abdominal CT imaging without further generation of evidence-based guidelines, as well as education and discussions, both within and between various practice specialty groups. Future work to generate evidence-based guidelines for obtaining CTs on children with abdominal trauma, and hospitalization of children with minor IAIs is needed.

LIMITATIONS

This study has several limitations. We achieved a response rate of 32%, and it is unclear if the reported practice patterns of non-responders might differ from those who responded to the survey. This may have limited the power to detect significant differences between specialties in some of our analyses. Nonetheless, we found important and significant variation between specialties among survey responders. Physicians were asked to respond to 2 hypothetical cases, and their responses on a survey may or may not accurately reflect their actual clinical practice when caring for children with blunt abdominal trauma.

We surveyed physicians practicing at major pediatric trauma centers and children's hospitals. Thus, our study results may not reflect the full spectrum of physician practice patterns in all clinical settings. However, the physicians we surveyed are those most likely to manage children with substantial injury mechanisms and likely have the most experience in management and with outcomes of such children. Finally, we did not assess the reasons that respondents decided to discharge or admit patients, so we are unable to determine what were the exact concerns driving the decision-making.

CONCLUSION

Substantial variation exists among specialties in reported hospitalization practices of clinically-asymptomatic children after blunt abdominal trauma and with minor traumatic abdominal CT findings. Pediatric surgeons and those seeing fewer than 30% children in their practices are less likely to discharge patients from the ED, and general EPs are more likely to discharge patients from the ED. Better evidence is needed to guide disposition decision-making in asymptomatic patients with normal abdominal examinations and various intra-abdominal injuries on CT after blunt abdominal trauma.

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REFERENCES

1. Brenner D, Elliston C, Hall E, et al. Estimated risks of radiation-induced fatal cancer from pediatric CT. *AJR Am J Roentgenol*. Feb 2001;176(2):289-96.
2. Jindal A, Velmahos GC, Rofougaran R. Computed tomography for evaluation of mild to moderate pediatric trauma: are we overusing it? *World J Surg*. Jan 2002;26(1):13-16.
3. Awasthi S, Mao A, Wooton-Gorges SL, et al. Is hospital admission and observation required after a normal abdominal computed tomography scan in children with blunt abdominal trauma? *Acad Emerg Med*. 2008 Oct;15(10):895-9. Epub 2008 Sep 5.
4. Holmes JF, Sokolove PE, Brant WE, et al. Identification of children with intra-abdominal injuries after blunt trauma. *Ann Emerg Med*. May 2002;39(5):500-9.
5. Isaacman DJ, Scarfone RJ, Kost SI, et al. Utility of routine laboratory testing for detecting intra-abdominal injury in the pediatric trauma patient. *Pediatrics*. Nov 1993;92(5):691-4.
6. Gaines BA. Intra-abdominal solid organ injury in children: diagnosis and treatment. *J Trauma.* Aug 2009;67(2):S135-9.
7. American College of Surgeons Committee on Trauma. Resources for the Optimal Care of the Injured Patient: 2006. Chicago, IL: *American College of Surgeons Committee on Trauma.* 2006.
8. Holm S. A simple sequentially rejective multiple test procedure, *Scand J Statist.* 1979;6(2):65-70.
9. Ford EG, Senac MO Jr. Clinical presentation and radiographic identification of small bowel rupture following blunt trauma in children. *Pediatr Emerg Care.* 1993;9:139–42.
10. Moss RL, Musemeche CA. Clinical judgment is superior to diagnostic tests in the management of pediatric small bowel injury. *J Pediatr Surg.* 1996; 31:1178–81.
11. Sivit CJ, Taylor GA, Newman KD, et al. Safety-belt injuries in children with lap-belt ecchymosis:CT findings in 61 patients. *AJR Am J Roentgenol.* 1991; 157:111–14.
12. Phelan HA, Velmahos GC, Jurkovich GJ, et al. An evaluation of multidetector computed tomography in detecting pancreatic injury: results of a multicenter AAST study. *J Trauma.* 2009; 66(3):641-6.
13. Hom J. The risk of intra-abdominal injuries in pediatric patients with stable blunt abdominal trauma and negative abdominal computed tomography. *Ann Emerg Med.* 2010;17(5):469-75.
14. Christiano JG, Tummers M, Kennedy A. Clinical significance of isolated intraperitoneal fluid on computed tomography in pediatric blunt abdominal trauma. *J Pediatr Surg.* 2009 Jun;44(6):1242-8.
15. Holmes JF, London KL, Brant WE, et al. Isolated intraperitoneal fluid on abdominal computed tomography in children with blunt trauma. *Acad Emerg Med.* 2000; 7(4):335-41.
16. Cass AS, Luxenberg M, Gleich P, et al. Clinical indications for radiographic evaluation of blunt renal trauma. *J Urol.* 1986;136:370-1.
17. Eastham JA, Wilson TG, Ahlering TE. Radiographic evaluation of adult patients with blunt renal trauma. *J Urol*. 1992;148:266-7.
18. Guice K, Oldham K, Eide B, et al. Hematuria after blunt trauma: when is pyelography useful? *J Trauma.* 1983;23:305-11.
19. Kisa E, Schenk WG 3rd. Indications for emergency intravenous pyelography (IVP) in blunt abdominal trauma: a reappraisal. *J Trauma.* 1986;26:1086-9.
20. McAndrew JD, Corriere JN Jr. Radiographic evaluation of renal trauma: evaluation of 1103 consecutive patients. *Br J Urol.* 1994;73:352-4.
21. Mee SL, McAninch JW, Robinson AL, et al. Radiographic assessment of renal trauma: a 10-year prospective study of patient selection. *J Urol.* 1989;141:1095-8.

22. Nicolaisen GS, McAninch JW, Marshall GA, et al. Renal trauma: re-evaluation of the indications for radiographic assessment. *J Urol.* 1985;133:183-7.
23. Dunfee BL, Lucey BC, Soto JA. Development of renal scars on CT after abdominal trauma: does grade of injury matter? *AJR Am J Roentgenol.* 2008;190:1174-9.
24. Wessells H, Suh D, Porter JR, et al. Renal injury and operative management in the United States: results of a population-based study. *J Trauma*. 2003;54:423-30.
25. Nance ML, Lutz N, Carr MC, et al. Blunt renal injuries in children can be managed nonoperatively: outcome in a consecutive series of patients. *J Trauma*. 2004;57:474-8.
26. Brenner DJ , Hall EJ. Computed tomography—An increasing source of radiation exposure, *N Engl J Med.* 2007;357:2277-84.

Sedation-assisted Orthopedic Reduction in Emergency Medicine: The Safety and Success of a One Physician/One Nurse Model

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Introduction: Much of the emergency medical research on sedation-assisted orthopedic reductions has been undertaken with two physicians—one dedicated to the sedation and one to the procedure. Clinical practice in community emergency departments (EDs), however, often involves only one physician, who both performs the procedure and simultaneously oversees the crendentialed registered nurse who administers the sedation medication and monitors the patient. Although the dual-physician model is advocated by some, evidence in support of its superiority is lacking.

Methods: In this electronic health records review we describe sedation-assisted closed reductions of major joints and forearm fractures in three suburban community EDs. The type of procedure and sedation medication, need for specialty assistance, success rates, and intervention-requiring adverse events are reported.

Results: During the 18-month study period, procedural sedation was performed 457 times on 442 patients undergoing closed reduction for shoulder dislocations (n = 111), elbow dislocations (n = 29), hip dislocations (n = 101), and forearm fractures (n = 201). In the vast majority of this cohort (98.4% [435/442]), a single emergency physician simultaneously managed both the procedural sedation and the initial orthopedic reduction without the assistance of a second physician. The reduction was successful or satisfactory in 96.6% (425/435; 95% confidence interval [CI], 95.8-98.8%) of these cases, with a low incidence of intervention-requiring adverse events (2.8% [12/435]; 95% CI, 1.5-4.8%).

Conclusion: Sedation-assisted closed reduction of major joint dislocations and forearm fractures can be performed effectively and safely in the ED using a one physician/one nurse model. A policy that requires a separate physician (or nurse anesthetist) to administer medications for all sedation-assisted ED procedures appears unwarranted. Further research is needed to determine which specific clinical scenarios might benefit from a dual-physician approach. [West J Emerg Med. 2013;14(1):47-54.]

INTRODUCTION

In many community emergency departments (ED) a single emergency physician simultaneously performs a complex painful procedure while directing procedural sedation—even deep sedation—administered by a credentialed emergency nurse. Most of the research on emergency procedural sedation, however, has not operated in this context. The study of the safety and efficacy of various sedatives during painful procedures has commonly been undertaken in academic settings with one physician dedicated to the sedation and a second physician dedicated to the procedure. Dual physician arrangements greatly facilitate data collection and have been employed with great success, for example, in propofol research with both prospective observational studies and controlled trials.[1-12] Yet many

community EDs do not have the resources to staff each sedation with two physicians, especially when experience suggests that a one physician/one nurse combination may well be adequate.

Insufficient research attention, however, has been paid to the study of a single physician managing both parts of the procedural sedation dynamic. No randomized trial has been published comparing the efficacy and safety of a one physician/one nurse model with a two physician/one nurse model. Miner and Krauss,[13] in a recent report on the state of the art of procedural sedation in emergency medicine, rank the issue of personnel at the top of their list of areas needing further investigation. They state, "The first question that needs to be addressed is whether emergency physicians can perform the procedure and the sedation simultaneously. Given the nature of emergency medicine, it is important to determine which agents at what levels of sedation can be safely used by a single emergency physician relative to using separate operators for the sedation and the procedure."

Only a handful of studies have been published that describe the safety and effectiveness of the one physician/one nurse model in emergency medicine procedural sedation. This model has been in operation in our EDs for decades.[14,15] We undertook this study to describe the practice patterns of 3 community EDs in performing closed reductions of common orthopedic dislocations and fractures under procedural sedation. The type of procedure, use of sedation medications, need for specialty assistance, procedural success rates, and adverse events requiring intervention are reported.

METHODS

Study Design, Setting, and Population

We conducted this 18-month retrospective health records review between November 2007 and April 2009 in the EDs of 3 affiliated suburban community hospitals that are part of a large integrated healthcare delivery system. The annual censuses for the 3 EDs during the study period ranged from 65,000 to 79,000 patient visits. All are staffed by board-certified (or board-eligible) emergency physicians. Two departments serve as satellite sites for a nearby emergency medicine residency-training program. None was a designated trauma center during the study period. The study was approved by the Kaiser Foundation Research Institute's Northern California Institutional Review Board.

The patient population consisted of a consecutive series of ED patients who received procedural sedation for reduction of one of the following four orthopedic diagnoses: shoulder dislocation, elbow dislocation, hip dislocation, and forearm fracture. We identified patients who underwent these orthopedic procedures using Current Procedural Terminology codes. The electronic medical record of each of these cases was reviewed for the concomitant use of procedural sedation. The ED patients who underwent their sedation-assisted orthopedic procedure without resident assistance during the study period constitute the study population. Cases that required immediate operative reduction without intervening ED sedation were not identified.

Measurements

The investigators obtained data from an explicit, systematic review of each patient's electronic medical record. Both abstractors agreed to the content and coding of each data element, procedures for data handling and data transmission, and protocols to handle possible questions or problems during the study. A structured data-abstraction tool was used.

We reviewed all physician and nursing notes from the index ED visit, any accompanying consultant notes, all associated radiology reports, and the immediate follow-up records. Demographic variables included age, sex, and date of ED visit. Orthopedic variables included radiographic and clinical diagnoses, nature of the closed reduction, presence of a prosthetic joint, bedside involvement of an orthopedic surgeon or additional emergency physician, post-procedural radiographic alignment (reduction for dislocations or improved alignment for forearm fractures), reduction complications, post-ED disposition, follow-up arrangements and management. Sedation variables included the American Society of Anesthesiologists Physical Status Classification Scale (ASA score 1-6), primary sedation agent, and adverse events that required intervention, defined a priori by the authors to include the following: oxygen desaturation (<90%) or apnea, airway obstruction, laryngospasm, vomiting, pulmonary aspiration, bradycardia (pulse less than 60 bpm in adults), hypotension (systolic blood pressure less than 90 mmHg in adults), dysrhythmia, and arrest.[16,17] Adverse events were recorded as such if they were attended by one of the following interventions: vigorous tactile stimulation, airway repositioning (chin lift, jaw thrust, neck extension, midline repositioning), suctioning, supplemental or increased oxygen delivery, placement of oral or nasal airway, application of positive pressure or ventilation with bag mask, tracheal intubation (laryngeal mask airway or endotracheal tube intubation), administration of reversal agents (flumazenil or naloxone), administration of anti-dysrhythmic agents, and chest compressions. The agent, dose, and effect of pre-procedural analgesia were not abstracted for this study. We identified and excluded from analysis cases with missing or incomplete records.

Procedural Sedation Protocol

Regional procedural sedation guidelines were implemented prior to, and were in effect throughout, the study period. The guidelines mandate the bedside presence of 2 licensed personnel, which in our setting equates to a board-certified (or board-eligible) emergency physician and an emergency nurse specifically trained and certified in procedural sedation. The emergency physician is required to conduct a history and physical examination, including an airway assessment and an ASA score, prior to the procedure to determine the patient's eligibility for ED procedural sedation. Supplemental oxygen is administered (at least 2L via nasal cannula, though usually 10L with a non-rebreather mask), intravenous access is secured, and age-appropriate resuscitation equipment is placed at the bedside.

Continuous cardiac and transcutaneous oxygen saturation are in place throughout the procedure until complete recovery has been achieved. Continuous end-tidal CO_2 monitoring also

is recommended. Blood pressure, pulse rate, respiratory rate, cardiac rhythm, oxygen saturation and level of consciousness are measured and documented serially a minimum of every 5 minutes during the procedure, then after the procedure every 15 minutes, for at least 30 minutes, or until vital signs stabilize near pre-sedation levels. The Procedure and Anesthesia Scoring System (PASS) is used to quantify the patient's overall status and to determine when the patient is safe for discharge.[18] PASS measures include level of consciousness, physical activity, hemodynamic stability, respiration, oxygen saturation, pain, and nausea/vomiting. Our procedural sedation protocol requires a pre-sedation, intra-sedation and post-sedation PASS score. The patient's discharge PASS score must have returned to their pre-procedure baseline score. All measurements are recorded by the nurse for each procedure on a standardized electronic form integrated into the ED record. The choice and dose of sedative, as well as the use of adjunct medication(s), are at the physician's discretion.

Data Analysis

Continuous variables are presented as medians with their interquartile range (IQR) (25-75). Categorical data are presented as percent frequency of occurrence. We calculated the 95% confidence intervals (CI) using the modified Wald method. We performed descriptive statistics using standard software (Microsoft® Excel, 2008, version 12.0). Chi-squared analysis was undertaken using STATA 11 software (StataCorp, College Station, Texas). Statistical significance was set at $P < 0.05$.

RESULTS

During the 18-month study period we identified 1,322 patients in the 3 EDs who underwent closed reduction for a dislocated shoulder, elbow, or hip, or a fractured forearm. Of these, 442 (33.4%) received procedural sedation during their reduction and constitute our study cohort. Patient demographics and characteristics are described in Table 1. No cases were excluded from analysis because of missing or incomplete records.

The 111 shoulder dislocations included 110 anterior dislocations and 1 posterior dislocation. Three of the anterior dislocations were noted to have minor pre-reduction fractures of the humeral head. Only 1 of the 29 elbow dislocations had a concomitant pre-reduction fracture—a small avulsion fracture of the lateral epicondyle. All 101 hip dislocations involved prosthetic hips; none was fractured. The 201 closed forearm fractures included 134 (66.7%) combined radius and ulna fractures, 66 (32.8%) isolated radius fractures and 1 (0.5%) isolated ulna fracture.

Procedural sedation was performed 457 times on 442 patients. The additional 15 rounds of sedation were required for a second reduction attempt when the first one had failed to achieve adequate anatomical results. Five medications were used during these 457 sedations: propofol (303; 66.3%), etomidate (67; 14.7%), ketamine (57; 12.5%), methohexital (17; 3.7%), midazolam alone (13; 2.8%). Midazolam alone was used exclusively for forearm fracture reduction, and ketamine was used exclusively in children.

In the vast majority of this cohort (98.4% [435/442]; 95%

Table 1. Demographics and clinical characteristics of emergency department patients undergoing closed reduction with procedural sedation.

