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Accuracy of ED Bedside Ultrasound for Identification of Gallstones: Retrospective Analysis of 575 Studies

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Study Objective: To determine the ability of emergency department (ED) physicians to diagnose cholelithiasis with bedside ultrasound.

Methods: ED gallbladder ultrasounds recorded over 37 months were compared to radiology ultrasound interpretation.

Results: Of 1,690 ED gallbladder ultrasound scans performed during this period, radiology ultrasound was performed in 575/1690 (34%) cases. ED physician bedside interpretation was 88% sensitive [95% CI, 84-91] and 87% specific [95% CI, 82-91], while positive predictive value (PPV) was 91% [88-94%] and negative predictive value (NPV) was 83% [78-87%], using radiology interpretation as the criterion reference.

Conclusion: ED physician ultrasound of the gallbladder for cholelithiasis is both sensitive and specific. [*West*JEM. 2008;9:1-5.]

INTRODUCTION

As less expensive, portable ultrasound machines became available in the mid-1980s, ultrasound made its debut in the emergency department (ED) as a diagnostic tool.[1,2] Ultrasound is now an accepted use in the ED by emergency physicians (EPs).[3-13] Training in ultrasound is part of the curriculum in 96% of emergency medicine (EM) residencies, and there are a growing number of fellowships in emergency ultrasound for EM–trained physicians.[14]

Approximately 20 million people in the United States have gallstones, with an additional one million diagnosed each year.[15] Traditionally, evaluation involves a right upper quadrant (RUQ) ultrasound by an ultrasound technician and interpretation by a radiologist. However, radiology ultrasound is not universally available to ED patients. ED ultrasonography of the RUQ can result in shorter stays, lower costs, and better patient satisfaction.[16,17]

Over three years we performed 2,321 RUQ ultrasounds. With this large experience, we attempt to assess the ability of emergency physicians to diagnosis cholelithiasis. This study is the largest sample to date of ED right upper quadrant ultrasound with image confirmation and comparison to radiology criterion reference.

METHODS

We performed the study in a 35-bed Level I trauma center ED, with a census of 41,000 patients per year, supporting a Post Graduate Year 1-3 EM residency. Thirteen attending emergency physicians and one ultrasound fellow had various levels of expertise with ultrasound. Three attendings were credentialed by the American Registry of Diagnostic Medical Sonography (RDMS) and seven (including the fellow) had sufficient experience to qualify to take the RDMS exam. The remaining three rarely performed

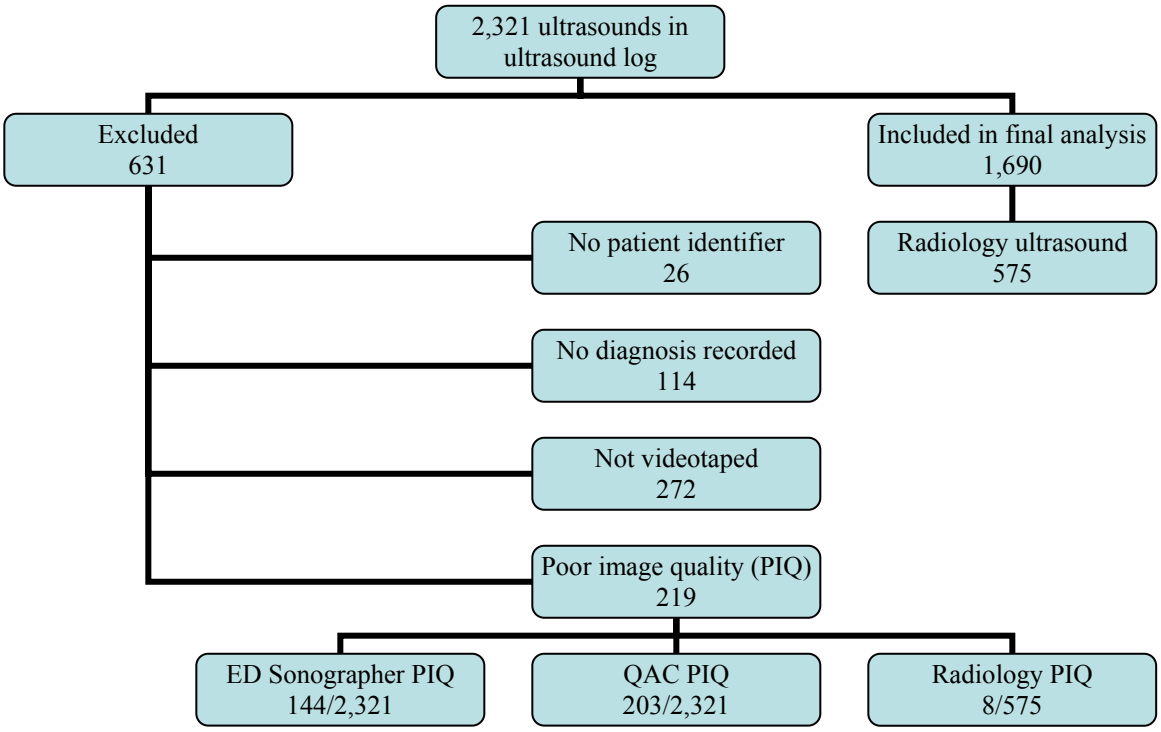

Figure 1. Flow diagram of right upper quadrant emergency department ultrasounds

ultrasound. Obtaining hospital privileges first required 300 ED ultrasound examinations, over-read by the Director of Emergency Ultrasound, who had completed an emergency ultrasound fellowship (JCF). After this provisional period, three ultrasounds were proctored for each application. Correct performance and interpretation then warranted hospital privileges. During the study period, three emergency physicians had hospital privileges to make clinical decisions based on ED ultrasound.

The 36 residents had performed 0-1000 ultrasounds prior to the 37-month study. During the study period, each performed 200-1200 ED ultrasounds of all applications; 15-200 were of the RUQ. The RUQ application was second only to trauma as the most common application of bedside ultrasound. Residents received 12 hours of didactic ultrasound training per year, in addition to six hours during EM-1 orientation. Faculty attended approximately half of these sessions.

Until July 2004, all ultrasounds were done with a B+K Hawk 2102 ultrasound machine (Copenhagen, Denmark). After that, a Sonosite Titan (Bothell, WA) was also available. Both machines had 3.5-5 MHz abdominal probes and video recorders. Physicians recorded each ultrasound and wrote the bedside interpretation on standard data sheets.

We reviewed emergency department RUQ ultrasounds from July 1, 2001 to August 10, 2004 for gallstones, and examined computer records for radiology ultrasound within one month of the index scan. We did not address other diagnostic ultrasound criteria for cholecystitis. We excluded cases lacking a valid patient identifier, bedside interpretation, video recording, or adequate images as determined at the bedside, or radiologist.

We calculated sensitivity, specificity and predictive values for ED bedside US compared with radiology US interpretations. These parameters were calculated in the usual manner with confidence intervals by the efficient-score method with continuity correction.[18]

The Institutional Review Board approved the study protocol and documentation of consent was waived.

RESULTS

ED physicians documented 2,321 gallbladder ultrasounds during the study period. Six hundred thirty-one (27%) scans were excluded for lack of: patient identifier (n=26, 1%), bedside interpretation (n=114, 5%), video recording (n=272, 12%), and adequate imaging (n=219, 9%). Of the remaining 1,690 ultrasounds (Figure 1), 575 (34% of 1690 and 25% of 2321) had radiology ultrasound and formed the final study population.

In the 575 patients who received both bedside and radiology ultrasounds, radiology diagnosed gallstones in 344 of 575 (60%). ED ultrasound was positive for gallstones in 332 (57.7%) patients. ED bedside interpretation was 88% sensitive [95% CI, 84-91%] and 87% specific [82-91%] (Table 1). Positive predictive value (PPV) was 91% [88-94%] and negative predictive value (NPV) was 83% [78-87%].

Six percent (144/2321) of bedside ultrasound examinations had inadequate images for emergency physician interpretation, compared to 1.4% (8/575) of ultrasound technologist-acquired examinations which were not interpretable by radiologists.

Table 1. Results of ED ultrasound compared to subsequent radiology ultrasound diagnosis.

	Gallstones present	Gallstones absent	Total
ED ultrasound postive	303	29	332
ED ultrasound negative	41	202	243
Total	344	231	575

Accuracy = 87.2%

DISCUSSION

Cholecystosonography is the initial imaging modality for the diagnosis of cholelithiasis.[15,19-24] Ultrasound is non-invasive, relatively inexpensive, requires no radiation, and is very accurate in skilled hands. As gallstones are present in 90-95% of acute cholecystitis and association with a sonographic Murphy's sign yields a PPV of 92%, bedside ultrasound may rapidly drive early diagnosis and disposition. This is important, as emergency physician ability to identify other markers of acute cholecystitis (i.e. pericholecystic fluid and thickened gallbladder wall) is much more limited.

We demonstrate that emergency physicians in this training program are accurate in ultrasound diagnosis of gallstones. The sensitivity and specificity of 88% and 87%, compared to radiology ultrasound, is consistent with the four prior studies in the EM literature as noted in the Table 2.[3,25-27]

The present study documents similar sensitivity as previous efforts. The specificity of studies, including this one, is high when ED ultrasound is performed on all patients with abdominal pain, but lower when considering only select patients who also had radiology ultrasound. This verification bias has been described by Shea et al.[19] regarding biliary ultrasound.

In our experience, use of radiology ultrasound is more likely when the bedside ultrasound finds abnormalities. Thus the specificity is underestimated. Descriptions of ultrasonographer experience, quality of machine, and level of practitioner (attending vs. resident) are variable in previous studies and may contribute to the differences in accuracy.

The sample size of 575 verified by radiology ultrasound almost doubles previously published experience with this comparison. The radiology literature demonstrates a sensitivity of 81-99% for radiology ultrasound for the diagnosis of cholelithiasis,[21,28-33] though the majority of the studies demonstrating sensitivities at the lower end of the range were performed in the early years of ultrasound. A rigorous meta-analysis of the radiology literature in 1994 by Shea et al.[19] for the diagnosis of cholelithiasis found a sensitivity of 97% and specificity of 95% (unadjusted for verification bias). The adjusted sensitivity was 84% and specificity 99% (adjustment by method of Greenes and Begg – ref 29 in Shea). Nevertheless, a variety of textbooks quoted in the same manuscript report sensitivities > 95%, which appears overstated.

Our study demonstrates a 6% rate of inadequate imaging by EPs. This compares to the 18% indeterminate

Table 2. Prior studies from the emergency medicine literature addressing sensitivity and specificity of ED ultrasound.

Author	Year	Design	Recruitment	Inclusion Group	Sample Size	Criterion Reference	Sensitivity	Specificity
Schlager (3)	1994	Prospective	Convenience	ED abdominal pain	65	Radiology ultrasound (only if ED US abnormal)	86%	97%
Kendall (27)	2001	Prospective	Convenience	ED abdominal pain with radiology ultrasound	109	Radiology ultrasound	96%	88%
Rosen (22)	2001	Prospective	Convenience	ED abdominal pain	116	Radiology ultrasound	91%	78%
Durston (25)	2001	Retrospective	Convenience	Known biliary disease	418	Pathology or Clinical or Radiology ultrasound	89%	98%
Scruggs (Current)	2006	Retrospective	Convenience	ED abdominal pain	575	Radiology ultrasound	88%	87%

rate reported by Durston and the 5% of cases in the Rosen study in which the gallbladder was not visualized.[1,3] The Kendall[27] and Schlager[3] studies did not comment on their rate of indeterminate scans. Our data suggests that radiology ultrasound is limited by inadequate imaging less frequently, finding only 8/575 (1.4%) to be indeterminate for cholelithiasis.

The increased rate of EP inadequate imaging has several potential explanations. First, EPs typically spend less than 10 minutes on their exams, and likely do not use adjuncts such as patient positioning and water ingestion.[27] Second, contracted gallbladders in the ED may distend during the 2-3 hours it takes the ultrasound technologist to respond. Finally, ED ultrasound machines sacrifice image quality for durability, portability, and cost.

We excluded bedside studies with inadequate images from our primary analysis. This mimics real-life practice, as EPs routinely obtain a radiology ultrasound if their own images are inadequate. Ninety-four percent of patients had adequate images in our study, potentially expediting their ED evaluation.