Procedure n = 442	Age (years)		Sex: Male	American Society of Anesthesiologists Physical Class
	Median (IQ 25, 75)	Range	No. (%)	No. (%)
Shoulder dislocation reduction (n = 111)	32 (19, 58)	14 to 89	72 (64.9)	n = 48 (43.2) I: 38 II: 9 III: 1
Elbow dislocation reduction (n = 29)	21 (16, 36)	7 to 74	18 (62.0)	n = 17 (58.6) I: 16 II: 1 III: 0
Hip dislocation reduction (n = 101)	75 (65, 83)	46 to 90	52 (51.5)	n = 54 (53.5) I: 11 II: 40 III: 3
Forearm fracture reduction (n = 201)	12 (7, 32)	1 to 91	115 (57.2)	n = 127 (63.2) I: 107 II: 19 III: 1

CI, 96.7 - 99.3%), a single emergency physician simultaneously managed both the procedural sedation and the initial orthopedic reduction without the assistance of a second physician. The reduction was successful or satisfactory in 96.6% (425/435; 95% CI, 95.8 - 98.8%) of these cases, with a low incidence of intervention-requiring adverse events (2.8% [12/435]; 95% CI, 1.5 - 4.8%). A two physician/one nurse model was employed in select cases in lieu of the one physician/one nurse model for orthopedic reasons (n = 7; 1.6%) and when the one physician/one nurse model failed to achieve adequate results (n = 15; 3.4%). The two physician team in all 22 cases included an emergency physician and an orthopedic surgeon. The results achieved for each model specific to each of the 4 orthopedic procedures are reported in Table 2.

Overall, procedural sedation was administered 457 times. Adverse events requiring intervention occurred in 12 (2.8%) of 435 cases using the one physician/one nurse model and in none of the 22 two physician/one nurse cases ($P = 0.43$). Note that the 15 cases initially in the one physician/one nurse group underwent an unsuccessful first attempt at reduction and then were moved into the two physician/one nurse group for the second attempt at reduction. None of these 15 patients experienced an adverse event during their first procedure while in the one physician/one nurse group.

In all cases the ED intervention was sufficient to resolve the adverse event without further sequelae. Most of the adverse events were respiratory in nature. No patients required endotracheal intubation, prolonged observation, or admission for complications. There were no cardiopulmonary arrests and no deaths. The adverse events and their interventions were as follows: One patient who had received etomidate developed apnea, which resolved after 30 seconds of a chin-lift procedure. Eight patients who had received propofol alone developed ventilatory insufficiency (4 with hypoxemia below 90% and 4 with apnea), all of whom were successfully treated with less than 2 minutes of supplemental ventilation via bag-valve mask. One patient who had received propofol developed hypotension, which was treated with a bolus of intravenous saline. Another patient who had received propofol and midazolam developed apnea and hypotension, both of which resolved with intravenous flumazenil. One child who had received ketamine developed urticaria, which resolved with intravenous diphenhydramine. No complication required prolonged observation or hospital admission.

DISCUSSION

This multicenter descriptive study of sedation-assisted closed reduction of major orthopedic injuries demonstrates

Table 2. Outcomes of emergency department (ED) patients undergoing closed reduction with procedural sedation.

	Major Joint Dislocations			Closed Fractures	Total
	Shoulder n = 111	Elbow n = 29	Hip n = 101	Forearm n = 201	n = 442
Closed reduction attempted by emergency physician (1 physician/1 nurse model)	No (%)	No (%)	No (%)	No (%)	No (%)
Yes	111 (100)	28 (96.6)	98 (97.0)	198 (98.5)	435 (98.4)
Successful or satisfactory reduction	107 (96.4)	28 (100)	95 (96.9)	190 (96.0)§	420 (96.6)
Unsuccessful or unsatisfactory reduction	4 (3.6)	0	3 (3.1)	8 (4.0)	15 (3.4)
No	0	1 (3.4)‡	3 (3.0)	3 (1.5)	7 (1.6)
Closed reduction attempted by orthopedic surgeon in the ED (2 physician/1 nurse model)*	4 (3.6)	1 (3.4)	6 (5.9)	11 (5.5)‖	22 (5.0)
Reduction					
Successful or satisfactory	3	1	5	11	20
Unsuccessful or unsatisfactory	1†	0	1	0	2
Admission for open reduction	0	0	1	1	2

* Includes cases in which closed reduction was not undertaken in the one physician/one nurse model and cases of unsuccessful reduction using that model, which then required a second round of procedural sedation

† This elderly woman had chronic glenohumeral subluxation and was discharged home from the ED with urgent outpatient orthopedic follow-up

‡ This patient was seen first at an outside ED where the initial reduction attempt with sedation using a one physician/one nurse model was unsuccessful. The emergency physician in our department then deferred the procedure to the orthopedic surgeon.

§ Includes full reduction (131 cases) and improved alignment (59 cases)

‖ Ten cases involved combined fractures of radius and ulna

the safety and effectiveness of the one physician/one nurse approach. In nearly all cases in this series, a single emergency physician performed the complex painful procedure while simultaneously directing procedural sedation—even deep sedation—administered by a credentialed emergency nurse.

The safety of this approach is suggested by the low incidence of adverse events that required intervention. These uncommon outcomes were all readily and fully resolved in the ED and had no impact on the patients' dispositions. The effectiveness of this approach is seen in the high success rate of our reductions. Over 95% of shoulder, elbow, and hip dislocations were successfully reduced, a rate comparable with or exceeding other published reports.[19-28] Our success rate with the reduction of forearm fractures was also comparable with figures reported in the emergency medicine literature.[29-32]

The bulk of the research on procedural sedation in emergency medicine has been undertaken using two physicians in addition to a registered nurse. This could imply that such a staffing model is the standard approach. One review of the recent literature on procedural sedation in emergency medicine went so far as to aver that "it is generally accepted that a separate professional administers sedation and another performs the procedure."[33] These authors go on to acknowledge that their preferred 4-person model (two physicians, one nurse, and one technician) is not realistically or pragmatically achievable in many community EDs. Nonetheless, they "recommend three professionals be present – one to perform the procedure, one to give medications, and one to watch the patient if feasible."[33]

What such an assertion lacks is a compelling warrant. There is insufficient evidence demonstrating an outcome advantage (or disadvantage, for that matter) of a dual-physician approach. No randomized trial has compared a two-physician with a one-physician model. The absence of such high quality research supports the agenda advanced by Miner and Krauss[13] that asks "whether emergency physicians can perform the procedure and the sedation simultaneously" and in what situations, if any, might separate operators be indicated.

The closest any ED study comes to comparing the safety of a one-physician with a two-physician model is the nation-wide ProSCED registry. Fourteen community EDs in the United States prospectively collected detailed data for over 1,000 sedations involving painful procedures in patients of all ages.[34,35] In over 80% these cases, one physician both oversaw the nurse-administered sedation and performed the procedure, which was predominantly a dislocation or fracture reduction. As in our study, they found a very low rate of complications, all of which resolved, and none of which required a change in patient disposition. They observed no difference in complication rates between the one-physician and the two-physician model. Outcomes were not affected when one physician tended exclusively to the sedation while a second physician performed the procedure. Why some procedures involved 2 physicians is not explained. Perhaps the two-physician cases were thought to be at some kind of higher respiratory risk or had a more complicated orthopedic injury, as in several of our cases.

The one physician/one nurse approach is commonly employed with procedural sedation in non-ED settings. Propofol, in fact, is widely and safely administered by a registered nurse under the oversight of a physician who is performing concentration-intensive endoscopy.[36-41] The abundance of this literature undergirds the conclusion of Miner and Burton in their review of propofol: "[T]here is no current evidence to suggest that propofol is unsafe without a second physician present."[42]

Worth noting is the nature of the procedures emergency physicians commonly perform. Emergency physicians undertake brief procedures, such as the reductions of dislocations and fractures that we describe here. These kinds of short procedures are less likely than endoscopy to interfere with the physician's overall perception of the patient's cardiorespiratory status. They also are less likely to impede the ability of the emergency physician to respond to the nurse who is carefully monitoring the patient's ventilatory and cardiovascular parameters so as to alert the physician of any changes. As Sacchetti et al[34] observe, "No emergency physicians performed endoscopies or similar procedures, which would have limited entirely the physician's ability to continually assess the patient." Although as noted above, endoscopists safely entrust the administration and monitoring of propofol-induced sedation to a trained registered nurse without a demonstrable compromise to patient safety.[36-41] If endoscopists are able to engage in their more demanding procedures while simultaneously overseeing nurse-administered, nurse-monitored procedural sedation, then emergency physicians should be capable of doing the same with their orthopedic procedures. The reassuring safety profile of our study supports this hypothesis.

Other studies in community and academic EDs have shown the safety and effectiveness of the one physician/one nurse-equivalent model, including studies in the U.S. and in Canada.[43-45] Emergency medicine's leading organizations have made explicit their support of the one physician/one nurse model. The American College of Emergency Physicians (ACEP) and the Emergency Nurses Association (ENA) issued a joint policy in 2005 supporting the administration of propofol, etomidate, and other sedatives by a credentialed emergency nurse under the direct supervision of an emergency physician.[46,47]

Yet even in 2007 some controversy remained, particularly surrounding ultra-short-acting "deep sedation" agents such as propofol, "whether there should be an emergency physician separate from the procedure who is wholly dedicated to drug administration and patient monitoring."[42] Contrary to the ACEP policy, some felt credentialed, supervised emergency nurses were not equal to the task. The American Society of Anesthesiology (ASA) is among this group. The ASA had proposed in 2004 (and amended in 2009) that a separate professional, "trained in the administration of general anesthesia," must be dedicated to the deep sedation, one who is "not simultaneously involved in these surgical or diagnostic procedures."[48] This is not a surprising recommendation from the ASA House of Delegates, who assert that deep sedation can be optimally managed only by anesthesia personnel.[48]

The Centers for Medicare & Medicaid Services (CMS)

issued a similarly restrictive regulation in December 2009, stating that deep sedation can be administered only by an anesthesiologist, a certified registered nurse anesthetist, or a trained medical doctor or a doctor of osteopathy not involved in the performance of a medical procedure. This would prohibit non-anesthesia nursing personnel from administering sedatives like propofol.[49] Only a two physician model, or a one physician/one nurse anesthetist model, could operate within these regulatory constraints.

Such a policy struck many as overreaching, cost ineffective, and out of step with the evidence of the safety of deep sedation medication use in the hands of specially trained nurses under direct contemporaneous physician oversight.[50-53] In 2010 ACEP, ENA, and the American Academy of Emergency Medicine collectively appealed to CMS.[53,54] CMS regulators then met with these leading representatives of the emergency medicine community and subsequently issued an updated bulletin that reflected a more flexible and evidence-based approach.

The revised CMS interpretive guidelines of January 2011 sought to appropriately balance patient safety "with avoidance of undue burdens on facilities or reductions in access to care".[55] These modified regulations transcended the confines of the ASA proscriptions, allowing hospitals to base their policies on a variety of nationally recognized guidelines. Among those now endorsed by the CMS are the ACEP/ENA guidelines that advocate a one physician/one nurse model in which sedation medications are delivered by credentialed emergency nurses working side-by-side with supervising emergency physicians, whom the CMS recognizes as being "uniquely qualified to provide all levels of analgesia/sedation and anesthesia (moderate to deep to general)".[55] ACEP's 2011 recommendations for physician credentialing, privileging, and practice in procedural sedation and analgesia reflect the revised CMS regulations and further undergird the one physician/one nurse model.[56]

The growing literature demonstrating the safety of non-anesthesia nurse-administered propofol sedation undercuts the justifiability of the restrictions by the ASA. The results of our study add to the accumulating evidence that most brief orthopedic reductions in emergency medicine can be safely and effectively performed using the one physician/one nurse model. There may be indications for a second physician operator, but further research is needed to spell out under what conditions a dual-physician approach is preferred.

LIMITATIONS

Our results need to be interpreted in the context of several limitations. The major limitation in using electronic health records as a primary data source for a descriptive study is missing, inconsistent, or erroneous documentation. We think this risk is lessened in this study because our EDs require the use of templated electronic documentation for all cases of procedural sedation. These templates call for the nurses to report all adverse events and their interventions. Moreover, all procedural sedation cases undergo monthly quality improvement review, which also tends to improve the quality of documentation. We supplemented the nurses' records by reviewing the notes of the emergency physicians and the notes of the consultants when present. Although we believe the data regarding the number of participating physicians, intervention-requiring complications, and radiographic outcomes are complete and accurate, we cannot ensure the absence of error to which such studies are liable.

Also, this is simply a descriptive study. Patient allocation to the one physician/one nurse group and the two physician/one nurse group was not randomized. The lack of equivalency between the 2 groups tempers the comparison of adverse events between them. Additionally, our study is underpowered to estimate accurately the incidence of rare events. We also had an insufficient number of patients to stratify outcomes by types of sedative, dosing, and route of administration. Lastly, these results are specific to our practice setting and may not be generalizable to other EDs or healthcare delivery systems.

CONCLUSION

This multicenter descriptive study suggests that sedation-assisted closed reduction of major joint dislocations and forearm fractures can be performed effectively and safely in the ED using a one physician/one nurse model. Requiring a second physician (or nurse anesthetist) to adminster medications for all sedation-assisted ED procedures is unncessarily cautious and would fail to match healthcare resources to patient needs. Further research is needed to determine which specific clinical scenarios might benefit from a dual-physician approach.

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REFERENCES

1. Kuypers MI, Mencl F, Verhagen MF, et al. Safety and efficacy of procedural sedation with propofol in a country with a young emergency medicine training program. *Eur J Emerg Med*. 2011; 18:162-7.
2. Andolfatto G, Willman E. A prospective case series of single-syringe ketamine-propofol (Ketofol) for emergency department procedural sedation and analgesia in adults. *Acad Emerg Med*. 2011; 18:237-45.
3. David H, Shipp J. A randomized controlled trial of ketamine/propofol versus propofol alone for emergency department procedural sedation. *Ann Emerg Med*. 2011; 57:435-41.
4. Shah A, Mosdossy G, McLeod S, et al. A blinded, randomized controlled trial to evaluate ketamine/propofol versus ketamine alone for procedural sedation in children. *Ann Emerg Med*. 2011; 57:425-33.e2.
5. Miner JR, Danahy M, Moch A, et al. Randomized clinical trial of etomidate versus propofol for procedural sedation in the emergency department. *Ann Emerg Med*. 2007; 49:15-22. Epub 2006 Sep 25.
6. Burton JH, Miner JR, Shipley ER, et al. Propofol for emergency department procedural sedation and analgesia: a tale of three centers. *Acad Emerg Med*. 2006; 13:24-30.
7. Dunn MJ, Mitchell R, Souza CD, et al. Evaluation of propofol and remifentanil for intravenous sedation for reducing shoulder dislocations in the emergency department. *Emerg Med J*. 2006; 23:57-8.
8. Miner JR, Biros M, Krieg S, et al. Randomized clinical trial of propofol versus methohexital for procedural sedation during fracture and dislocation reduction in the emergency department. *Acad Emerg Med*. 2003; 10:931-7.
9. Godambe SA, Eliot V, Matheny D, et al. Comparison of propofol/fentanyl versus ketamine/midazolam for brief orthopedic procedural sedation in a pediatric emergency department. *Pediatrics*. 2003; 112:116-23.
10. Coll-Vincent B, Sala X, Fernández C, et al. Sedation for cardioversion in the emergency department: analysis of effectiveness in four protocols. *Ann Emerg Med*. 2003; 42:767-72.
11. Bassett KE, Anderson JL, Pribble CG, et al. Propofol for procedural sedation in children in the emergency department. *Ann Emerg Med*. 2003; 42:773-82.
12. Guenther E, Pribble CG, Junkins EP, Jr., et al. Propofol sedation by emergency physicians for elective pediatric outpatient procedures. *Ann Emerg Med*. 2003; 42:783-91.
13. Miner JR, Krauss B. Procedural sedation and analgesia research: state of the art. *Acad Emerg Med*. 2007; 14:170-8.
14. Vinson DR, Bradbury DR. Etomidate for procedural sedation in emergency medicine. *Ann Emerg Med*. 2002; 39:592-8.
15. Burton JH, Vinson DR, Drummond K, et al. Electrical cardioversion of emergency department patients with atrial fibrillation. *Ann Emerg Med*. 2004; 44:20-30.
16. Bhatt M, Kennedy RM, Osmond MH, et al; Consensus-based recommendations for standardizing terminology and reporting adverse events for emergency department procedural sedation and analgesia in children. *Ann Emerg Med*. 2009; 53:426-35.e4.
17. Green SM, Yealy DM. Procedural sedation goes Utstein: the Quebec guidelines. *Ann Emerg Med*. 2009; 53:436-8.
18. White PF, Song D. New criteria for fast-tracking after outpatient anesthesia: a comparison with the modified Aldrete's scoring system. *Anesth Analg*. 1999; 88:1069-72.
19. Hendey GW, Avila A. The Captain Morgan technique for the reduction of the dislocated hip. *Ann Emerg Med*. 2011; 58:536-40.
20. Jacques KG, Dewar A, Gray A, et al. Procedural sedation and analgesia in a large UK Emergency Department: factors associated with complications. *Emerg Med J*. 2011; 28:1036-40.
21. Wakai A, O'Sullivan R, McCabe A. Intra-articular lignocaine versus intravenous analgesia with or without sedation for manual reduction of acute anterior shoulder dislocation in adults. *Cochrane Database Syst Rev*. 2011; 4:CD004919.
22. Cutts S, Prempeh M, Drew S. Anterior shoulder dislocation. *Ann R Coll Surg Engl*. 2009; 91:2-7.
23. Mathieu N, Jones L, Harris A, et al. Is propofol a safe and effective sedative for relocating hip prostheses? *Emerg Med J*. 2009; 26:37-8.
24. Gagg J, Jones L, Shingler G, et al. Door to relocation time for dislocated hip prosthesis: multicentre comparison of emergency department procedural sedation versus theatre-based general anaesthesia. *Emerg Med J*. 2009; 26:39-40.
25. Fitch RW, Kuhn JE. Intraarticular lidocaine versus intravenous procedural sedation with narcotics and benzodiazepines for reduction of the dislocated shoulder: a systematic review. *Acad Emerg Med*. 2008; 15:703-8.
26. Frymann SJ, Cumberbatch GL, Stearman AS. Reduction of dislocated hip prosthesis in the emergency department using conscious sedation: a prospective study. *Emerg Med J*. 2005; 22:807-9.
27. Germann CA, Geyer DA, Perron AD. Closed reduction of prosthetic hip dislocation by emergency physicians. *Am J Emerg Med*. 2005; 23:800-5.
28. Austin T, Vilke GM, Nyheim E, et al. Safety and effectiveness of methohexital for procedural sedation in the emergency department. *J Emerg Med*. 2003; 24:315-8.
29. Betham C, Harvey M, Cave G. Manipulation of simple pediatric forearm fractures: a time-based comparison of emergency department sedation with theatre-based anaesthesia. *N Z Med J*. 2011; 124:46-53.
30. Khan S, Sawyer J, Pershad J. Closed reduction of distal forearm fractures by pediatric emergency physicians. *Acad Emerg Med*. 2010; 17:1169-74.
31. Pershad J, Williams S, Wan J, et al. Pediatric distal radial fractures treated by emergency physicians. *J Emerg Med*. 2009; 37:341-4.
32. Sharieff GQ, Trocinski DR, Kanegaye JT, et al. Ketamine-propofol combination sedation for fracture reduction in the pediatric emergency department. *Pediatr Emerg Care*. 2007; 23:881-4.
33. Smally AJ, Nowicki TA, Simelton BH. Procedural sedation and analgesia in the emergency department. *Curr Opin Crit Care*. 2011; 17:317-22.
34. Sacchetti A, Senula G, Strickland J, et al. Procedural sedation in the community emergency department: initial results of the ProSCED registry. *Acad Emerg Med*. 2007; 14:41-6.
35. Hogan K, Sacchetti A, Aman L, Opiela D. The safety of single-physician procedural sedation in the emergency department. *Emerg Med J*. 2006; 23:922-3.
36. van Beek EJ, Leroy PL. Safe and effective procedural sedation for

gastrointestinal endoscopy in children. *J Pediatr Gastroenterol Nutr*. 2012; 54:171-85.

37. Bosslet GT, Devito ML, Lahm T, Sheski FD, Mathur PN. Nurse-administered propofol sedation: feasibility and safety in bronchoscopy. *Respiration*. 2010; 79:315-21.
38. Horiuchi A, Nakayama Y, Hidaka N, Ichise Y, Kajiyama M, Tanaka N. Low-dose propofol sedation for diagnostic esophagogastroduodenoscopy: results in 10,662 adults. *Am J Gastroenterol*. 2009; 104:1650-5.
39. Tohda G, Higashi S, Wakahara S, Morikawa M, Sakumoto H, Kane T. Propofol sedation during endoscopic procedures: safe and effective administration by registered nurses supervised by endoscopists. *Endoscopy*. 2006; 38:360-7.
40. Rex DK, Heuss LT, Walker JA, Qi R. Trained registered nurses/endoscopy teams can administer propofol safely for endoscopy. *Gastroenterology*. 2005; 129:1384-91.
41. Walker JA, McIntyre RD, Schleinitz PF, et al. Nurse-administered propofol sedation without anesthesia specialists in 9152 endoscopic cases in an ambulatory surgery center. *Am J Gastroenterol*. 2003; 98:1744-50.
42. Miner JR, Burton JH. Clinical practice advisory: Emergency department procedural sedation with propofol. *Ann Emerg Med*. 2007; 50:182-7,7.e1.
43. Charles M, McGinnis HD, Wehner P. Propofol for procedural sedation: one versus two physicians. *Ann Emerg Med*. 2005; 46:S73-4, abstract 261.
44. Campbell SG, Magee KD, Kovacs GJ, et al. Procedural sedation and analgesia in a Canadian adult tertiary care emergency department: a case series. *CJEM*. 2006; 8:85-93.
45. Mensour M, Pineau R, Sahai V, et al. Emergency department procedural sedation and analgesia: A Canadian Community Effectiveness and Safety Study (ACCESS). *CJEM*. 2006; 8:94-9.
46. Emergency Nurses Association; American College of Emergency Physicians. Delivery of agents for procedural sedation and analgesia by emergency nurses. *Ann Emerg Med*. 2005; 46:368.
47. Godwin SA, Caro DA, Wolf SJ, et al; American College of Emergency Physicians. Clinical policy: procedural sedation and analgesia in the emergency department. *Ann Emerg Med*. 2005; 45:177-96.
48. American Society of Anesthesiologists. Statement on safe use of propofol. (Approved October 27, 2004, and amended on October 21, 2009). Available at: http://www.asahq.org/~/media/for%20members/documents/standards%20guidelines%20stmts/safe%20use%20of%20propofol.ashx. Accessed July 20, 2012.
49. Centers for Medicare & Medicaid Services (CMS). Clarifications of the Interpretive Guidelines for the Anesthesia Services Condition of Participation, and Revised Hospital Anesthesia Services Interpretive Guidelines–State Operations Manual (SOM) Appendix A, S&C-10-09-Hospital. CMS publication no. 100-07. December 11, 2009.
50. Rex DK. Effect of the Centers for Medicare & Medicaid Services policy about deep sedation on use of propofol. *Ann Intern Med*. 2011; 154:622-6.
51. Hannenberg AA. Effect of the Centers for Medicare & Medicaid Services policy about deep sedation on use of propofol. *Ann Intern Med*. 2011; 155:405; author reply.
52. Vargo JJ. A SEER snapshot of anesthesiologist-assisted procedural sedation: in or out of focus? *Clin Gastroenterol Hepatol*. 2012; 10:7-8.
53. Clinical Practice Statement: Propofol and other sedating agents can be safely used by emergency physicians without an anesthesiologist present. (2/17/2012) Available at: http://www.aaem.org/UserFiles/file/propofol_references.pdf. Accessed July 20, 2012.
54. Gardner AF, Blumstein H, Gurney D. Appeal letter [re: Revised Hospital Anesthesia Services Interpretive Guidelines Ref. S&C 10-09 (revised 2/5/10) 42. CFR.482.52] to Thomas Hamilton, Director, Survey and Certification Group, Centers for Medicare and Medicaid Services, Baltimore, MD (sent on behalf of the American College of Emergency Physicians, the American Academy of Emergency Medicine, and the Emergency Nurses Association by the Presidents of these three organizations). March 22, 2010.
55. American Academy of Emergency Medicine. Centers for Medicare & Medicaid Services (CMS). State Operations Provider Certification. Revised Appendix A, Interpretive Guidelines for Hospitals. CMS publication no. 100-07. January 14, 2011. Available at: https://www.cms.gov/SurveyCertificationgeninfo/downloads/SCLetter11_10.pdf. Accessed July 20, 2012.
56. O'Connor RE, Sama A, Burton JH, et al. American College of Emergency Physicians. Procedural sedation and analgesia in the emergency department: recommendations for physician credentialing, privileging, and practice. *Ann Emerg Med.* 2011;58:365-70.

Impact of Emergency Department Management of Atrial Fibrillation on Hospital Charges

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Introduction: Emergency department (ED) cardioversion (EDCV) and discharge of patients with recent onset atrial fibrillation or atrial flutter (AF) has been shown to be a safe and effective management strategy. This study examines the impact of such aggressive ED management on hospital charges.

Methods: A random sample of 300 AF patients were identified from an ED electronic data base and screened for timing of onset of their symptoms. Patients were considered eligible for EDCV if either nursing or physician notes documented an onset of symptoms less than 48 hours prior to ED presentation and the patient was less than 85 years of age. An explicit chart review was then performed to determine patient management and disposition. Cardioversion attempts were defined as ED administration of procainamide, flecainide, propafenone, ibutilide, amiodarone or direct current cardioversion (DCCV). Total hospital charges for each patient were obtained from the hospital billing office. Differences across medians were analyzed utilizing through Wilcoxon rank sum tests and chi square.

Results: A total of 51 patients were included in the study. EDCV was attempted on 24 (47%) patients, 22 (92%) were successfully cardioverted to normal sinus rhythm (NSR). An additional 12 (23%) spontaneously converted to NSR. Twenty (91%) of those successfully cardioverted were discharged from the ED along with 4 (33%) of those spontaneously converting. Pharmacologic cardioverson was attempted in six patients and was successful in three (50%), one after failed DCCV attempt. Direct current cardioversion was attempted in 21 (88%) and was successful in 19 (90%), two after failed pharmacologic attempts. Median charges for patients cardioverted and discharged from the ED were $5,460 (IQR $4,677-$6,190). Median charges for admitted patients with no attempt at cardioversion were $23,202 (IQR $19,663-$46,877). Median charges for patients whose final ED rhythm was NSR were $5,641 (IQR $4,638-$12,339) while for those remaining in AF median charges were $30,299 (IQR $20,655 - $69,759).

Conclusion: ED cardioversion of recent onset AF patients results in significant hospital savings. [West J Emerg Med 2013;14(1):55-57.]

INTRODUCTION

Atrial fibrillation and atrial flutter (AF) are common emergency department (ED) cardiac arrhythmias.[1,2] The initial management of newly recognized AF of greater than 48 hours is generally considered to be rate control with anticoagulation to prevent embolic sequelae. AF of less than 48 hours may be managed similarly, but also may be managed with cardioversion back into normal sinus rhythm. Such rhythm control of recent onset AF in the ED has been demonstrated to be both safe and effective,

although controversy still exists as to whether cardioversion is the most appropriate management strategy in this patient population. [2-4]

This study examines the impact on hospital resources of these two different approaches to recent onset atrial fibrillation.

METHODS

A random number generator was used to select a sample of 300 patients with a primary diagnosis of either atrial fibrillation or atrial flutter from the ED electronic records of an urban community teaching hospital. The study hospital maintains a general ED which treats approximately 57,000 adults and children annually. The hospital has an active cardiac program, which includes an open heart surgery service, interventional cardiac catheterization facilities and 3 cardiac electrophysiology (EP) laboratories. The medical staff includes 7 practicing cardiac electrophysiologists distributed among 4 different private practices.

The ED records of the identified AF patients were examined for individuals considered eligible for ED Cardioversion (EDCV). Eligible patients were defined as those less than 85 years of age whose initial ED electrocardiogram demonstrated either atrial fibrillation or atrial flutter and whose record contained a nursing or emergency physician note stating specifically that the onset of the patient's arrhythmia symptoms were less than 48 hours prior to ED presentation.

An explicit chart review was performed of these patient's records to classify the patients by 3 dichotomous categories, EDCV attempted: yes or no, ED disposition: discharge to home or admission to hospital and Final ED cardiac rhythm: Normal Sinus Rhythm (NSR) or AF. A cardioversion attempt was defined by an ED record containing administration of procainamide, flecainide, propafenone, ibutilide, amiodarone or electrical synchronized cardoversion. Additional clinical information was collected to define the patient's clinical characteristics at the time of presentation. Abstracted data included, patient age, systolic blood pressure, past medical history of hypertension, past history of atrial arrhythmia, history of shortness of breath, chest pain, or neurologic symptoms associated with the onset of the arrhythmia and initial myoglobin and troponin I levels.

All patient management in this study was at the discretion of the attending emergency physician caring for that particular patient, although any EP was free to obtain cardiology input on their patients. There is no ED policy addressing the management of recent onset atrial fibrillation.

The total hospital charges associated with each ED presentation were obtained from the hospital's central billing office.

EDCV 's were performed under the direction of the single attending emergency physician. Procedural sedation was directed by the same attending emergency physician with either bolus propofol administration or remifentanil infusion.

Differences across medians were analyzed utilizing through Wilcoxon rank sum tests, additional analysis was through chi square.

This study was approved by the hospital's Institutional Review Board.

RESULTS

A total of 51 patients were included in this study over a 30 month period. Patients in the different treatment groups were clinically similar with no statistically significant differences in age, systolic blood pressure, history of hypertension, history of atrial arrhythmia, history of shortness of breath, chest pain, or neurologic symptoms on presentation or initial myoglobin and troponin I levels. There was no evidence that the patients in any treatment group were less stable that those in any other group.

ED cardioversion was attempted in 24 (47%) patients and was successful in 22 (92%), with 20 (91%) discharged from the ED. Cardioversion was attempted through Direct Current Cardioversions (DCCV) in 21 (88%) patients and was successful in 19 (90%). Pharmacologic cardioversion was attempted in 6 (24%) patients and was successful in 3 (50%). Three (12%) patients underwent both pharmacologic and DC cardioversion, 1 after a failed DCCV and 2 after a failed pharmacologic attempt. Another 13 (25%) spontaneously converted to sinus rhythm with 4 (30%) discharged. Median charges for patients cardioverted and discharged from the ED were $5,460 (IQR $4,677-$,190). Median charges for admitted patients with no attempt at cardioversion were $23,202 (IQR $19,663-$46,877). The table summarizes the relation between charges and ED management. Median charges for patients who's final ED rhythm was NSR were $5,641 (IQR $4,638-$12,339) while for those remaining in AF median charges were $30,299 (IQR $20,655 - $69,759) regardless of patient disposition.

DISCUSSION

The optimal ED management of recent onset atrial fibrillation remains unclear.[2,4] Advocates for rate control believe that once an emergency physician controls the patient's rate, the decisions concerning the timing of the rhythm control are best left to the admission cardiologists caring for the patient.[4] Proponents of rhythm control in the ED state that the longer a heart remains in atrial fibrillation the more the atrium become conditioned to accept this rhythm. The concept that a-fib begets a-fib would support a more aggressive approach to conversion of these patients as rapidly as possible.[5] Immediate cardioversion also eliminates the need for anticoagulation and reduces the risk of stroke for those remaining in atrial fibrillation.[6,7] It is also believed that the sooner after the onset of atrial fibrillation the cardioversion is attempted the more likely the procedure is to be successful and the greater the chance that the patient will maintain normal sinus rhythm following discharge.[8,9]

Table. Hospital Charges for Study Groups

EDCV Attempt	Disposition	Number of Patients	Median Charges	IQR
No	Admit	23	$23,203	$19,663-$46,877
Yes	Admit	4	$14,575	$10,006-$18,029
Yes	Discharge	20	$5,460	$4,677-$6,190
No	Discharge	4	$3,359	$2,643-$3,625

EDCV, Emergency Department Cardioversion; *IQR,* interquartile range

The safety of this approach to the management of recent onset AF has already been established in a number of prior reports on this topic and EDCV is considered standard management in many EDs. [1,2,5,10] This current study was not designed to re-examine this question.

This is the first study to examine the economic implications of the aggressive ED management of recent onset atrial fibrillation/flutter. The incidence of atrial fibrillation related ED visits have increased by 88% from 1993 though 2003 with 65% resulting in ED admissions at a cost of over $6.65 billion dollars. [1] ED Cardioversion and Discharge could produce substantial savings if more universally applied to this population.

An unexpected finding in this study was the resource savings produced by simply attempting EDCV regardless of the results. Admitted patients remaining in atrial fibrillation or flutter following cardioversion attempts still exhibited hospital charges $8,628 lower than those admitted with no EDCV attempt.

LIMITATIONS

Because this was a retrospective study, patient treatments were not randomized. Even though we attempted to control for this in the structured data abstraction process, it is still possible that different treatment paths were selected based on the patient's presentation.

CONCLUSION

The use of ED Cardioversion in patients with recent onset of AF is associated with decreased hospital charges. These findings would support the cost effectiveness of aggressive ED management of patients with this condition.

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REFERENCES

1. Barrett TW, Martin AR, Storrow AB, et al. A clinical prediction model to estimate risk for 30-day adverse events in emergency department patients with symptomatic atrial fibrillation. *Ann Emerg Med*. 2011;57:1-12.
2. Stiell IG, Clement CM, Brison RJ, et al. Variation in management of recent-onset atrial fibrillation and flutter among academic hospital emergency departments. *Ann Emerg Med*. 2011;57:13-21.
3. Dankner R, Shahar A, Novikov I, Agmon U, Ziv A, Hod H. Treatment of stable atrial fibrillation in the emergency department: a population-based comparison of electrical direct-current versus pharmacological cardioversion or conservative management. *Cardiology*. 2009;112:270-8.
4. Roy D, Talajic M, Nattel S, et al. Rhythm control versus rate control for atrial fibrillation and heart failure. *N Engl J Med*. 2008;358:2667–2677.
5. Stiell IG, Clement CM, Perry JJ, et al. An aggressive protocol for rapid management and discharge of emergency department patients with recent-onset episodes of atrial fibrillation and flutter. *CJEM*. 2010;12:181–191.
6. Stead LG, Vaidyanathan L. Evidence-based Emergency Medicine/Systematic Review Abstract. Rhythm control with electrocardioversion for atrial fibrillation and flutter. *Ann Emerg Med*. 2009;54:745-7.
7. Stewart S, Hart CL, Hole DJ, et al. A population-based study of the long-term risks associated with atrial fibrillation: 20-year follow-up of the Renfrew/Paisley Study. *Am J Med*. 2002;113:359–364.
8. Zahir S, Lheureux P. Management of new-onset atrial fibrillation in the emergency department: is there any predictive factor for early successful cardioversion? *Eur J Emerg Med*. 2005;12:52-6.
9. Fundarò C, Galli A, Paglia S, et al. Atrial fibrillation in emergency department: prevalence of sinus rhythm 1 week after discharge. *Emerg Med J*. 2011 Mar 25. [Epub ahead of print]
10. von Besser K, Mills AM. Is discharge to home after emergency department cardioversion safe for the treatment of recent-onset atrial fibrillation? *Ann Emerg Med*. 2011 Dec;58:517-20.