LIMITATIONS

Our study has several limitations. Verification bias is inherent in a retrospective study of a diagnostic test. Three-fourths of patients who had emergency department RUQ ultrasound did not have a confirmatory study by radiology, and it is possible that gallstones were missed completely in those that did not undergo the criterion reference. Conversely, some ED patients undoubtedly had radiology ultrasounds ordered initially, foregoing ED bedside ultrasound.

Second, the clinical and sonographic experience of our physicians varied widely. Paradoxically, some of the most experienced clinicians had limited ultrasound skills whereas many of the junior residents had performed several hundred scans. Finally, our criterion reference lacked pathologic confirmation, a recurrent problem with EM biliary imaging literature.

Given the consistent performance of ED bedside ultrasound, its incorporation in the diagnostic process needs further investigation. The EM and radiology literature lack any likelihood ratios that could be used in a Fagan nomogram to modify the pretest probability for acute cholecystitis.[34] The ultimate goal of ED bedside ultrasound is to expedite disposition or consultation of patients with RUQ pain. Although this is commonly done, the process has not been studied quantitatively.

CONCLUSION

We found that emergency physicians are accurate in diagnosing cholelithiasis with bedside ultrasound in the largest sample size to date in emergency medicine ultrasound literature. This study adds to the growing body of evidence supporting the use of ultrasound by emergency physicians for gallbladder pathology.

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Validation of the Social Security Death Index (SSDI): An Important Readily-Available Outcomes Database for Researchers

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Study Objective: To determine the accuracy of the online Social Security Death Index (SSDI) for determining death outcomes.

Methods: We selected 30 patients who were determined to be dead and 90 patients thought to be alive after an ED visit as determined by a web-based searched of the SSDI. For those thought to be dead we requested death certificates. We then had a research coordinator blinded to the results of the SSDI search, complete direct follow-up by contacting the patients, family or primary care physicians to determine vital status. To determine the sensitivity and specificity of the SSDI for death at six months in this cohort, we used direct follow-up as the criterion reference and calculated 95% confidence intervals.

Results: Direct follow-up was completed for 90% (108 of 120) of the patients. For those patients 20 were determined to be dead and 88 alive. The dead were more likely to be male (57%) and older [(mean age 83.9 (95% CI 79.1 – 88.7) vs. 60.9 (95% CI 56.4 – 65.4) for those alive]. The sensitivity of the SSDI for those with completed direct follow-up was 100% (95% CI 91 -100%) with specificity of 100% (95% CI 98-100%). Of the 12 patients who were not able to be contacted through direct follow-up, the SSDI indicated that 10 were dead and two were alive.

Conclusions: SSDI is an accurate measure of death outcomes and appears to have the advantage of finding deaths among patients lost to follow-up. [*West*JEM. 2008;9:6-8.]

INTRODUCTION

Death has always been an important, if not the ultimate outcome in cohort studies, particularly for cardiovascular studies.[1,2] Most of these have used direct follow-up of patients to determine death. This is not only a costly endeavor but often ends up with an inevitable number of patients lost to follow-up. Recently, federal databases have become available to investigators to track death as an outcome. The two readily available source databases for mortality are the National Death Index (NDI) and the Social Security Death Index (SSDI).

The advantage of these databases is that there is an incentive for the federal government to maintain their accuracy to help administer Social Security and other federal benefits. As such, these databases are reported to be accurate within six months of a person's death, as it is mandatory for hospitals and funeral homes to report deaths so Social Security numbers (SSN) can be retired. The National Death Index (NDI) requires a formal submission and request for a third-party search at cost to the investigator. The SSDI has the advantage in that it is free and online.[3] While others have compared the SSDI and the NDI databases as well as various search methods, the accuracy of the SSDI versus direct follow-up has never been assessed.[4,5]

The purpose of this study was to validate the accuracy of the SSDI to determine whether it could be easily used as a source of death outcomes for researchers.

METHODS

After obtaining IRB approval, we identified a consecutive sample of patients presenting with syncope from an existing ED study database.[6] Searching the SSDI, we took the first 30 patients who the SSDI listed as dead and the first 90 patients listed as alive after their ED presentation. The search was done at least one year after the initial ED visit to allow ample time for completion of the database. Although the database can be searched with incomplete information, for this study we used the patient's complete SSN as well as full given name, surname and date of birth. If the patient was said to be dead, we requested the death certificate from the state in which they died (usually California) to confirm that it was a person from our study cohort. We then had a research coordinator blinded to the results of the SSDI search, complete direct follow-up. This was done by contacting the patients themselves, their families or their primary care physicians to determine their vital status and date of death. We used direct confirmation of death from these three sources as the criterion reference.

Statistical Analysis

We determined the sensitivity and specificity of the SSDI for determining death at six months, using direct follow-up as the criterion reference, and calculated 95% confidence intervals using 2x2 table and exact binomial distributions. The study was powered to have a 95% confidence interval width of 10% for the sensitivity.

RESULTS

All 30 patients deemed dead by the SSDI had confirmatory death certificates. There were a variety of causes of death in the selected cohort as illustrated in the Figure.

Of the 120 patients in the study we were able to contact 108 patient families or primary physicians to confirm vital status (90%). For the 108 patients with direct follow-up 20 were determined to be dead and 88 alive. Those dead at six months were more likely to be male (57%) and older [(mean age 83.9 years (95% CI 79.1 – 88.7) vs. 60.9 years (95% CI 56.4 – 65.4) for those alive)]. The sensitivity of the SSDI for those with completed direct follow-up was 100% (95% CI 91 -100%) with specificity of 100% (95% CI 98-100%) (Table). Of the 12 patients not able to be contacted through direct follow-up, the SSDI indicated that 10 were dead and two alive.

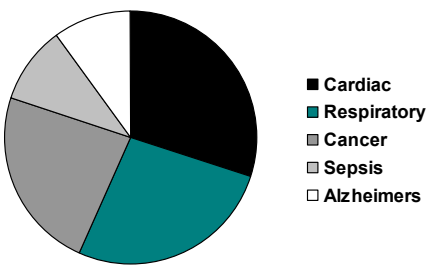

Figure. Causes of death reported on the 30 death certificates.

DISCUSSION

In this study we found that the readily available online SSDI was an accurate and facile database to determine death outcomes. It showed excellent sensitivity and specificity for those for whom we could complete direct follow-up, as well as information on patients who we could *not* contact, including 10 with confirmatory death certificates. If a study used mortality as a primary endpoint, 33.3% (95% CI 17% – 53%) of subjects who would ordinarily be reported as "lost to follow up" would be, in fact, positively identified by the SSDI as dead.