Accuracy of Handheld Point-of-Care Fingertip Lactate Measurement in the Emergency Department

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Introduction: Early recognition of elevated lactate levels in sepsis may hasten the detection of those patients eligible for aggressive resuscitation. Point-of-care (POC) testing is now increasingly available for use in the emergency department (ED). We examined the accuracy and time-saving effect of a handheld POC device for the measurement of fingertip and whole blood lactate as compared with reference laboratory testing in critically ill ED patients.

Methods: A convenience sample of adult ED patients receiving serum lactate testing was prospectively enrolled at an urban, tertiary care US hospital. Consenting patients underwent fingertip POC lactate measurement with a portable device and simultaneous whole blood sampling for analysis by both the POC device and standard laboratory analyzer ("reference method"). Lactate measurements were compared by intraclass correlation (ICC) and Bland and Altman plots. Differences in time to test result were compared by paired *t* test.

Results: Twenty-four patients, 19 (79%) with sepsis and 21 (88%) with lactate levels below 4 mmol/L, were included from April 2005 to May 2005. Fingertip POC and whole blood POC lactate measurements each correlated tightly with the reference method (ICC = 0.90 and ICC = 0.92, respectively). Mean time between obtaining fingertip lactate samples and whole blood reference lactate samples was 8 ± 13 minutes. Mean time between obtaining POC and reference laboratory lactate results was 65 minutes (95% confidence interval, 30–103).

Conclusion: Fingertip POC lactate measurement is an accurate method to determine lactate levels in infected ED patients with normal or modestly elevated lactate values and significantly decreases time to test results. These findings should be verified in a larger, more critically ill, ED population. [West J Emerg Med. 2013;14(1):58–62.]

INTRODUCTION

Sepsis is defined as the systemic inflammatory response to infection. When associated with organ dysfunction, sepsis is considered severe and is accompanied by an increased risk of mortality. Like myocardial infarction and stroke, sepsis is a time-sensitive condition amenable to early intervention. Serum lactate level obtained in the emergency department (ED) is predictive of mortality among patients with suspected infection and is used to help determine which septic patients are candidates for early, aggressive resuscitation.[1–3] International consensus-based guidelines on sepsis recommend that serum lactate measurement be available with a rapid turnaround time ("within minutes") to help identify patients with tissue hypoperfusion who are at increased risk of morbidity and mortality.[4]

Several obstacles exist to the rapid determination of lactate levels in the ED and the use of these results in patient care. Prolonged ED wait times, whether due to increased patient volume, protracted boarding times for admitted patients, or local hospital closures, have an impact on time to patient triage and evaluation.[5] Further delays result from limitations in traditional laboratory analysis, in which test results can take hours to return and must be actively sought out by the clinician. Point-of-care (POC) devices have recently been implemented in a wide range of clinical settings, from ED triage to the intensive care unit (ICU), to hasten detection of time-sensitive disease states and expedite care.[6–8] While the accuracy of whole blood POC lactate has been validated in ED and ICU patients, the performance of POC fingertip lactate measurement has been called into question.[7,8] Furthermore, studies to date of ED POC lactate measurement in sepsis have not evaluated the use of a handheld device, which may allow for even more rapid determination of test results in the hectic ED environment.[9]

The purpose of this study was to determine the accuracy of a handheld POC device for the measurement of fingertip lactate, as compared with (1) whole blood POC and (2) whole blood laboratory testing, in critically ill ED patients. We hypothesized that both whole blood and fingertip POC measurements would closely correlate with laboratory testing and that POC testing would significantly decrease time to lactate results.

METHODS

Study Design

Prospective, observational study of a convenience sample of adult ED patients conducted from April 2005 to May 2005. The research design was preapproved by the Institutional Review Board for Human Research at the Hospital of the University of Pennsylvania. Written informed consent was obtained from all patients before enrollment.

Study Setting and Population

The study was conducted in a 700-bed urban tertiary care hospital with a 56-bed ED that provides care to approximately 55,000 adult patients annually. All patients receiving serum lactate testing ordered by the treating emergency physician were eligible for inclusion. Patients were excluded only if fingertip or whole blood venipuncture samples could not be technically obtained, which did not occur in any patients eligible for the study. No formal departmental protocol encouraging lactate measurement in patients with suspected sepsis was in place at the time of study enrollment. The purpose of examining the accuracy of the POC device was for future research examining POC lactate as a screening tool at ED triage.[10]

Study Protocol

Point-of-care analysis was performed with a Lactate Pro analyzer (LT-1710, Arkray Inc, Kyoto, Japan), which uses a 5-μL sample, has a detection range from 0.8 to 23.3 mmol/L, and provides results in 60 seconds. This device is Clinical Laboratory Improvement Amendments (CLIA)–approved for POC testing of lactate in the United States. For the purposes of statistical analysis, values registering less than 0.8 mmol/L, read as "Lo" on the device, were coded as 0.7 mmol/L. The device uses single-use test strips containing an enzyme-coated electrode.[10,11] The machine was calibrated by one of the study investigators by using a factory-supplied calibration strip, and tested by using a check strip with a known value, every 8 hours while in use. The principal investigators (M.G., D.F.G.) received in-depth training on use of the POC device from a representative of the manufacturer and then trained the remaining study investigators, who all performed at least 2 fingertip samples on the principal investigators before enrolling subjects into the study. Documents related to CLIA approval of the Lactate Pro POC device were reviewed by the hospital's POC testing specialists before the start of the study.

Consenting patients received a finger-prick with a disposable lancet to puncture the skin and obtain capillary blood for POC analysis. Whole blood samples (approximately 5 cc) were subsequently obtained from a venipuncture site or indwelling arterial catheter and collected in grey-top tubes (BD Vacutainer, sodium fluoride 10 mg/potassium oxalate 8 mg). Fingertip and whole blood samples were drawn as close in time as possible. A single drop of whole blood was used to measure POC lactate concentration with the Lactate Pro device. Whole blood grey-top tube samples were sent to the central hospital laboratory per institutional practice and were analyzed on a Vitros 950 analyzer (Ortho-Clinical Diagnostics, Rochester, New York), which served as the "reference method." The Vitros 950 analyzer measures whole blood lactate level in approximately 12 minutes and was calibrated and maintained according to manufacturer standards. Whole blood reference method results were entered into the hospital electronic medical record by laboratory personnel. No messages were sent or callbacks made to the treating physicians regardless of the lactate result, since elevated lactate values were not considered critical values in our hospital laboratory at the time the study was conducted. Treating ED physicians were blinded to POC test results.

Measurements

Triage time and the time of blood sampling for lactate analysis, as well as the reason for obtaining lactate measurement, were recorded for all patients. The primary outcome measure was the accuracy of fingertip POC lactate in comparison to the reference method for lactate analysis. Secondary outcomes were the accuracy of whole blood POC lactate compared to the reference method and the time differential from fingertip POC lactate result to laboratory reference method result. Data were documented on collection forms and then entered into database software (Access 2000, Microsoft Corp, Redwood, Washington).

Data Analysis

Agreement of the POC device with the laboratory reference method was assessed by calculating the intraclass correlation coefficient (ICC), and ICC values greater than 0.9 were considered excellent agreement. To determine the variability of the POC device, as compared to the reference method, Bland and Altman plots[12] were developed with mean difference and limits of agreement. Fingertip POC and whole blood POC values were each compared with the reference method. Post hoc analysis demonstrated that a sample size of 24 subjects with 2 observations per subject achieves 89% power to detect an intraclass correlation of 0.900 under the alternative hypothesis when the intraclass correlation under the null hypothesis is 0.700, using an F test with a significance level of 0.05000. The mean difference in the time between blood sampling and determination of lactate results between assays was compared by paired *t* test. Analyses were performed with SAS statistical software (version 9.1, SAS Institute, Cary, North Carolina).

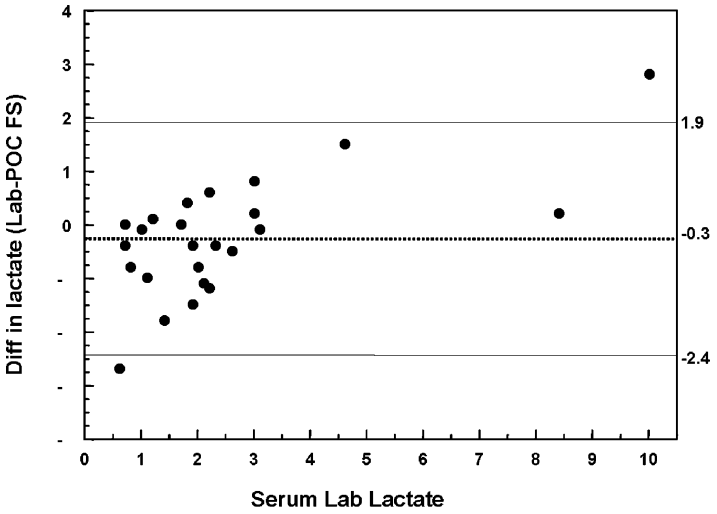

Figure 1. Reference versus fingertip point-of-care (POC). Dotted line represents the mean difference between reference value and POC value. Dashed lines represent limits of agreement (95% confidence interval). *FS*, fingerstick.

RESULTS

Twenty-five patients consented and were enrolled in the study. One patient was withdrawn from the study because of incomplete data collection. Seventy blood samples were taken from the remaining 24 patients; 24 fingertip and 22 whole blood samples were analyzed with the POC device and 24 whole blood samples were analyzed by the reference method. Patient characteristics upon inclusion are shown in the Table. Most patients (79%) presented with sepsis (≥2 Systemic Inflammatory Response Syndrome criteria and suspected infection). Three patients (13%) had suspected infections but did not meet criteria for sepsis. Three patients (13%) were discharged to home, while the other 21 (87%) were admitted to the hospital and 9 (38%) were admitted to the intensive care unit.

Fingertip POC lactate measurement correlated closely with the reference method, with ICC equal to 0.90 (Figure 1). The Bland and Altman plot demonstrated that fingertip POC measurements more often measured slightly higher (mean difference = −0.3 with limits of agreement between −2.4 and 1.9, Figure 1). Only 2 values fell outside of the limits of agreement (−2.4, 1.9); 1 patient with POC value equal to 3.3 mmol/L and laboratory value equal to 0.6 mmol/L and another patient with POC value equal to 7.2 mmol/L and laboratory value equal to 10 mmol/L. Whole blood POC lactate measurement correlated more closely with the reference method, with ICC equal to 0.92 (Figure 2). The Bland and Altman plot demonstrated a mean difference of 0.25, with limits of agreement between −1.2 and 1.7 (Figure 2). In this case, whole blood POC measurements more often measured lower than the reference method. Only 1 value fell outside of the limits of agreement.

Table. Demographics.

No. of patients enrolled	24
Age, y	57.5 ± 15.9
Male, %	58
Reason for inclusion, n (%)	
Sepsis syndrome*	19 (79)
Infection without sepsis	3 (13)
Hemoptysis	1 (4)
Nausea/vomiting	1 (4)

* Sepsis was defined as a suspected infection and 2 or more systemic inflammatory response syndrome criteria.

Mean time between fingertip POC blood sampling and whole blood reference sampling was 8 ± 13 minutes. Mean time between whole blood POC sampling and whole blood reference lactate sampling was 4 ± 13 minutes. Mean time from triage to fingertip POC lactate result was 86 minutes (95% confidence interval [CI] = 13–159), while mean time from triage to whole blood reference lactate result was 151 minutes (95% CI = 73–230). Mean time to fingertip POC lactate result was shorter than whole blood reference lactate result by 65 minutes (95% CI, 30–103; $P < 0.005$).

DISCUSSION

The use of POC blood lactate measurement has been examined in the care of critically ill ICU and trauma patients but has only recently been studied in an ED population. Whole blood POC lactate measurement has previously been shown to correlate well with laboratory-measured whole blood lactate in the ED, which our results support.[9] However, Boldt et al[8] recently cautioned against the use of fingertip POC lactate

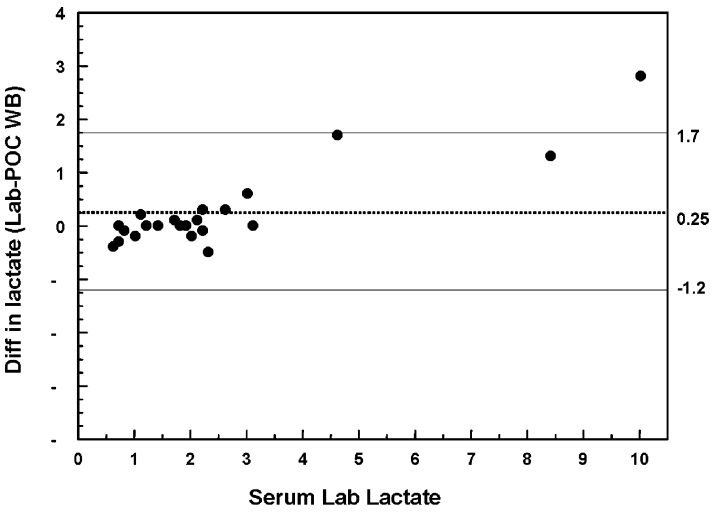

Figure 2. Reference versus whole blood point-of-care (POC). Dotted line represents mean difference between reference value and POC value. Dashed lines represent limits of agreement (95% confidence interval). *WB*, whole blood.

because of suboptimal accuracy when compared to laboratory-analyzed arterial blood in an ICU population. Our results, however, demonstrated good agreement between fingertip POC and whole venous blood laboratory-determined lactate levels. While Boldt et al[8] used a different POC device than that used in the current study, the difference may also be attributed to the patient population tested. Patients in the ICU have often received large volumes of intravenous fluid resuscitation which, in addition to continued capillary leak and decreased intravascular osmotic pressure, can lead to diffuse tissue edema.[13] In contrast, critically ill patients presenting to the ED are often hypovolemic, potentially decreasing the amount of extravascular fluid that enters a fingertip blood sample. This may account for the improved accuracy noted in our study compared to prior trials.

We also found that use of a handheld POC lactate device reduced the time to obtain test results as compared to the reference method by 65 minutes. This represents a significantly greater time than the 12 minutes required by the laboratory device to display test results. Although turnaround time for laboratory blood sampling measurement is institution specific, several factors, such as time spent during physician evaluation, test ordering, or blood sampling and availability of laboratory personnel, delay test results in many hospitals. Mislabeling or misplacing samples can also delay time to test results using central laboratory testing. A handheld POC device provides an immediate result, visualized by the bedside care provider in real time, as opposed to results of standard ED POC and central laboratory testing, which must be actively sought out in the medical record by the clinician. Use of handheld, portable POC lactate measurement, either by bedside care providers, emergency medical services personnel, or as a screening tool at ED triage, could allow for immediate risk stratification of potentially critically ill patients, a strategy that has recently undergone preliminary evaluation.[10,14] Combined with initial history and bedside evaluation, such results could allow for rapid administration of time-sensitive sepsis therapies, such as broad-spectrum antibiotics and aggressive fluid resuscitation.[15] When the speed of obtaining lactate results provided by a POC device is combined with the risk stratification ability of an initial lactate reading for ED patients with severe sepsis,[3] POC lactate measurement has significant clinical utility. Handheld fingertip lactate meter may also allow for repeated lactate levels to be more readily obtained after initial resuscitation, which could be used to determine lactate clearance. Lactate clearance has recently been shown to be equivalent to invasive central venous oxygen saturation monitoring in ED-based early goal-directed therapy of severe sepsis and septic shock.[16]

LIMITATIONS

This study has a number of limitations. Severe sepsis was not a strict inclusion criterion for this study; thus, our results may not be fully generalizable to all patients along the sepsis spectrum. However, most patients presented with sepsis (79%) or a clinically significant suspected infection (13%). Another limitation was that we did not standardize the location or tourniquet time for whole blood or POC sampling. By restricting blood flow to the distal portion of the limb, a tourniquet may theoretically cause increased anaerobic metabolism leading to an elevation in capillary blood lactate levels. One recent study using healthy volunteers, however, showed this assumption to be incorrect.[17] Nonetheless, our results showed that POC lactate values were biased slightly higher than reference lactate results, which could be a consequence of this phenomenon. Standardization of tourniquet time and location would be ideal, but in practice is difficult in the emergency setting and in critically ill patients with potentially limited peripheral venous access. We also did not examine the precision of the POC device in this population, though prior work has validated this parameter in healthy individuals.[11] Another key limitation is the small sample size. With only 24 patients, of whom only 3 had whole blood lactate levels of 4 mmol/L or greater, we can only draw limited conclusions regarding the ability of the POC device to accurately measure serum lactate levels in patients with sepsis who are eligible for early goal-directed resuscitation.[1] Given that the few elevated lactate levels obtained in our study showed a slightly greater disagreement between POC and reference results, this limitation must be explicitly addressed before use of this handheld device is considered beyond an experimental setting. Formal cost-effectiveness analyses should also be conducted to examine the economic impact of bedside POC lactate testing in sepsis.

CONCLUSION

In conclusion, fingertip POC lactate measurement closely correlated with reference laboratory whole blood testing in an

ED population consisting primarily of patients with sepsis and normal or modestly elevated lactate levels. Use of a handheld POC lactate device also reduced time to lactate test results. The small sample size and small number of elevated (>4 mmol/L) values limit conclusions regarding the use of this device in patients eligible for early goal-directed therapy. Further studies are needed to verify these results in a larger population, particularly patients with shock or severe global tissue hypoxia, and to test the effects of early detection of lactate levels on the prognosis and treatment of ED patients with sepsis.

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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. None of the researchers involved in this project have received compensation from, have intellectual property interest in, or own stock in the manufacturers of the point-of-care lactate device used to conduct the research. No manufacturer sponsorship was involved in the study. The device and cartridges used were provided by the manufacturer at no cost. Arkray, Inc, had no role in study design, data acquisition, data analysis, or writing of the manuscript. They did not review the manuscript at any point during the submission process.

REFERENCES

1. Rivers E, Nguyen B, Havstad S, et al. Early goal-directed therapy in the treatment of severe sepsis and septic shock. *N Engl J Med*. 2001;345: 1368–1377.
2. Shapiro N, Howell M, Talmor D, et al. Serum lactate as a predictor of mortality in emergency department patients with infection. *Ann Emerg Med*. 2005;45:524–528.
3. Mikkelsen ME, Miltiades AN, Gaieski DF, et al. Serum lactate is associated with mortality in severe sepsis independent of organ failure and shock. *Crit Care Med*. 2009;37:1670–1677.
4. Dellinger RP, Levy MM, Carlet JM, et al. Surviving Sepsis Campaign: international guidelines for management of severe sepsis and septic shock: 2008. *Crit Care Med*. 2008;36:296–327.
5. Purnell L. Reducing waiting time in emergency department triage. *Nurs Manage*. 1995;26:64Q,64T,64V.
6. Degroote N, Pieper B. Blood glucose monitoring at triage. *J Emerg Nurs*. 1993;19:131–133.
7. Slomovitz B, Lavery R, Tortella B, et al. Validation of a hand-held lactate device in determination of blood lactate in critically injured patients. *Crit Care Med*. 1998;26:1523–1528.
8. Boldt J, Kumle B, Suttner S, et al. Point-of-care (POC) testing of lactate in the intensive care patient. Accuracy, reliability, and costs of different measurement systems. *Acta Anaesthesiol Scand*. 2001;45: 194–199.
9. Shapiro N, Fisher C, Donnino M, et al. The feasibility and accuracy of point-of-care lactate measurement in emergency department patients with suspected infection. *J Emerg Med*. 2010;39:89–94.
10. Moore C, Jacob S, Pinkerton R, et al. Point-of-care lactate testing predicts mortality of severe sepsis in a predominantly HIV type 1-infected patient population in Uganda. *Clin Infect Dis*. 2008;46:215–222.
11. Shimojo N, Naka K, Uenoyama H, et al. Electrochemical assay system with single-use electrode strip for measuring lactate in whole blood. *Clin Chem*. 1993;39:2312–2314.
12. Bland J, Altman DG. Statistical methods for assessing agreement between two methods of clinical measurement. *Lancet*. 1986;1:307–310.
13. Koomans H, Boer W. Causes of edema in the intensive care unit. *Kidney Int Suppl*. 1997;59:S105–S110.
14. Goyal M, Pines J, Drumheller B, et al. Point-of-care testing at triage decreases time to lactate level in septic patients. *J Emerg Med*. 2010;38: 578–581.
15. Gaieski DF, Mikkelsen MM, Band RA, et al. Impact of time to antibiotics on survival in patients with severe sepsis or septic shock in whom early goal-directed therapy was initiated in the emergency department. *Crit Care Med*. 2009;38:1045–1053.
16. Jones A, Shapiro N, Trzeciak S, et al. Lactate clearance vs central venous oxygen saturation as goals of early sepsis therapy: a randomized clinical trial. *JAMA*. 2010;303:739–746.
17. Jones A, Leonard M, Hernandez-Nino J, et al. Determination of the effect of in vitro time, temperature, and tourniquet use on whole blood venous point-of-care lactate concentrations. *Acad Emerg Med*. 2007;14: 587–591.

Fatality and Injury Severity of Older Adult Motor Vehicle Collisions in Orange County, California, 1998–2007

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Introduction: Injuries and fatalities in adult drivers 18–65 years of age have decreased in recent years due to safer vehicles, enhanced medical policies, and implementation of injury prevention policies. However, adult drivers over 65 years of age are continuing to suffer from motor vehicle collision-related injuries and fatalities at a more constant rate. A number of physiological factors contribute to the deterioration in visual acuity, slower reaction speeds, and decreased awareness in older drivers. The objective of this study was to examine injury severity and fatality rates in older drivers compared to their younger counterparts in Orange County, California.

Methods: This study used the Statewide Integrated Traffic Record System data for Orange County for the years 1998–2007. Drivers were categorized into 4 age groups: 25–64, 65–74, 75–84, and older than 85 years of age. Injury severity was assessed by the investigating officer.

Results: Of the 197,814 drivers involved in motor vehicle collisions, 178,481 (90.2%) were in the 25–64 age group; 11,397 (5.8%) were 65–74; 6,592 (3.3%) were 75–84; and 1,344 drivers (0.7%) were over 85. Those aged 25–64 had the lowest fatality rate per 100,000 people, 2.5, whereas those 75–84 had the highest fatality rate, 4.9. The percent of crashes involving a left turn increased with age, and the percent that were stopped in the road decreases with age. Change in injury collision involvement ratio in the 3 younger age groups decreased by 26% to 32%, but decreased by 18% among drivers aged 85 years and older.

Conclusion: The decrease in collision fatalities was greater in the 25–64-year-old group compared to the older adult population. This disparity highlights the need for further injury prevention efforts for older drivers. [West J Emerg Med. 2013;14(1):63–68.]

INTRODUCTION

In 2009, the US Census Bureau reported that, by the year 2050, the population of adults 65 years of age and older will more than double (39 million to 89 million).[1] Based on the US census between 1990 and 2000, California experienced a 15% increase in residents over age 65 and a 42% increase in those over age 85. In 2000, in the United States, Orange County had the eighth largest population of older adults (over 65) and was 10th in population of older adults over 85.[2] As a result of this population growth, the number of licensed older drivers continues to be on the rise. In 2004, nearly 2.7 million licensed drivers in the US were older adults.[3] The Centers for Disease Control and Prevention reported that, in 2007, for those 65 and older, unintentional injury was the ninth leading cause of

mortality with over 38,000 deaths. Motor vehicle collisions (MVC) made up a little over 17% of those deaths; only falls account for a greater number of unintentional deaths for this age group.[4] According to the National Highway Traffic Safety Administration, in 2008, drivers 65 and older accounted for 14% of all traffic fatalities.[5] Many federal and state government agencies, including traffic safety organizations, have tried to understand and reduce the risk associated with MVCs in older drivers; however, the death rate from MVCs in older drivers is decreasing more slowly compared to other age groups. In the United States between 1990–2000, the death rate in older adults decreased from 23.1 to 21.4 (7%) deaths per 100,000 people, compared to a drop from 34.1 to 26.9 (21%) in the 15–24 age group, and from 23.6 to 17.3 (27%) in the 25–34 age group.[6] Although the fatality rate decreased in older adult drivers, the fact that younger drivers drive more miles per year and show a greater decrease may present an even greater problem for the older adult age group. This suggests that MVC-related deaths among the older adult age group may be less responsive to improvements in traffic safety, including improved automobiles, better street lighting and traffic signals to enhance visibility, better enforcement of traffic and seatbelt laws, and efforts against impaired driving. In this study, we attempt to analyze the impact these safety strategies have had on older drivers by investigating older adult MVC incidence and severity in Orange County, California, from 1998–2007.

METHODS

This study used the Statewide Integrated Traffic Record System (SWITRS) data for Orange County, California (urban-suburban mix with population 2.7–3.0 million), for the years 1998–2007. The SWITRS accumulates data for vehicle traffic collisions occurring on public roadways in California. The Information Management Division of the California Highway Patrol maintains SWITRS.

We excluded drivers aged 24 and younger, those with no reported age, and collisions with no reported injuries.[7] The remaining drivers were categorized into 4 age groups: working age (25–64 years), and 3 categories of older drivers, using conventional vital statistics categories (65–74, 75–84, and older than 85). The severity of each injury was assigned by the investigating police officer for 1 of 4 categories: fatality (occurring within 30 days), severe injury (including broken or dislocated limbs, severe lacerations, or unconsciousness), other visible injury (including bruises and abrasions), and complaint of pain (which is interpreted to include confusion, limping, and claims of injury).[8] These categories do not necessarily correspond to medically-assessed severity.[9,10]

We defined the injury collision involvement ratio as the number of collisions divided by estimated population and the driver fatality ratios as the number of driver deaths divided by the estimated population. Data was taken from MVCs occurring in Orange County, California. We calculated injury collision involvement ratios and driver fatality ratios by age and sex using population estimates from the California Department of Finance and calculated confidence intervals (CI) for the ratios using the log normal approximation to the Poisson distribution.[11,12] These ratios approximate rates if the number of Orange County drivers involved in collisions outside of Orange County is equal to the number of non-Orange County drivers involved in collisions in Orange County and if the population is equal to the number of drivers. Trends in ratios were assessed by variance-weighted least squares regression using Stata (version 10.1, Stata Corporation, College Station, Texas).

Due to the use of a publicly available dataset, this project was exempt from the institutional review board.

RESULTS

Age and Gender

Of the 197,814 drivers involved in MVCs, 178,481 (90.2%) were in the 25–64 age group; 11,397 (5.8%) were 65–74; 6,592 (3.3%) were 75–84; and 1,344 drivers (0.7%) were over 85. Excluding 151 (0.08%) drivers where sex was unknown, the injury collision involvement ratios by age and sex are shown in Figure 1. Collision involvement decreased with age ($P < 0.0005$). Female drivers had a lower injury collision involvement ratio, and their ratio decreased more steeply with age than that of males ($P < 0.0005$).

Severity of Injury

Figure 2 shows the driver fatality ratios per 100,000 people in each age group. The trend across age groups was the opposite of the trend for the injury collision involvement shown in Figure 1. Those aged 25–64 had the lowest fatality ratio per 100,000 people, 2.5 (95% CI was 2.3–2.7), whereas those 75–84 had the highest fatality ratio, 4.9 (95% CI was 3.7–6.4), despite having a lower collision involvement. As shown in the Table, of the 178,481 collisions in those aged 25–64, complaint of pain was the most common category of injury (70.1%). The percentage of collisions classified as complaint of pain deceased with increasing age, while the percentage of

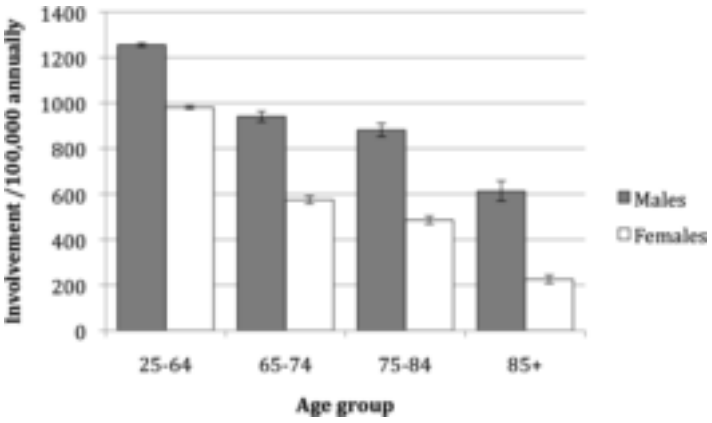

Figure 1. Injury collision involvement ratio per 100,000 people annually by age group and sex, Orange County, California, 1998–2007.

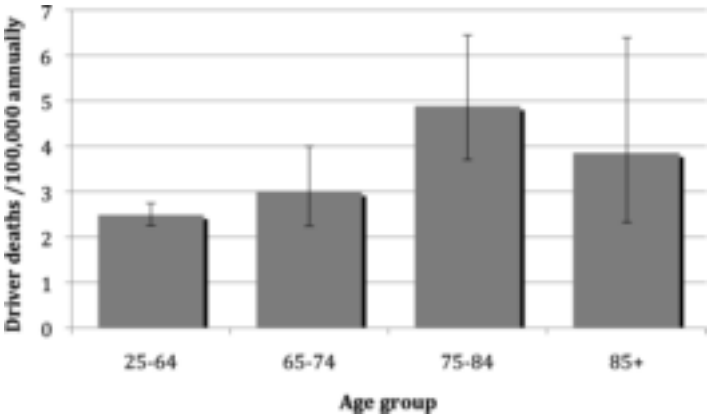

Figure 2. Driver fatality ratio per 100,000 people annually by age group, Orange County, California, 1998–2007.

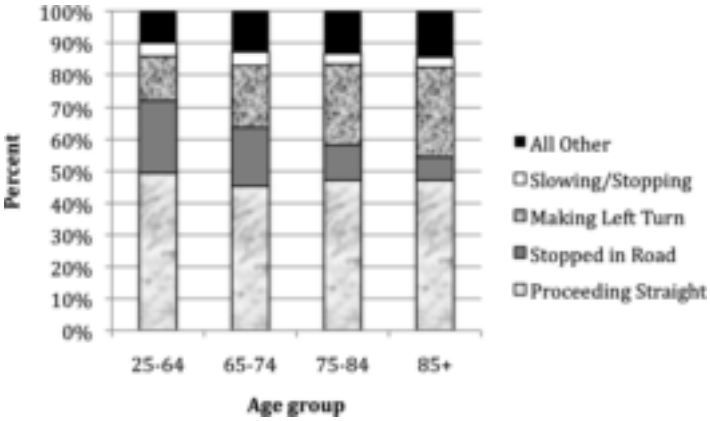

Figure 3. Type of movement preceding collision in nonfreeway collisions by driver age, Orange County, California, 1998–2007.

collisions that involved other visible injuries, severe injuries, and fatalities increased with age.

The type of movement preceding collision for 149,769 nonfreeway collisions (76% of the total) is shown in Figure 3. The percent of collisions involving a left turn increased progressively with each age group, and the percent that were stopped in the road decreased with each age group. Presumably, young people stop in the road, and older adults avoid heavy traffic.

Figure 4 shows the change in injury collision involvement ratio over the study period for the 4 age groups. The injury collision involvement ratio decreased by 26% to 32% in the 3 younger age groups, but the ratio decreased by only 18% among drivers aged 85 years and older (P value for difference by age group < 0.0005).

DISCUSSION

Age and Gender

Biophysical changes, human factors, and socioenvironmental factors contribute to older drivers having higher risks of an MVC. Age-related declines in their useful field of view, dynamic visual acuity, lateral motion detection, cognition, hearing, trunk/neck mobility, polypharmacy factors, and psychomotor function contribute to their high collision rates.[13–15]

However, older drivers do compensate for some of their impairments and adjust their driving to maintain safety.[16] Our study demonstrated a decreased injury collision involvement ratio per 100,000 people by age, but McGwin et al reported a collision rate per million miles driven that was increasing by age.[17] This contradiction may be explained by the difference in denominators. There are 3 conventional choices for injury-collision rate denominators: population, the number of older adults with valid driver's licenses, and vehicular miles driven. Miles driven (the denominator used by McGwin et al) is probably the most accurate denominator to evaluate collision rates since approximately two thirds of older adults have a valid driver's license, and they also drive less than middle-aged drivers. Male drivers have greater potential for risk-taking behaviors, such as alcohol-impaired driving and speeding, which may explain the higher collision involvement rate than that of female drivers.[18,19]

We found decreases in the injury collision involvement ratio for all age groups. However, the decrease was smaller for those aged 85 years and older than for younger drivers. Changes in motor vehicle crash protection may not be as effective for the oldest drivers.

Older Driver Movements and Collisions

Older drivers had proportionally more collisions involving left turns. This may be related to perceptual and cognitive difficulties in assessing the movements of other vehicles. On

Table. Highest degree of injury by driver age, Orange County, California, 1998–2007.