The database is available online and does not require cost or special expertise. However, its use does require institutional review board permission since protected health information (PHI) elements are used to search. We were able to secure a HIPAA (Health Insurance Portability and Accountability Act of 1996) waiver to complete the necessary follow-up for this and other studies.

The comparable federal database used successfully in previous research is the National Death Index (NDI). However, it takes a formal submission with a two-month response time and has associated costs. The fees for routine NDI searches consist of a $350.00 service charge plus $0.15 per user record for each year of death searched. For example, 1,000 records searched against 10 years would cost $350 + ($0.15 x 1,000 x 10) or $1,850. A recent study showed the two databases to have comparable accuracy.[2] Other studies looking at the SSDI and NDI found results that were not as sensitive as ours. However, these studies compared databases and did not use direct follow-up as the criterion reference.[4,5] One also used different search criteria.[5]

It is possible to search the SSDI database without a SSN. This can be done by name and other demographics. Studies not using the SSN in their searches found poorer sensitivity compared to when it was used, and investigators should beware of searches not using the SSN.[4] Even compared to previous studies where the SSN was used, our sensitivity was better and may indicate that the maintenance and search tools of the database have improved over time.

Table. Performance of the SSDI to Determine Death Outcomes

SSDI	Dead	Alive	Lost To Follow-Up
Dead	20	0	10
Alive	0	88	2

Sensitivity 100% (95% CI 91% - 100%)
Specificity 100% (95% CI 98% - 100%)

LIMITATIONS

For our syncope cohort, this was a secondary analysis carried out up to two years after the index ED visit. Hence, we were not able to determine how current the online SSDI is, nor verify the governmental claim that it is completed within six months of a death. Several online database ancestry and

genealogy websites incorporate the SSDI search engine, so researchers should take care to use only the native search site. We did not evaluate the engine at these secondary sites and cannot comment on their accuracy. Although our syncope study recorded accurate SSNs, this may not be the case for other ED-based studies, with a high proportion of undocumented subjects or frequent recording errors in demographic information.

CONCLUSION

Searching the online SSDI, with a correct SSN provides an accurate method to determine death as an outcome in clinical research studies. A majority of subjects ordinarily lost to follow-up can have their vital status determined.

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Under Utilization of Local Anesthetics in Infant Lumbar Punctures

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Background: Lumbar Puncture (LP) is an invasive procedure frequently used to diagnose meningitis among the pediatric population. Neonates and infants have not routinely received local anesthesia prior to LP.

Study Objective: To determine whether emergency medicine physicians and pediatricians use local analgesics on neonates and infants prior to performing an LP and to identify which local anesthetics, if any, were used.

Methods: Prospective, cohort study of all infants, six months of age or less, that received an LP in the emergency department (ED) or inpatient pediatric units for suspected meningitis during a period of year at a university tertiary care hospital.

Results: A total sample population of 111 infants that received an LP within the study period. A control population of 42 adults received an LP. Only 40.4% (45/111) of the infants received local analgesia prior to LP: either 1% lidocaine, EMLA or a combination of the two. Infants were less likely to receive lidocaine or EMLA prior to LP compared to adult subjects (OR= 0.27; 95% CI0.12 to 0.62). No neonates that were less than one month of age received local procedural anesthesia by emergency medicine or pediatric physicians. ED physicians' use of local anesthesia prior to LP increased with increasing age of the infant. The pediatricians in this study used local anesthesia prior to LP when the infant was at least five months of age.

Discussion: The data objectively support recent literature regarding the under use or lack of use of analgesia prior to LP among neonates and infants. Local anesthetics should be used routinely without exception prior to performing an LP in the pediatric population. [*West*JEM. 2008;9:9-12.]

INTRODUCTION

Lumbar punctures (LP) are performed frequently in emergency departments (EDs) and on hospitalized pediatric patients. It is an invasive but essential procedure, most often used to diagnose meningitis. Local anesthetics, including the common amide and ester anesthetics (lidocaine, mepivicaine, procaine) are commonly used prior to performing LPs as in adults and adolescents. It is felt that infants and neonates should receive local anesthetics, such as lidocaine or a 1:1 mixture of lidocaine and prilocaine also know as eutectic mixture of local anesthetics (EMLA), as standard medical care prior to an LP. Infants are a vulnerable population with regards to assessing pain as they are unable to verbally communicate, therefore presenting a challenge to the medical community. The *International Association of the Study of Pain* defines pain as "an unpleasant sensory and emotional experience associated with the actual or potential tissue damage or described in terms of such damage."[1]

Recent studies have linked altered pain responses in infants with cumulative exposures to pain. [5,6] Neonatal and infant nervous systems may be less effective in managing

painful stimuli.[5,6] Invasive procedures during infancy cause distress, delayed recovery and can lead to developmental issues. [5,6] A paradigm shift has occurred within the medical community in the recognition of pediatric pain resulting in attempts to develop methods for quantifying pain such as behavioral observational scales.

This prospective study is in response to the medical and general community's awareness of pain control. The aim was to determine if analgesics were administered prior to pediatric LPs in the emergency and pediatric departments.

METHODS

The study occurred at a university-based tertiary referral hospital in southern California. Subjects included children six months of age or less who underwent LP in the ED or any pediatric unit. Pediatric units included the pediatric intensive care unit, the neonatal intensive care unit, and the general pediatric ward. Patients were excluded if they were intubated or developmentally disabled. If multiple LPs were performed, only the first procedure was included. The LP procedural data forms specific for this study were distributed to the ED and pediatric units and were collected and reviewed over a one-year period from September 2001 though September 2002. Identification of patients who underwent LPs occurred by weekly collection of LP procedural data forms from the ED and pediatric units. Data was abstracted from the pediatric chart to complete any missing data from the study LP procedural data forms. The hospital laboratory logs were used to cross-reference all received cerebrospinal fluid (CSF) samples, thus enabling capture of all LPs performed in our study age population. Data were abstracted by a trained and qualified research associate for the following data: patient age, date of LP, type of LA, and other medications administered. To assess the data abstraction methods 10 medical data collection forms were randomly chosen and reviewed by a second reviewer, yielding an assessment of inter-rater reliability (kappa). To control for documentation deficiencies, 42 consecutive data LP forms for adult ED patients who underwent LP were collected and reviewed. The protocol was approved by the institutional review board as an exempt study.

Statistical Analysis

Data were analyzed using STATA (version 7.0, Stata Corp., College Station, Texas). Proportions with 95% confidence intervals (CI) were calculated for local anesthetic use, defined as lidocaine or EMLA for pediatric and adult patients. In order to estimate the effect of missing documentation on the magnitude of the proportion of local anesthetic used, a sensitivity analysis was performed in which three different proportions of the missing data were estimated. The situations in which all, one half, and none of the procedures with missing documentation would have demonstrated local anesthetic use was estimated. This demonstrates the maximum and minimum proportions possible. Finally, the odds ratio of infants six months of age or less receiving local anesthetic in conjunction with lumbar puncture compared to adult patients was calculated.

RESULTS

The age of the study subjects was based on a prior retrospective cross-sectional study conducted the year before at the same institution. Data was collected and statistically analyzed on a total of 82 infants, 12 months of age or less, who had an LP performed for suspected meningitis in the ED and inpatient pediatric units.

A total of 194 LP procedural data forms were collected and reviewed including 42 adult and 111 pediatric subjects (Figure 1). Twelve pediatric charts were excluded due to intubation or conscious sedation and 29 subjects had incomplete data collection forms. The ED physicians and pediatric physicians preferentially used 1% lidocaine and EMLA, respectively, for local analgesic prior to infant LP. The Table shows that the use of local anesthetics was more common among adult subjects. Narcotics, benzodiapepines, and conscious sedation use were also more common among adults. Ketamine was not used in this series. Infants were less likely to receive lidocaine or EMLA before an LP compared to adult subjects (OR= 0.33; 95% CI 0.13 to 0.79).

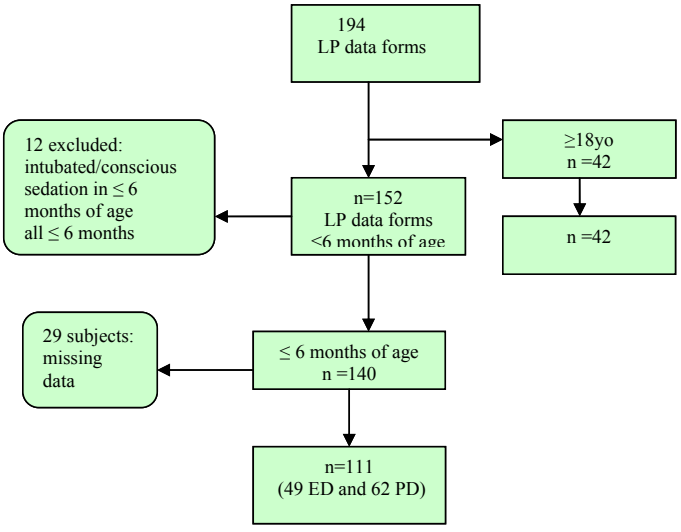

Figure 1. Flow diagram of sample population. LP = lumbar puncture, ED = emergency department, PD = pediatric department

Of all the subjects that received either EMLA or 1% lidocaine, only one infant received Tylenol as an adjunct for

Table 1. Medications Used Prior to Lumbar Punctures Performed in the Emergency Department and Pediatric Units.

	Pediatric Subjects (n = 111)		Adult Subjects (n = 42)	
	Total, n(%)	95% CI	Total, n (%)	95% CI
Lidocaine	40 (36.0)	27 - 46	30 (71.4)	55 - 84
EMLA*	5 (4.5)	1 - 10	0	0 - 8
Other local anesthesia	1 (0.9)	0 - 5	0	0 - 8
Any local anesthesia (A)	45 (40.5)	31 - 50	30 (71.4)	55 - 84
Benzodiazepine	8 (7.2)	3 - 14	3 (7.1)	1 - 19
Narcotic	3 (2.7)	1 - 8	9 (21.4)	10 - 37
Conscious sedation	0	0 - 3	1 (2.4)	0 - 13
Any benzodiazepine, narcotic, or conscious sedation (B)	10 (9.0)	4 - 16	11 (26.2)	14 - 42
No medications (neither A nor B above)	59 (53.2)	43 - 63	6 (14.3)	5 - 29
Acetaminophen	3 (2.7)	1 - 8	0	0 - 8
NSAID	1 (0.9)	0 - 5	0	0 - 8

* EMLA = eutetic mixture of lidocaine anesthetics

analgesia and three subjects that had EMLA applied, two had received Tylenol and only one had received a NSAID agent. Narcotics and Benzodiapzepines were not administered as an adjunct agent in those infants that had received either EMLA or lidocaine.

There were more LPs performed in the pediatric units than in the ED since our institution is a referral center with a PICU transport service that provides direct admissions to the pediatric units bypassing the ED for their initial evaluation.

A sensitivity analysis was conducted to account for the missing data from 29 subjects. The minimum ranges from 33.3 (95% CI 24.7 to 42.9) of infants receiving lidocaine or EMLA. The minimum assumes none of the 29 subjects were administered lidocaine or EMLA prior to the LP. Forty-seven (95% CI 37 to 56.6) signifies half of the 29 subjects received lidocaine or EMLA. Finally, if all 29 subjects received lidocaine or EMLA a maximum 59.5 (95% CI 49.7 to 68.7) subjects received appropriate local analgesic prior to an LP.

DISCUSSION

Anatomic, physiologic and biochemical prerequisites for nocioreception are developed by the neonatal period.[2] Standard medical practice dictates lidocaine or EMLA should be used to minimize the pain of an LP.[4] Local anesthetics can be safely used in neonates and children although excessive plasma concentrations can result in seizures and cardiac depression. The maximal recommended dose of lidocaine is 4mg per kilogram without epinephrine and 5mg per kilogram with epinephrine in neonates.[3] Orthotoludine is a metabolite of prilocaine, an oxidant that can lead to methemoglobinemia in neonates. EMLA, therefore should be limited in neonates. A single application of EMLA for procedures, such as LP, has been shown to be safe and effective.[1]

Infants are easily held in the appropriate LP position and cannot verbalize their perception of pain or be observed for visual pain assessment. "Perception reflects the effect of the nocioreceptive information on the existing psychological framework. Perception is the emotional and physical experience of pain. That experience then changes the framework thereby affecting subsequent painful experiences altering subsequent pain pathway development resulting in decreased pain tolerance."[2,6] Several short-term observational studies have been conducted illustrating neonates and infants without adequate anesthesia during a painful procedure showed more distress in subsequent procedures.[7,8]

The odds ratio of receiving anesthetic prior to LP if you are a neonate or infant is low in the emergency and pediatric departments at our institution. We can speculate if all 29 data collection forms were positive for analgesic then the pediatric population would be 10% lower than the adult group, increasing the odds ratio dramatically.