	25–64 years of age		65–74 years of age		75–84 years of age		85+ years of age	
Highest degree of injury	Number	%	Number	%	Number	%	Number	%
Complaint of pain	125,039	70.1%	7,675	67.3%	4,064	61.7%	755	56.2%
Other visible injury	47,096	26.4%	3,285	28.8%	2,228	33.8%	525	39.1%
Severe injury	4,924	2.8%	320	2.8%	205	3.1%	43	3.2%
Fatal	1,422	0.8%	117	1.0%	95	1.4%	21	1.6%
Total	178,481		11,397		6,592		1,344	

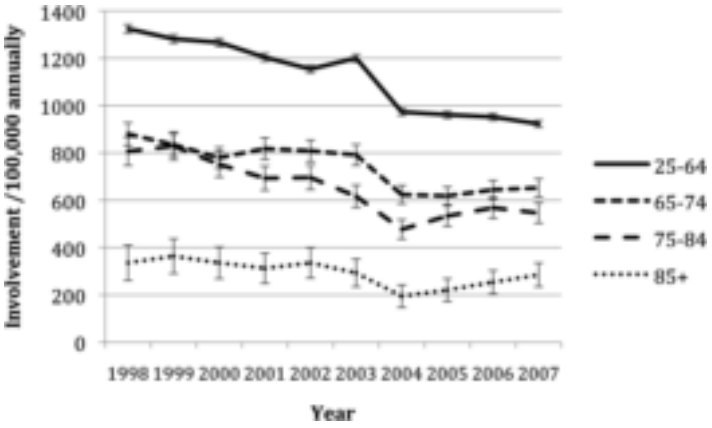

Figure 4. Injury collision involvement ratio per 100,000 people annually by age group and calendar year, Orange County, California, 1998–2007.

the other hand, older drivers had fewer collisions while stopped in the road. This may be related to less commuting and driving in congested traffic.

Severity of Injury

Studies in Maryland and Western Australia have shown that drivers became more fragile as they aged, especially drivers over 80.[20,21] Our study found older drivers had a higher fatality ratio per 100,000 people than middle-aged drivers. Cook et al also found that older drivers were more likely to be killed in MVCs than younger drivers.[21] Furthermore, some studies found older adults were more likely to be hospitalized, their hospital stays were longer, and their mortality rates were higher than younger patients.[22,23] With regards to prevention, the presence of passengers has been shown to decrease risk of motor vehicle collisions. Rueda-Domingoa et al found that the presence of passengers with drivers over the age of 65 years reduced the risk of motor vehicle collisions.[24] This relationship could be further investigated to assist in advising older adults on driving safety.

Older Adult Fragility

The current study demonstrates that older adults are more prone to injury and have lower injury tolerance thresholds in MVCs. Furthermore, physiological and pathological changes in this group increase their morbidity and mortality when involved in MVCs. While the reasons for this increase are multifactorial, it likely reflects biophysical changes of aging, coupled with concomitant disease processes of the crash victim at the time of the collision. Some of the specific reasons for older adult frailty can be delineated by age-related limitation of biological systems. Changes in the cardiovascular system, including the stiffening of the heart and pericardium, combined with atherosclerotic vessels, limit the ability of the heart to compensate after blood loss in MVCs.[25] Pulmonary parenchyma changes and osteoporosis make older adults more prone to rib fractures and pulmonary contusion. Chronic bony changes and narrowing of the spinal canal place older adults at risk for cord contusions as well as central cord syndrome. Loss of the ability of older adults to concentrate urine makes urine output an unreliable indicator for evaluating shock. Subdural hematoma can occur more commonly compared to younger age groups because of less brain volume in a rigid skull.[26] Furthermore, the effect of medications, such as anticoagulants and beta blockers, can increase the difficulty in evaluation and treatment of MVCs. Therefore, evaluation of the older adult patients requires specific attention to the physiologic changes, thorough evaluation, and careful inpatient observation.[27]

Injury Prevention

Injury prevention for the older driver involves 3 distinct aspects: the driver, the vehicle, and the road. Approaches to driver fitness include fitness-to-drive screening and medical and administrative strategies. All approaches should focus on optimizing the opportunity for the senior to safely maintain their mobility because many regions of the US have very poor alternative mobility opportunities for seniors.

Approaches to injury prevention would also include training healthcare providers, family, and the community about the risks of unsafe driving due to age or driving habits. The educational interventions would include providing material to help seniors drive more safely, collaboration with senior focus groups on assessment and licensing tools, as well as looking at options for mobility when driving is no longer safe. Driver aspects would also include screening older adults for safe driving. These would include tools such as the "Roadwise Review" by the American Automotive Association (AAA) and the "Physician's Guide to Assessing and Counseling Older Drivers" by the American Medical Association. In 2004, Florida passed a law that required drivers aged 80 and older to pass a visual screening test before a driver's license can be renewed. Recent research has shown that since the implementation of this mandated law, fatalities in this age group in Florida have decreased linearly.[28]

The vehicle component includes emerging in-vehicle technologies (such as side airbags, age-appropriate restraints that accommodate older drivers' different physiology, and automatic crash notification, blind spot warning systems, and night vision) and helping mature drivers find their perfect fit in their car. Other problems include drivers who cannot reach the brake pedal properly, inappropriately positioned steering wheels (either up or down too much), incorrectly adjusted head restraints or mirrors, and drivers needing instruction in seat adjustment. One AAA program in California administered by trained personnel leads each senior driver through a 20-minute educational assessment to identify and address vehicle fit.

The road aspect focuses on senior-friendly road designs, improving visibility and size of street signs, larger traffic signals, improved lighting, and protected left-turn lanes. Traffic calming may benefit both senior drivers and other road users.[29]

LIMITATIONS

The SWIRTS data were collected by many departments, which can lead to errors during collection and entry. However, the requirement to use the same report as the Traffic Collision Report (CHP555) likely reduces this variability among departments. Regarding severity of injuries, correlating with the hospital medically assessed severity will be much more accurate and comprehensive than using field-assessed data by the investigating officers. Also, most studies have used Injury Severity Scores or Anatomic Injury Scores to report injury severity, but these were not available via the data collected on the CHP555.[30,31] This study also concentrated on only Orange County, California, but a better representative sample for the US would have likely been the state of California. Orange County older adult drivers could have different characteristics than older drivers in other parts of California or in rural parts of the US. The lack of available and viable public transportation in Orange County creates a dynamic that is different than other places in the United States Orange County geography and the comparatively vast distances required to commute create special circumstances for older adults, placing them at further risk than might be encountered on relatively shorter drives common in smaller towns.

CONCLUSION

This study demonstrated that older adult fatalities and the percentage of collisions that involved other visible injuries or severe injuries increased with age. Factors associated with older drivers' MVCs are different from other age groups. There is need for further investigation and prevention strategies to reduce fatalities as well as rate of collisions in older adults.

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REFERENCES

1. US Census Bureau. Census bureau reports world's older population projected to triple by 2050. Available at: http://www.census.gov/PressRelease/www/releases/archives/international_population/013882.html. Accessed October 27, 2009.
2. He W, Sengupta M, Velkoff VA, et al. US Census Bureau, current population reports: special studies. In: *65+ in the United States: 2005*. Washington, DC: US Government Printing Office; 2005:23–209.
3. Federal Highway Administration. Section III: Driver licensing. Highway statistics 2004. Available at: http://www.fhwa.dot.gov/policy/ohim/hs04/dl.htm. Accessed August 22, 2006.
4. National Center for Injury Prevention and Control. Center for Disease Control injury research agenda 2009–2018. Atlanta, GA: Center for Disease Control and Prevention; 2009.
5. National Highway Safety Administration. *Traffic Safety Facts 2008: Older Drivers*. Washington, DC: National Highway Safety Administration's National Center for Statistics and Analysis; 2009:1–6.
6. National Center for Health Statistics. *Health, United States, 2005 with Chartbook on Trends in the Health of Americans*. Washington, DC: US Government Printing Office; 2005:214.
7. California Highway Patrol. *2007 Annual Report of Fatal and Injury Motor Vehicle Traffic Collisions*. Sacramento, CA; 2008.
8. Department of California Highway Patrol. *Collision Investigation Manual (complete revision). HPM 110.5*. Sacramento, CA; 2003.
9. Shinar D, Treat JR, McDonald ST. The validity of police reported data. *Accident Analysis & Prevention*. 1983;15:175–191.
10. Farmer CM. Reliability of police-reported information for determining crash and injury severity. *Traffic Injury Prevention*. 2003;4:38–44.
11. State of California, Department of Finance. *Race/Ethnic Population with Age and Sex Detail, 1990–1999*. Sacramento, CA; 2009.
12. State of California, Department of Finance. *E-3 Race/Ethnic Population Estimates with Age and Sex Detail, 2000–2007*. Sacramento, CA; 2009.
13. Grabowski DC, Morrisey MA. The effect of state regulations on motor vehicle fatalities for younger and older drivers: a review and analysis. *Milbank Q*. 2001;79:517–545.
14. Messinger-Rapport BJ. Assessment and counseling of older drivers: a guide for primary care physicians. *Geriatrics*. 2003;58:16–18.
15. Lotfipour S, Vaca F. Commentary: polypharmacy and older drivers: beyond the doors of the emergency department (ED) for patient safety. *Ann Emerg Med*. 2007;49:535–537.
16. Center for Injury Prevention Policy and Practice. California's aging drivers fact sheet. Available at: http://www.eldersafety.org. Accessed February 18, 2006.
17. McGwin G, Brown DB. Characteristics of traffic crashes among young, middle-aged, and older drivers. *Accid Anal Prev*. 1999;31:181–198.
18. Liu C, Chen C, Subramanian R, et al. Analysis of speeding-related fatal motor vehicle traffic crashes. In: *National Highway Traffic Safety Administration Technical Report*. Springfield, VA: National Technical Information Service; 2005:18.
19. National Highway Traffic Safety Administration. Alcohol involvement in fatal crashes 2000. *DOT HS 809 419*. Washington, DC: National Highway Traffic Safety Administration; 2002:10.
20. Li G, Braver ER, Chen LH. Fragility versus excessive crash involvement

as determinants of high death rates per vehicle-mile of travel among older drivers. *Accid Anal Prev*. 2003;35:227–235.

21. Meuleners LB, Harding A, Lee AH, et al. Fragility and crash over-representation among older drivers in Western Australia. *Accid Anal Prev*. 2006;38:1006–1010.
22. Cook LJ, Knight S, Olson LM, et al. Motor vehicle crash characteristics and medical outcomes among older drivers in Utah, 1992–1995. *Ann Emerg Med*. 2000;35:585–591.
23. Schiller WR, Knox R, Chleborad W. A five-year experience with severe injuries in elderly patients. *Accid Anal Prev*. 1995;27:167–174.
24. Rueda-Domingoa T, Lardelli-Claret P, Luna-del-Castillo J, et al. The influence of passengers on the risk of the driver causing a car collision in Spain: analysis of collisions from 1990 to 1999. *Accident Analysis and Prevention*. 2004;36:481–489.
25. Branfronbrener M, Landowne M, Shock NW. Changes in cardiac output with age. *Circulation*. 1984;69:203–213.
26. Timiras P. *Physiological basis of Aging and Geriatrics*. 4th ed. New York, NY: Lippincott Williams & Wilkins; 2007.
27. Lotfipour S, Vaca FE. *Harwood-Nuss' Clinical Practice of Emergency Medicine*. 4th ed. Philadelphia, PA: Lippincott Williams & Wilkins; 2005: 1124–1128.
28. McGwin G, Sarrels SA, Griffin R, et al. The impact of a vision screening law on older driver fatality rates. *Arch Ophthalmol*. 2008;126:1544–1547.
29. Bunn F, Collier T, Frost C, et al. Traffic calming for the prevention of road traffic injuries: systematic review and meta-analysis. *Inj Prev*. 2003;9: 200–204.
30. Shih HC, Hu SC, Yang CC, et al. Alcohol intoxication increases morbidity in drivers involved in motor vehicle accidents. *Am J Emerg Med*. 2003;21:91–94.
31. Cunningham RM, Maio RF, Hill EM, et al. The effects of alcohol on head injury in the motor vehicle crash victim. *Alcohol*. 2002;37:236–240.

Vital Signs
from the Centers of Disease Control and Prevention's MMWR

Guidelines for Field Triage of Injured Patients

In conjunction with the Morbidity and Mortality Weekly Report published by the Center for Disease Control and Prevention

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The Centers for Disease Control and Prevention (CDC) has published significant data and trends related to the national public health burden associated with trauma and injury. In the United States (U.S.), injury is the leading cause of death for persons aged 1-44 years. In 2008, approximately 30 million injuries resulted in an emergency department (ED) evaluation; 5.4 million (18%) of these patients were transported by Emergency Medical Services (EMS).[1] EMS providers determine the severity of injury and begin initial management at the scene. The decisions to transport injured patients to the appropriate hospital are made through a process known as "field triage." Since 1986, the American College of Surgeons Committee on Trauma (ACS-COT) has provided guidance for the field triage process though its "Field Triage Decision Scheme." In 2005, the CDC, with financial support from the National Highway Traffic Safety Administration (NHTSA), collaborated with ASC-COT to convene the initial meeting of the National Expert Panel on Field Triage (the Panel) to revise the decision scheme. This revised version was published in 2006 by ASC-COT, and in 2009 the CDC published a detailed description of the scientific rational for revising the field triage criteria entitled, "Guidelines for Field Triage of Injured Patients."[2-3] In 2011, the CDC reconvened the Panel to review the 2006 Guidelines and recommend any needed changes. We present the methodology, findings and updated guidelines from the *Morbidity & Mortality Weekly Report* (MMWR) from the 2011 Panel along with commentary on the burden of injury in the U.S., and the role emergency physicians have in impacting morbidity and mortality at the population level. [West J Emerg Med. 2013;14(1):69-76.]

CDC MORBIDITY & MORTALITY WEEKLY REPORT FINDINGS

In the January 2012 *Morbidity & Mortality Weekly Report*, the Centers for Disease Control and Prevention (CDC) published the 2011 recommendations of the National Expert Panel on Field Triage, the latest update on the "Guidelines for Field Triage of Injured Patients" since 2006. The MMWR report described the dissemination and impact of the 2006 Guidelines, outlined the methodology used by the Panel for its 2011 review, explained the revisions and modifications of the 4 triage criteria (physiologic, anatomic, mechanism-of-injury, and special considerations), updated the schematic of the 2006 guidelines, and provided the rationale used by the Panel. They noted that the report is intended to help prehospital–care providers in their daily duties recognize individual injured patients who are most likely to benefit from specialized trauma center resources, and not intended as a mass casualty or disaster triage tool.

BACKGROUND

Trauma and injury play a significant role in the disease burden suffered by the population. In the U.S., unintentional injury is the leading cause of death for persons aged 1-44 years.[4] In 2008, injuries accounted for approximately 181,226 deaths in the U.S.[5] In the same year, approximately 30 million injuries were serious enough to prompt an emergency department (ED) visit; 5.4 million (18%) of these injuries were transported by Emergency Medical Services (EMS) personnel.[1] A national evaluation on the effect of trauma-center care on mortality published in the *New England Journal of Medicine* found that the risk of death is significantly lower when care is provided in a trauma center than in a nontrauma center.[6] EMS personnel provide the entry point for which injured patients enter the health care system. They are responsible for the initial evaluation and management of injured patients in the field and play an integral role in the triage of the injured patient to the appropriate health

care facility. The triage of injured patients to the appropriate health care facility plays a substantial role in patient outcome. The National Study on the Costs and Outcomes of Trauma (NSCOT) identified a 25% relative risk reduction in mortality for severely injured adult patients who received care at a Level I trauma center rather than at a nontrauma center.[6] They concluded that the risk of death is significantly lower when care is provided in a trauma center than in a non-trauma center and argued for continued efforts at regionalization.

In 2005, the CDC, with financial support from NHTSA, collaborated with American College of Surgeons Committee on Trauma (ACS-COT) to convene the initial meetings of the Panel. The Panel comprises persons with expertise in acute injury care, including EMS providers and medical directors, state EMS directors, hospital administrators, adult and pediatric trauma surgeons, persons in the automotive industry, public health personnel, and representatives of federal agencies.[1] The Panel is charged with periodically reevaluating the Guidelines in the context of recently published literature and community experience and, as appropriate, making revisions. In 2006, the end product of that comprehensive revision process was published by ACS-COT with the name "Field Triage Decision Scheme." (Figure 1) In 2009, the CDC published a detailed description of the scientific rational for revising the field triage criteria entitled "Guidelines for Field Triage of Injured Patients: recommendations of the National Expert Panel on Field Triage." In 2011, the Panel reconvened to review the 2006 Guidelines and made revisions where appropriate. A major outcome produced from these meetings was the latest iteration of the Guidelines. (Figure 2)

METHODS

The *Morbidity & Mortality Weekly Report* on the Guidelines for Field Triage of Injured Patients described the methodology used by the Panel for its 2011 review. Published peer-reviewed research was the primary basis for making revisions to the Guidelines. Articles were identified by a structured Medline literature search for articles related to the overall field triage process that were published between January 1, 2006 and May 1, 2011. A total of 2,052 articles were identified for further review. Through an iterative and collaborative process, 4 CDC injury researchers reviewed abstracts to determine their appropriateness for presentation to the Panel. This process identified 241 articles pertaining to field triage. To supplement the structured literature searches, a working group of the Panel reviewed the selected articles, identified additional relevant literature that had not been examined, and made recommendations regarding individual components of the Guidelines. This process identified an additional 48 articles, which, together with the originally identified 241 articles, were provided to the Panel for review. The final recommendations of the Panel were based on the best available evidence and expert opinion where the evidence was lacking.