One common deficiency among physicians is the lack of proper training in current concepts, methods and use of procedural pain management in the pediatric population. Additionally, the preconceived notion that the physician will obtain the CSF with one attempt at LP and therefore rationalizing that prior subcutaneous injection of lidocaine may cause more pain and discomfort is not supported by the literature.[8,9] In the majority of cases several attempts are usually required before a successful LP. EMLA requires approximately 60 minutes for adequate analgesia and in the ED it is not routinely used because of the urgency to obtain CSF and initiate antibiotics.[8,9] Another common generalization that local injection of an anesthetic may obscure the landmarks for LP is unsubstantiated by the medical literature.[8,9]

LIMITATIONS

The data collection tool should have included the CSF sample results or a diagnosis of whether viral or bacterial meningitis was present and the physical assessment of the subject. The diagnosis of meningitis and some key features of the physical assessment could have been used as an indicator of time signifying if the LP needed to be performed emergently disallowing the use of topical anesthetics, particularly EMLA. This study was centered in one institution and may not be representative of the entire medical community.

A multi-center prospective study should be considered in the future that utilizes video recordings of lumbar punctures in infants and the elderly. Trained observers could quantify the pain using a visual pain assessment scale and the use of anesthetic prior to lumbar punctures would be recorded.

CONCLUSIONS

The data demonstrates the underutilization of local anesthesia prior to LP in infants six months of age or less by both emergency medicine and pediatric physicians. The data supports prior generalized statements in the literature regarding under use or lack of use of procedural analgesics among the pediatric population.

It is the authors' opinion that local anesthetics should be used prior to performing pediatric lumbar punctures. ED physicians and pediatricians must proactively educate and practice maximal procedural pain management in the pediatric population.

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Adaptation of Predictive Models to PDA Hand-Held Devices

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Prediction models using multiple logistic regression are appearing with increasing frequency in the medical literature. Problems associated with these models include the complexity of computations when applied in their pure form, and lack of availability at the bedside. Personal digital assistant (PDA) hand-held devices equipped with spreadsheet software offer the clinician a readily available and easily applied means of applying predictive models at the bedside. The purposes of this article are to briefly review regression as a means of creating predictive models and to describe a method of choosing and adapting logistic regression models to emergency department (ED) clinical practice. [*West*JEM. 2008;9:13-19.]

INTRODUCTION

Articles reporting clinical prediction models that employ regression techniques are appearing with increasing frequency in the medical literature.[1] One of the principal reasons for carrying out a regression analysis is to generate a tool that will help predict an outcome (dependent variable) from available clinical information (independent, explanatory or predictive variables). When validated, such tools may be used to supplement clinical judgment and improve patient care. Comparisons of clinical performance with and without the use of such models support the contention that improved diagnostic accuracy and standardization of care can result from their use in the workplace.[2-8]

Two major problems associated with predictive models are the complexity of computations associated with their application, and their lack of availability when they are needed at the bedside. Investigators typically modify their derived model to a simplified scoring system using whole numbers. This facilitates calculations, but at the cost of reduced precision of their model, and does not solve the problem of availability.

Use of personal digital assistant (PDA) hand-held devices as a readily available source of medical information is expanding.[9] Programs for such devices which incorporate predictive instruments and medical calculators in a "user friendly" format may be downloaded, in many instances for a fee. Unfortunately, such programs are limited in scope and ability to incorporate ongoing changes in medical evidence, and are not easily modified by the user to meet the needs of differing clinical settings.

This article briefly reviews regression as a vehicle for creating predictive models, provides a system for evaluating an article with a predictive model, and describes a relatively simple method for translating the results of studies that use logistic regression (the most common of the regression techniques for creating predictive models) to a PDA spreadsheet format that can be easily applied at the bedside.

Simple Linear Regression

Regression techniques, at their most basic level, employ simple linear regression that describes the straight-line relationship between two variables. A single explanatory (independent) variable (X) is used to predict another (dependent) outcome variable (Y). In the regression model, the slope of the regression line is symbolized by "b", called the regression coefficient, and "a" denotes the Y-Intercept of the regression line, a constant for that model.

$$Y = a + bX$$

An example of the application of this most elementary form of regression analysis was published by Després et al who examined the ability of waist circumference measurements (in cm) to predict the amount of deep abdominal adipose tissue noted on CT scan (in cm^2).[10] In their study, waist circumference was the independent variable (X),

and the amount of adipose the dependent variable (Y). The regression formula obtained was:

$$Y = -216 + 3.46(X)$$

Thus, if the waist circumference of an individual was found to be 70 cm, the predicted amount of adipose on CT was:

$$-216 + 3.46(70) = 26 \text{ cm}^2$$

Multiple Linear Regression

Many problems in medicine involve multiple predictive variables, all of which must be taken into consideration to predict a single outcome, measured in terms of continuous data, as in the above example. The multiple regression model incorporates two or more independent variables to explain, or predict, an outcome or response. The model, an extension of simple regression, may be represented as follows:

$$Y = a + b_1X_1 + b_2X_2 + b_3X_3 \ldots \text{ etc.}$$

where Y is the dependent (outcome, response) variable, "a" is the intercept of the regression line (a constant for that relationship), X_1 is the value of the first independent (predictor) variable and b_1 is the regression coefficient associated with it, X_2 is the value of the second independent variable and b_2 is the regression coefficient associated with it, and so on.

The independent variables typically have continuous numerical values (e.g., weight in kilograms, age in years, etc.). These variables may also have dichotomous ("either/or") values in which case the presence of that variable is represented by one and its absence by zero. Ordinal values, in which the variable is stratified and ranked in order of increasing severity or exposure, may also be used.

A study published by Benowitz et al illustrates this type of regression analysis.[11] They found that the nicotine intake while smoking a cigarette was predictable given the total particulate matter per cigarette and the number of puffs taken. The relation is described by the equation:

$$Y = -0.75 + 0.211\ (X_1) + 0.025\ (X_2)$$

where Y is nicotine intake (in mg), X_1 is the number of puffs per cigarette, and X_2 is the total particulate matter in mg per cigarette, and -0.75 is the constant (intercept) for the model.

With multiple linear regression, while the independent variables may take on dichotomous values, the outcome variable may not. In the frequent case in which the clinician is interested in an outcome with a dichotomous value (e.g., the presence or absence of a particular disease; survival versus death; cure versus treatment failure) the technique of logistic regression is most often employed.

Logistic Regression

In studies using multiple logistic regression the outcome of interest is dichotomous ("either/or" type data) and is expressed within a derived model in terms of the odds that one outcome or the other will occur. Unfortunately, when using odds, the range from zero-chance to even-chance (odds ranging from zero to one) is disproportionate to the range from even-chance to 100% chance (odds ranging from one to infinity). In order to correct for this imbalance, the outcome is expressed in terms of the natural logarithm (ln) of the odds. Ln (odds) can range from minus infinity when the odds are zero, to zero when the odds are one, to positive infinity when the odds are very large. The natural logarithm of the odds is also known as the *logit*, hence the term *logistic* regression.

Multiple logistic regression uses the following general formula:

$$\text{Ln(odds) of outcome} = a + b_1X_1 + b_2X_2 + b_3X_3 \ldots b_nX_n$$

When used in a study seeking to formulate a predictive model, "a" is a constant (analogous to the Y-intercept of the simple linear regression model) generated by the results of the study; b_1, b_2, b_3, and b_n are regression coefficients for each independent variable, also generated by the study; and X_1, X_2, etc. represent the values of each variable for a particular patient. Some authors use α or β_0 to represent the regression constant, and β_1, β_2, etc. to represent the coefficients. Numerical values for the constant (intercept) and the regression coefficients for each variable are often included by the author in the results section. When they are, the reader can reconstruct a formula that will allow precise calculation of probability of outcome, given the values of the variables for a particular patient. This reconstruction of a predictive formula proceeds as follows.

From the above relationship, the ln (odds) of outcome for a particular patient is first calculated by substituting the values for each variable for that patient. Next, by exponentiation, the odds may be found as follows:

$$\text{Odds} = e^{\ln(\text{odds})}$$

where *e* represents the base of the natural logarithm (equal to 2.71828). Finally, the probability of disease is determined:

$$\text{Probability} = \text{odds} / (1 + \text{odds})^*$$

Such calculations are impractical for the bedside. However, standard spreadsheet applications created for PDAs may be fairly easily programmed to rapidly carry out these computations as described in the appendix.

SELECTION OF AN APPROPRIATE PREDICTIVE MODEL

Before adapting a predictive model to the ED bedside, an appropriate model must first be selected and evaluated systematically to ensure the accuracy and proper interpretation

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*Some authors list the formula for probability as

$$\text{Probability} = 1 / (1 + \text{odds}^{-1})$$

or

$$\text{Probability} = 1 / \{1 + \exp[-(a + b_1X_1 + b_2X_2 \ldots + b_nX_n)]\}^{-1}$$

or

$$\text{Probability} = \{1 + \exp[-(a + b_1X_1 + b_2X_2 \ldots + b_nX_n)]\}^{-1}$$

all of which are equivalent.

of the data. Various guidelines have been suggested for the execution, interpretation, and reporting of multivariate methods. However, as of yet, no consensus exists.[12-13] We evaluated the literature, and suggest a set of seven criteria to evaluate a predictive logistic regression model for adaptation to the bedside PDA application (Table 1). We do not propose that if an article does not fulfill all seven criteria it would be deemed unworthy of use in clinical practice. Rather, our goal is to provide a method to evaluate the literature, so that the interpretation of the data and its worth can be appraised by the individual practitioner. The results calculated from the model itself can then be added to the clinician's fund of knowledge to make a sound clinical decision.

Table 1. Evaluating a Logistic Regression Model

1. Appropriate study population
2. Inclusion of regression coefficients and regression constant
3. Description of variable coding and selection
4. Effect modification reporting
5. Goodness of fit and Validation of the model
6. Overfitting
7. Nonconformity to a linear gradient

Appropriate study population

When interpreting or applying the result of a study, the study population must be taken into account. For a predictive model to be applied in the emergency department, the study must have a patient population representative of an ED population. This strengthens the external validity of a study, i.e. how generalizable the findings are outside of the study population. Similarly, spectrum bias may distort the accuracy of diagnostic tests and apparent effectiveness of treatments when studied using samples of patients with disease severity more advanced or less advanced, than that in your own clinical population. For example, a model derived from an outpatient medicine clinic or an ICU population may not be applicable to your ED. Examination of the characteristics of the study participants, as well as the inclusion and exclusion criteria must take place, to determine whether the results would be relevant to your patient population.

Inclusion of regression coefficients and regression constant

In order to fully implement the logistic regression model, the regression coefficients and the regression constant (intercept) for the final model must be included. While odds ratios are typically reported, which can be transformed into a regression coefficient by taking the ln(odds ratio), the regression constant is often omitted, making the calculation of probability (the *raison d'etre* of the model) impossible for the reader.

Description of variable coding and selection

Proper description of the coding of individual variables must be included and examined. The apparent effect of a variable can depend on how the variable is coded. For example, the regression coefficient for the impact of age (independent variable) on long-term mortality (dependent variable) will be different if age is coded in one-year increments versus 10-year intervals, or as a dichotomous variable (less than or greater than 65 years). If a dichotomous (or other categorical) variable is included, the coding method must be replicated to generate accurate results. For example, most authors code presence of the variable as "1" and absence as "0." Others may use "2" and "1." The method used by the author must be followed in creating a bedside tool.

Additionally, the reasoning behind selecting independent variables for the model must also be considered, including the level of significance at which the variables were included into the model. An assessment must be made as to whether variables were considered based on prior results, clinical experience, or based on an automated algorithm ("forward" or "backward" selection).[12] Proper coding and selection can add to the strength of the result of the model, and thus your clinical practice.