2011 FIELD TRIAGE GUIDELINE RECOMMENDATIONS

The MMWR elaborated on the Panel recommendations and broke each step of the triage process into its own respective section. There are four steps to the triage process: Step One: Physiologic Criteria, Step Two: Anatomic Criteria, Step Three: Mechanism-of-Injury Criteria, and Step Four: Special Considerations. They also provided a summary of the modifications to the previously published 2006 Guidelines. (Box 1) For the following sections pertaining to the four steps, the reader is encouraged to refer to Figure 2.

Step One: Physiologic Criteria

In Step One, the Glasgow Coma Scale score (GCS), and Respiratory Rate criteria were modified. Step One is intended to allow for rapid identification of critically injured patients by assessing level of consciousness (GCS) and measuring vital signs. Vital sign criteria have been used since the 1987 version of the ACS Field Triage Decision Protocol, and systolic blood pressure (SBP) <90 mmHg and respiratory rate <10 or >29 breaths per minute remain significant predictors of severe injury and need for a high level of trauma care.[1] The report commented on how the GCS criteria guidelines were changed from GCS <14 to GCS ≤13 owing to many readers of the previous guidelines perceiving GCS <14 criterion to mean a recommendation to take patients with at GCS ≤14 to a trauma center. After reviewing the literature, the Panel added "or need for ventilatory support" to the respiratory rate criterion, recognizing that adults and children requiring advanced airway interventions represent a very high-risk group, whether or not other physiologic abnormalities were present.

The Panel recommended transport to a facility that provides the highest level of care within the defined trauma system if any of the following are identified:

- Glasgow Coma Scale ≤13, or
- SBP of <90 mmHg, or
- Respiratory rate of <10 or >29 breaths per minute (<20 in infant aged <1 year), or need for ventilatory support

Step Two: Anatomic Criteria

Step Two of the Guidelines recognizes that certain patients, on initial presentation in the field, have normal physiology but have an anatomic injury that might require the highest level of care within the defined trauma system. The criteria pertaining to chest and extremity injury were modified. The "crushed, degloved, or mangled extremity" criterion was modified to include "pulseless" extremities after review of the literature and because vascular injury of the extremity might lead to significant morbidity and mortality, require a high level of specialized trauma care involving multiple medical specialties, and be present in the absence of a crushed, degloved, or mangled extremity.[1,7] The "flail chest" criterion was modified to "chest wall instability or deformity

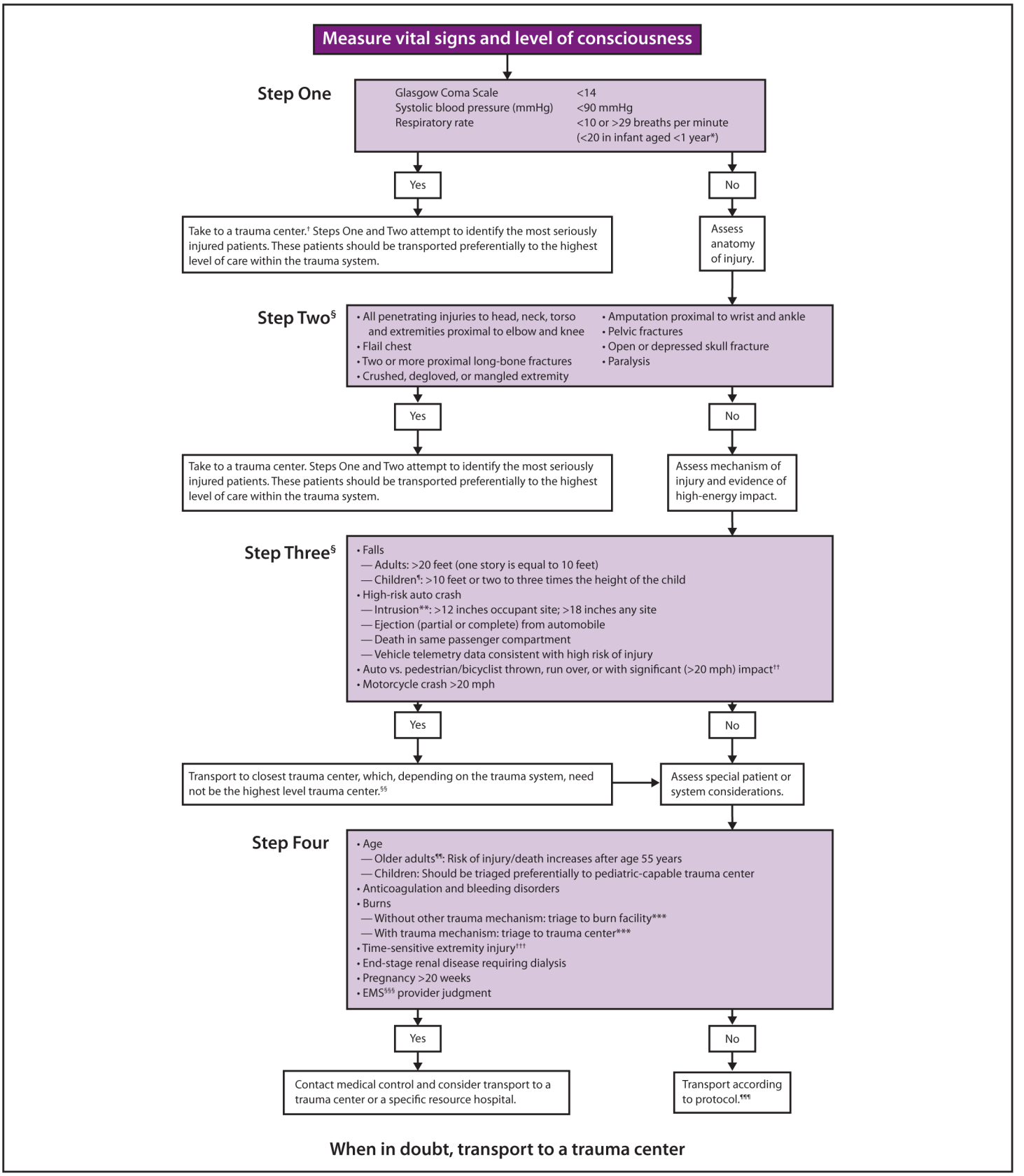

Figure 1. Field triage decisions scheme - United States, 2006.[3]

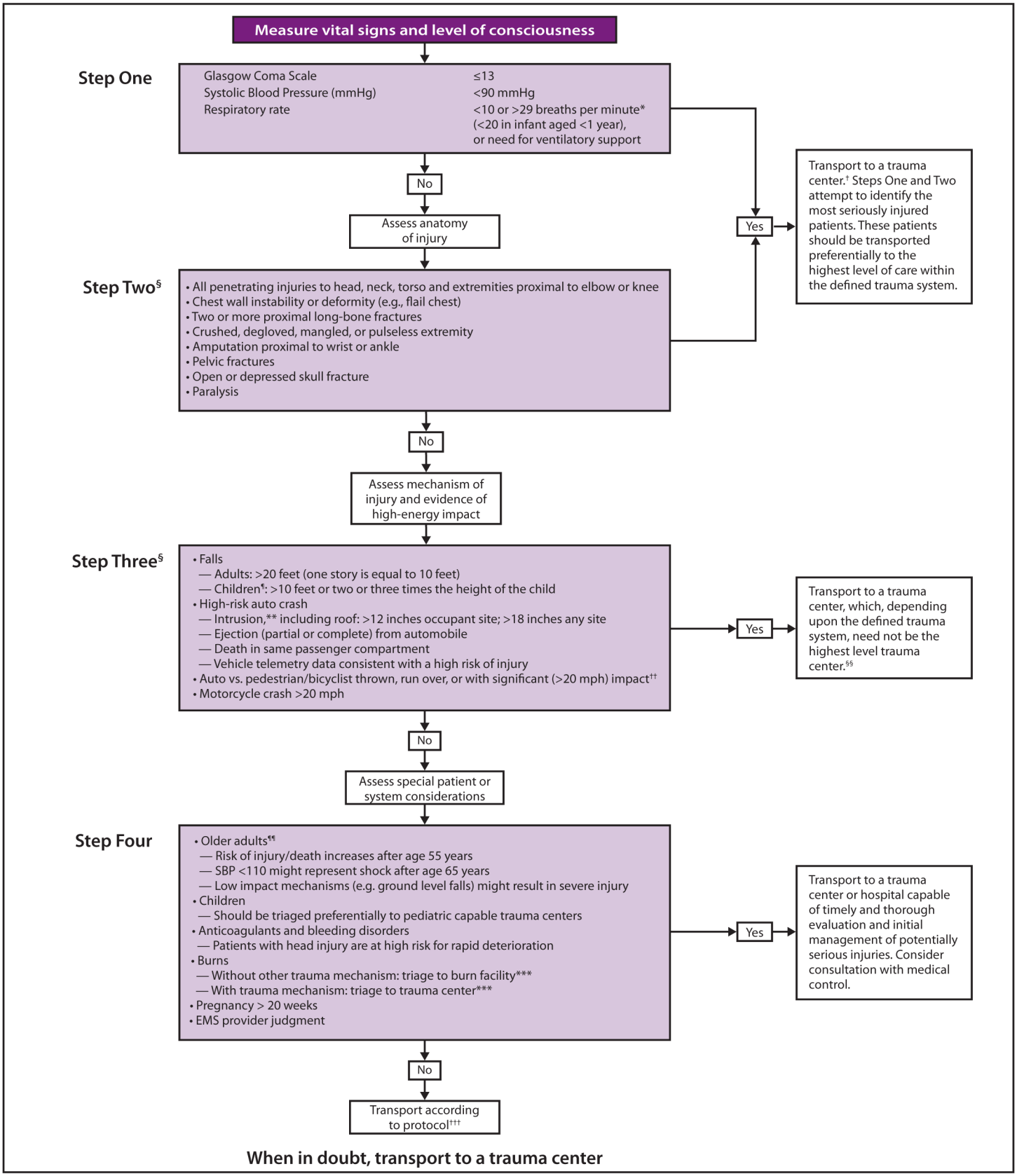

Figure 2. Guidelines for field triage of injured patients - United States, 2011.[1]

(e.g., flail chest).” The report commented on how the Panel recognized that the field diagnosis of a flail chest is rare and that this criterion might be too restrictive, citing studies where flail chest was identified in 0.002% of patients and in 0.02% of patients with chest injuries.[8-9] The Panel decided that the terminology “chest wall instability or deformity (e.g., flail chest)” more accurately describes what EMS providers are asked to identify in the field, and the broader terminology ensures that additional blunt trauma to the chest will be identified and the patient transported to the appropriate facility. The “All penetrating injuries to the head, neck, torso, and extremities proximal to the elbow and knee” criterion was slightly modified to read “elbow or knee.” Consequently, the “amputation proximal to wrist and ankle” criterion was slightly modified to read “wrist or ankle.”

The Panel recommended transport to a facility that provides the highest level of care within the defined trauma system if any of the following are identified:

- All penetrating injuries to head, neck, torso, and extremities proximal to the elbow or knee;
- Chest wall instability or deformity (e.g., flail chest);
- Two or more proximal long-bone fractures;
- Crushed, degloved, mangled, or pulseless extremity;
- Amputation proximal to the wrist or ankle;
- Pelvic fractures;
- Open or depressed skull fractures; or
- Paralysis

Step Three: Mechanism of Injury

An injured patient who does not meet Step One or Step Two should be evaluated in terms of mechanism of injury (MOI) to determine if the injury might be severe but occult. The “high-risk auto crash: intrusion >12 inches occupant site; >18 inches any site” criterion was modified to include roof intrusion. The report cites studies demonstrating the utility of MOI in decreasing the rate of undertriage compared to when physiologic and anatomic criterion were used alone, as well as MOI being an independent predictor of mortality and functional impairment of blunt trauma patients.[10-12] The Panel decided to add “including roof” to the intrusion category because the 2006 guidelines did not convey clearly that vertical intrusion has the same implication for increased injury severity as horizontal intrusion.

The Panel recommended transport to a trauma center if any of the following are identified:

- Falls
  - Adults: >20 feet (one story = 10 feet)
  - Children: >10 feet or two to three times the height of the child
- High-risk auto crash
  - Intrusion, including roof: >12 inches occupant site; >18 inches any site
  - Ejection (partial or complete) from automobile
  - Death in the same passenger compartment
- Vehicle telemetry data consistent with a high risk for injury
- Automobile versus pedestrian/bicyclist thrown, run over, or with significant (>20 mph) impact; or
- Motorcycle crash >20 mph

Step Four: Special Considerations

In Step Four, EMS personnel must determine whether persons who have not met physiologic, anatomic, or mechanism steps have underlying conditions or comorbid

Box 1. Summary of modifications to the 2006 Guidelines.[1]

Step One: Physiologic Criteria
- Change GCS <14 to GCS ≤13
- Add “or need for ventilatory support” to respiratory criteria

Step Two: Anatomic Criteria
- Change “all penetrating injuries to head, neck, torso and extremities proximal to elbow and knee” to “all penetrating injuries to head, neck, torso and extremities proximal to elbow or knee”
- Change “flail chest” to “chest wall instability or deformity (e.g., flail chest)”
- Change “crushed, degloved, or mangled extremity” to “crushed, degloved, mangled, or pulseless extremity”
- Change “amputation proximal to wrist and ankle” to “amputation proximal to wrist or ankle”

Step Three: Mechanism-of-Injury Criteria
- Add “including roof” to intrusion criterion

Step Four: Special Considerations
- Add the following to older adult criteria
  - SBP <110 might represent shock after age 65 years
  - Low-impact mechanisms (e.g., ground-level falls) might result in severe injury
- Add “patients with head injury are at high risk for rapid deterioration” to anticoagulation and bleeding disorders criterion
- Remove “end-stage renal disease requiring dialysis” and “time-sensitive extremity injury”

Transition Boxes
- Change layout of the figure
- Modify specific language of the transition boxes

Abbreviation: GCS = Gasgow Coma Scale; SBP = systolic blood pressure.

factors that place them at higher risk of injury or that aid in identifying the seriously injured patient. Persons who meet Step Four criteria might require trauma center care. In Step Four, the criteria for older adults and anticoagulation were modified, and the criteria for end stage renal disease requiring dialysis and time-sensitive extremity injury were removed.

The "Older adults" criterion was modified to include statements that recognize that a SBP <110 might represent shock after age 65 and that low-impact mechanisms might result in severe injury. The report commented on a retrospective chart review noting an increase in mortality of geriatric patients (aged ≥65 years) presenting to a Level I trauma center with SBP <110mmHg as well as a study finding that occult hypotension being present in 42% of patients with "normal" vital signs.[13-14] In addition, the Panel reviewed literature that indicated that older adults might be severely injured in low-energy events such as ground level falls. The report cited a study indicating that ground level falls accounted for 34.6% of deaths in patients ≥65 years of age, and another study of 57,302 patients with ground level falls demonstrating higher rates of intracranial injury and in-hospital mortality among adults aged ≥70 years of age.[15-16] The changes made to Step Four regarding older adults reflects the Panels view on strengthening the criteria in the context of the latest literature.

After review of the literature, the Panel also elected to strengthen the "anticoagulation and bleeding disorders" criterion, underscoring the potential for anticoagulated patients who do not meet any of the previous criteria but who have evidence of head injury that may undergo rapid decompensation and deterioration. The modification was the addition of the statement "patients with head injury are at high risk for rapid deterioration." The report noted that patients who meet this criterion should be transported preferentially to a hospital capable of rapid evaluation and imaging of these patients and initiation of reversal of anticoagulation if necessary.

The Panel elected to remove the "end-stage renal disease requiring dialysis" criterion, noting that research demonstrating the value of dialysis as a triage criterion for identifying patients with serious injury is lacking, and that concerns regarding anticoagulation in this population are addressed under the anticoagulation and bleeding disorders criterion. The "time-sensitive extremity injury" criterion was also removed. With the addition of "pulseless" of Step Two criteria, the Panel felt this criterion to be redundant, and removed it from the 2011 guidelines.

The Panel recommended transport to a trauma center or hospital capable of timely and thorough evaluation and initial management of potentially serious injuries for patients who meet the following criteria:

- Older adults
  - Risk for injury/death increases after age 55 years
  - SBP <110 might represent shock after age 65 years
  - Low impact mechanisms (e.g., ground-level falls) might result in severe injury
- Children
  - Should be triaged preferentially to pediatric capable trauma centers
- Anticoagulants and bleeding disorders
  - Patients with head injury are at high risk for rapid deterioration
- Burns
  - Without other trauma mechanism: triage to burn facility
  - With trauma mechanism: triage to trauma center
- Pregnancy >20 weeks
- EMS provider judgment

COMMENTARY

Trauma and injury play a significant role in the burden of disease on the population. As the CDC reports, injury is the leading cause of death for persons aged 1-44 years in the U.S., with approximately 30 million injuries resulting in an ED visit annually. In 2008, injuries accounted for approximately 181,226 deaths in the U.S.[5] With 1 American dying approximately every three minutes, the disease burden of trauma and injury in the U.S. is one that cannot be ignored. Efforts to address this issue must come from collaborative efforts from health care providers, public health personnel, policy makers, administrators, automotive industry personnel, law enforcement, healthcare related agencies, and the public. These communities must utilize the available research pertaining to trauma and injury related morbidity and mortality to affect change at the policy level.

Research has demonstrated the benefit that regionalized trauma centers provide those individuals suffering an injury. The National Study on the Costs of Outcomes of Trauma identified a 25% relative risk reduction in mortality for severely injured adult patients who received care at a Level I trauma center rather that at a nontrauma center.[6] Similarly, a retrospective cohort study of 11,398 severely injured adult patients who survived to hospital admission in Ontario, Canada, indicated that mortality was significantly higher in patients initially undertriaged to nontrauma centers (odds ratio [OR] = 1.24; 95% confidence interval [CI] = 1.10 – 1.40).[17] Studies by Gervin et al and Ivatury et al found that rapid transport to a trauma center for patients sustaining penetrating injuries was associated with increased survival.[18-19] Gervin et al found that patients with potentially salvageable injuries had a survival rate of 38%. In this group, a salvage rate of 80% was achieved if transport delays were minimized, as compared to a zero percent salvage rate in patients with prolonged prehospital delay. Similarly, Ivatury et al found a zero percent survival rate in those patients receiving penetrating thoracic injuries who were not immediately transported to the hospital. Many other studies have demonstrated a survival benefit of treating seriously

injured patients in trauma centers, suggesting that the time lost when bypassing nontrauma centers is recouped by the benefits of receiving care at trauma centers.[20-23]

With the significant burden of disease that trauma and injury have on the U.S. population, along with the myriad of studies demonstrating the hospital-based beneficial effect trauma centers have on survival, a major strategy to decrease the morbidity and mortality of injured patients is to care for them at the appropriate health care facility. The concept of field triage addresses this issue specifically. At the individual level, EMS providers are tasked with the initial evaluation and treatment of injured patients. One of the critical decisions they must make is whether the patient has suffered an injury that would be best managed at a trauma center. At the population level, EMS providers make decisions that could potentially decrease injury related mortality by up to 25%. It is this fact that makes field triage resources so vitally important to the population, and also one of the major reasons the CDC has committed resources to disseminating the Guidelines for Field Triage of Injured Patients.

Since 2009, the CDC has undertaken an effort to ensure dissemination, implementation, and evaluation of the Guidelines including the development of training guides, educational material, and resources for EMS providers.[1] The 2009 report was reprinted in its entirety in the *Journal of Emergency Medical Services*, and reproduced in multiple textbooks targeting the EMS, emergency medicine, and trauma care community.[1] In 2010, the national Association of EMS Physicians (NAEMSP) and ACS-COT issued a joint position paper recommending adoption of the Guidelines for local trauma and EMS systems.[24] The National Registry of Emergency Medical Technicians (NREMT) adopted the Guidelines as a standard upon which all certification examination test items relating to patient disposition will be based. The efforts of the CDC to disseminate the field triage criteria as well as the widespread acceptance and implementation of the Guidelines reflect the collective value that many health care organizations, affiliates, and providers place on decreasing trauma and injury related morbidity and mortality.

The "Guidelines for Field Triage of Injured Patients" provide a valuable tool to assist health care providers in the management of injured patients. Given the heterogeneity of EMS systems, this tool must be utilized to maximize the benefit individual patients receive in the context of the available human and capital resources in their communities. Not all systems are the same and not all patients will fit neatly into one of the specified categories. Indeed the heterogeneity of the patient population and EMS system and structure lends to the difficulty in identifying which risk factors may have an effect on patient outcome. The heterogeneity of health care delivery through the EMS system can in part be explained by its development. The North American EMS system developed precipitously in the early 1970s with significant federal grant support and guidance that defined essential system components; however, that guidance did not include a national organizational model for providing EMS services. That decision was left to local communities, and thus, in contrast with many other countries, local EMS systems in the U.S. vary considerably on how they are organized and financed.[25,26] The Guidelines provide the framework for assisting individual EMS systems in providing evidenced based quality care, keeping in mind the local, state, and regional variances on how care is delivered. Accordingly, the Panel recommended that the Guidelines not be referred to as a "national protocol" because using the term "protocol" has an unintended proscriptive inference for the end-user that could restrict local adaptation required for optimal implementation.[1]

At the physician level, emergency physicians and trauma surgeons play a critical role in the evaluation and management of the injured patient. The ED is the gateway for which practically all patients suffering injury enter the health care system to begin receiving definitive treatments. Emergency physicians manage injured patients at the interface between the prehospital and inpatient setting. Having knowledge of EMS systems operations as well as being the first physician to manage injured patients allows emergency physicians the opportunity to have a substantial impact on patient outcome both at the individual and population level. The "Guidelines for Field Triage of Injured Patient" is a vital resource the emergency medicine physician has to combat the morbidity and mortality associated with trauma and injury in the population.

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REFERENCES

1. Centers for Disease Control and Prevention (CDC). Guidelines for Field Triage of Injured Patients. Recommendations of the National Expert Panel on Field Triage, 2011. *MMWR Morbidity and Mortality Weekly Report.* 2012; 61(1): 1-21.
2. American College of Surgeons. Resources for the optimal care of the injured patient: 2006. Chicago, IL: American College of Surgeons; 2006.
3. Centers for Disease Control and Prevention (CDC). Guidelines for Field Triage of Injured Patients. Recommendations of the National Expert Panel on Field Triage, 2009. *MMWR Morbidity and Mortality Weekly Report.* 2009; 58 (No. RR-1)
4. CDC. WISQARS: web-based injury statistics query and reporting

system. Available at www.cdc.gov/injury/wisqars/LeadingCauses.html. Accessed October 5, 2012.
5. DCD. WISQARS: web-based injury statistics query and reporting system: injury mortality reports, 2008, United States. Available at http://www.cdc.gov/injury/wisqars/fatal.html. Accessed October 5, 2012.
6. Mackenzie EJ, Rivara FP, Jurkovich GJ, et al. A national evaluation of the effect of trauma center care on mortality. *N Engl J Med* 2006;354;366-78.
7. Heis HA, Bani-Hani KE, Elheis MA. Overview of extremity arterial trauma in Jordan. *Int Angiol* 2008;27:522-8.
8. Borman JB, Aharonson-Daniel L, Savitsky B, et al. Israeli Trauma Group. Unilateral flail chest is seldom a lethal injury. *Emerg Med J* 2006;23:903-5.
9. Bastos R, Calhoon JH, Baisden CE. Flail chest and pulmonary contusion. *Semin Thoracic Cardiovasc Surg* 2008;20:39-45.
10. Brown JB, Stassen NA, Bankey PE, et al. Mechanism of injury and special consideration criteria still matter: an evaluation of the National Trauma Triage Protocol. *J Trauma* 2011;70:38-44.
11. Haider AH, Chang DC, Haut ER, et al. Mechanis of injury predicts patient mortality and impairment after blunt trauma. *J Surg Res* 2009;153:138-42.
12. Newgard C, Zive D, Holmes JF, et al. A multi-site assessment of the American College of Surgeons Committee on Trauma field triage decision scheme for identifying seriously injured children and adults. *J Am Coll Surg* 2011;213(6):709-21.
13. Heffernan DS, Thakkar RK, Monaghan SF, et al. Normal presenting vital signs are unreliable in geriatric blunt trauma victims. *J Truama* 2010;69(4):813-20.
14. Martin JT, Alkhoury F, O'Connor JA, et al "Normal" vital signs belie occult hypoperfusion in geriatric trauma patients. *Am Surg* 2010;76:65-9.
15. Chisholm KM, Harruff RC. Elderly deaths due to ground-level falls. *Am J Forensic Med Pathol* 2010;31:350-4.
16. Spaniolas K, Cheng JD, Gestring ML, Sangosanya A, Stassen NA, Bankey PE. Ground level falls are associated with significant mortality in elderly patients. *J Trauma* 2010;69:821-5.
17. Haas B, Gomez D, Zagorski B, et al. Survival of the fittest: the hidden cost of undertriage of major trauma. *J Am Coll Surg* 2010;211:804-11.
18. Gervin AS, Fishers RP. The importance of prompt transport in salvage of patients with penetrating heart wounds. *J Trauma* 1982;22:443-8.
19. Ivatury RR, Nallathambi MN, Roberge RJ, et al. Penetrating thoracic injuries: in-field stabilization vs. prompt transport. *J Trauma* 1987;29:1066-73.
20. Mullins Mullins RJ, Veum-Stone J, Helfand M, et al. Outcome of hospitalized injured patients after institution of a trauma system in an urban area. JAMA. 1994;271:1919-24.
21. Mullins RJ, Mann NC, Hedges JR, et al. Preferential benefit of implementation of a statewide trauma system in one of two adjacent states. J Trauma. 1998;44:609-17.
22. Mullins RJ, Veum-Stone J, Hedges JR, et al. Influence of a statewide trauma system on location of hospitalization and outcome of injured patients. J Trauma. 1996;40:536-45.
23. Demetriades D, Martin M, Salim A, Rhee P, et al. The effect of trauma center designation and trauma volume on outcome in specific severe injuries. Ann Surg. 2005;242:512-19.
24. National Association of EMS Physicians. Field triage of the injured patient. Available at www.naemsp.org/documents/FieldTriageoftheInjuredPatient.pdf Accessed October 5, 2012.
25. Boyd DR. The history of emergency medical services in the United States of America. In: Boyd DR, Edlich RF, Micik S, eds. Systems Approach to Emergency Medical Care. Norwalk, Conn: Appleton-Century-Crofts; 1983.
26. Overton J, Stout J. System design. In: National Association of EMS Physicians, eds. Prehospital Systems and Medical Oversight. Dubuque, Iowa: Kendall/Hunt; 2002.

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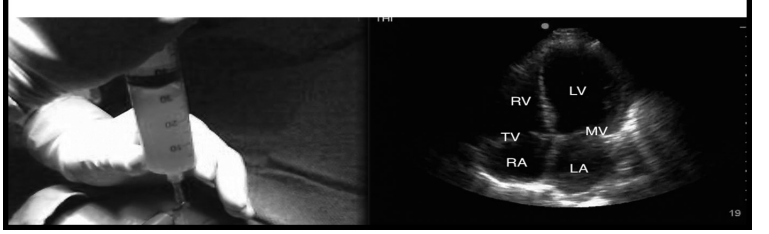

Call for Papers

Gender-Specific Research in Emergency Medicine:
Investigate, Understand and Translate How Gender Affects Patient Outcomes

The 2014 *Academic Emergency Medicine* Consensus Conference, **Gender-Specific Research in Emergency Medicine** will be held on Wednesday, May 14, 2014, immediately preceding the SAEM Annual Meeting Dallas, TX. Original papers on the this topic, if accepted, will be published together with the conference proceedings in the December 2014 issue of *Academic Emergency Medicine.*

Gender-specific medicine is the "science of how normal human biology differs between men and women and how the manifestations, mechanisms and treatment of disease vary as a function of gender." While gender-specific medicine incorporates advances in reproductive health issues, the AEM consensus conference will focus on broad disease-specific EM issues that are relevant to both women and men. The key domains of the conference are cardiovascular/resuscitation, cerebrovascular, pain, trauma/injury/violence, diagnostic imaging, mental health and substance abuse.

Consensus Goal:
The goal of the 2014 AEM Consensus Conference is to stimulate EM researchers to methodically recognize, investigate and translate the impact of gender on their clinical research outcomes. The conference proposes to build a foundation upon which researchers can build interdisciplinary scholarship, networks of expertise, discussion forums, multicenter collaborations, evidence-based publications, and improved education. The overarching themes of the conference have been guided and informed by NIH research priorities on gender medicine and include study of the lifespan, sex/gender distinctions, health disparities/differences and diversity and interdisciplinary research.

Consensus Objectives:
1) Summarize and consolidate existing data and create a blueprint that furthers gender-specific research in the prevention, diagnosis and management of acute diseases

2) Discuss the conceptual models for designing studies and analysis that incorporate gender as an independent variable.

3) Build a multinational interdisciplinary consortium to study gender medicine for acute conditions.

Accepted manuscripts will describe relevant research concepts in gender-specific areas with priority placed on differential disease risk, vulnerability, progression and outcomes. They may include work in clinical/translational, health systems, policy or basic sciences research. Descriptions of specific research, projects, or collaborations may be used for illustrative purposes but should not comprise the core of the submission. Original contributions describing relevant research or concepts on these or similar topics will be considered, and original high-quality research may also be submitted alone or in conjunction with concept papers. Papers will be considered for publication in the December 2014 issue of *Academic Emergency Medicine* if received by Monday, March 11, 2014. All submissions will undergo peer review and publication cannot be guaranteed.

For queries, please contact Marna Rayl Greenberg, DO, MPH (Marna.Greenberg@lvh.com) or Basmah Safdar, MD (basmah.safdar@yale.edu) the 2014 Consensus Conference Co-Chairs.

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Early bird rate $35.00 until March 4, 2013 (includes t-shirt)
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Get up early and get the blood flowing for a good cause! All conference attendees and their families/guests – from walkers and novice runners to seasoned marathoners – are welcome to join the FOEM 5K Run for Research! Proceeds will benefit the Foundation for Osteopathic Emergency Medicine (FOEM).

FOEM Case Study Poster Competition

Wednesday April 3, 2013 from 12:30 – 5:00 p.m.

The Foundation for Osteopathic Emergency Medicine (FOEM) is proud to present the annual Case Study Poster Competition, in which students and residents present interesting or unique cases that have presented at their hospital. Winners receive certificates, cash prizes, and recognition in FOEM publications throughout the year. The deadline for submission of applications and abstracts is January 31, 2013.

For more information or to register for an event, contact Stephanie Whitmer at swhitmer@foem.org, or register online!

Emergency Medicine Fellowship Opportunities

The Department of Emergency Medicine at Baystate Medical Center (BMC), the Western Campus for Tufts University School of Medicine, offers 5 fellowships each year. The BMC ED is a Level 1 trauma center in an urban setting with 112,000 visits annually. We have a 3-year EM residency with 12 residents per year. Clinical responsibilities for fellows are at BMC and affiliate hospitals. Positions are available to BC/BE emergency physicians who have completed an EM residency. Pediatric BC/BE is acceptable for the pediatric EM fellowship. Further information can be found at www.baystatehealth.com. Inquiries can be made to Tara Rivest at (413)794-5999 or at Tara.Rivest@baystatehealth.org.

Research: One-year Certificate Program or two-year Masters Degree fellowship in EM Research. The program integrates training in clinical and basic science research with didactics in clinical and translational science through the Tufts University School of Graduate Biomedical Sciences. The purpose of the fellowship is to provide young investigators with the mentored experience and didactics necessary to become successful independent clinical or basic science investigators. Contact Tara Rivest for an application.

Wilderness Medicine: One-year fellowship that provides training in the care of patients with limited access - often in extreme environments. We hope to recruit enthusiastic fellows interested in providing excellent medical care while traveling and studying in some of the most amazing places on earth. Competitive salary with 8-10 weeks of protected travel time per year. Contact Tara Rivest for an application.

Ultrasound: One-year fellowship focused on expanding basic US skills gained in residency and learning new applications. Development of teaching skills is stressed, as are aspects of US program development including QA processes, hardware/network integration, documentation, billing, and purchase of equipment. The goal is to provide the tools necessary to become an effective US director. Apply online at www.eusfellowships.com.

International EM and Global Health: One-year fellowship provides training in global health and a certificate in tropical medicine. Collaboration with Tufts School of Medicine and the Baystate EM Residency training program, as well as international time for scholarly projects and a capstone experience. The scope of the program is global with special focus on Latin America and Pan-American collaborative projects. Competitive salary, benefits and travel package. Apply online at www.iemfellowships.com.

Pediatrics: ACGME accredited 3-year educational track for pediatric residency trained fellows and a two year track for EM trained fellows. The pediatric ED will move into a brand new 18 bed facility this fall. Applicants are accepted through the Electronic Residency Application Service. Contact Dr. Blake Spirko, Pediatric Fellowship Director, at blake.spirko@baystatehealth.org.

Visit our recruitment portal at: ChooseBaystateHealth.org

Baystate Medical Center

The Western Campus of Tufts University School of Medicine

“I’m very fortunate that I chose a group that makes me happy and whose leadership I respect and want to be part of.”

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—Tiffany Hackett, MD
ED Medical Director
San Leandro Hospital

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