Effect of modification reporting

Interactions between independent variables may influence the coefficients associated with those variables.[12] This interaction, known as effect modification, refers to variation in the magnitude of effect by the variable with varying levels of exposure of another variable.[14] Consider, for example, a logistic regression model with lung cancer as the binary outcome variable with two independent (exposure) variables: smoking and asbestos exposure. If the interaction between the exposure variables is not considered, a deceptive regression coefficient estimate for smoking would result. This is because the effect modification of asbestos exposure on smoking is synergistic with respect to lung cancer. When evaluating a model with potential effect modification between variables, mention should be made of the testing for such interactions.

Goodness-of-fit and validation of the model

The validity of inferences drawn from logistic regression techniques depends on the assumptions of the model being satisfied. A critical step in assessing the appropriateness of a logistic regression model is to examine how well the model describes the observed data.[15] In other words, if an estimate of the outcome is calculated using the model, how well does this estimate "fit" with an actual patient with similar characteristics from the dataset? This is known as "goodness-of-fit," and is measured by various indexes, including the Hosmer-Lemeshow statistic or reporting of

a percentage of the dependent variable that was correctly identified by the model.[16]

Validation or retesting of a model in a population different from that used in creating the model is especially important with predictive models to assess model success outside of the derivation study population.[12] Internal validation, using the "jackknife" or "bootstrap" procedures, perform the analysis on subsets of the data used to derive the model, investigating the stability of coefficients and predictive ability of the model.[12] A better method includes validation analysis on a separate subset of patients not used in the creation of the model. Most desirable is external validation of the model in a population independent of and external to that used in deriving the model, preferably at a separate institution. Reporting of any of these techniques is essential in assessing the validity of model being evaluated.

Overfitting

Overfitting implies that the model has been so refined to conform to the study sample that it has lost general usefulness in application to different populations. A model must have enough outcome events per independent variable in order to have a reliable estimate of risk. Though controversial, studies having fewer than 10 outcome events per independent variable may result in questionable accuracy.[16] With overfitting, the resulting regression coefficient may represent spurious associations, or the effects may be estimated with low precision.[12]

Nonconformity to a linear gradient

In logistic regression modeling, while the dependent variable is binary (dichotomous), the independent variable may be ordinal or even continuous. When a regression coefficient is established for an independent variable, the assumption is that the relationship between the variable and the outcome is linear in nature. That is, a unit change in that variable should always have the same effect on the outcome, regardless of where that unit change occurs in the range of that variable. This may be a problem if the independent variable does not act according to a linear gradient. As an example, the impact of left ventricular ejection fraction on mortality depends not only on the unit change in ejection fraction, but also where the baseline ejection fraction stands. A decrease of 10%, from 30% to 20%, carries greater risk than a decrease from 50% to 40%.[12] An article should report the evaluation of conformity to a linear gradient for such variables. Not doing so may overestimate or underestimate the effect depending on the value for an independent variable.

Example

An example below is taken from an article by Shapiro et al,[8] which describes a model for predicting 28-day hospital mortality among septic patients based on nine independent dichotomous variables available in the emergency department. Our evaluation of the clinical model based on our seven criteria can be found in Table 2. The study did meet the majority of criteria. The basics of setting up the PDA spreadsheet can be found in the appendix. The variables and their associated coefficients were as follows:

Table 2. Evaluating Predictive Model for Severe Sepsis [From Shapiro et al[8]]

Evaluation Criteria	Result
Appropriate Study Population	Population consisted of patients > 18 years presenting to the ED at an urban, academic teaching hospital with 50,000 visits annually
Inclusion of regression coefficients and regression constant	The proper coefficient and intercept were reported in the results
Description of variable coding and selection	There was adequate description of the variables in the model. Variables were eligible for inclusion into a forward selection model at a level of p<0.1. Presence of a dichotomous variable was coded as "1" and absence as "0."
Effect modification reporting	Effect modification and interactions were not mentioned in the article.
Goodness of fit and Validation of the model	Goodness of fit was assessed using Hosmer-Lemeshow goodness-of-fit test. Validation of the model was done by the bootstrap method as well as creating a separate validation set to test the final model created from the derivation set.
Overfitting	Also assessed using the bootstrap method. There were greater than 10 events per independent variable
Nonconformity to a linear gradient	Not mentioned in the article, and often difficult to assess.

Variable	Coefficient (b)
Terminal illness (<30 days)	1.80
Tachypnea or hypoxia	0.98
Septic shock	0.98
Platelets <150,000/mm^3	0.93
Bands >5%	0.82
Age >65	0.77
Lower respiratory infection	0.66
Nursing home resident	0.62
Altered mental status	0.50

The value of the constant (a) for their model was -5.45.

The logistic regression formula can be reconstructed as follows (taking care to enter plus and minus signs accurately):

Ln (odds of death) =
-5.45 + 1.80(terminal illness)
+ 0.98(tachypnea/hypoxia)
+ 0.98(septic shock)
+ 0.93(platelets <150,000)
+ 0.82(bands <5%)
+ 0.77(age >65)
+ 0.66(lower respir infec)
+ 0.62(nursing home)
+ 0.50(altered mental status)

Recall that the presence of a dichotomous independent variable in this study was designated by the value 1, its absence by the value 0. For example, if a patient had tachypnea, was in septic shock, had bands of >5%, was 68 years old, had clinical pneumonia and was a nursing home patient (other variables being normal), the calculation becomes:

ln(odds of death) = -5.45 +
1.80(0) + 0.98(1) + 0.98(1) + 0.93(0) + 0.82(1) + 0.77(1) +
0.66(1) + 0.62(1) + 0.50(0)
= -0.62
Odds of death = $e^{-0.62}$
Probability of death = $e^{-0.62} / (1 + e^{-0.62})$
= 0.538 / (1 + 0.538)
= 0.35
= 35%

Setting up this predictive model on a PDA spreadsheet can be found in the appendix.

DISCUSSION

The frequency of use of multivariable methods in the medical literature has steadily increased over the years. One study revealed an 8% increase over a five-year period between 1985-1989.[12] Computer-assisted predictive tools as described in this article offer several potential benefits to take advantage of this trend. The results of investigations that produce predictive models may be directly translated into clinical practice without alteration, thereby maintaining their original precision. Physicians using PDAs may be more likely to use the tools when they can be easily tailored to their clinical practice.[9] Using widely available spreadsheet software, newly validated models may be quickly translated into a form that can be used at the bedside (see appendix), without waiting for third-party software creation and distribution.

There are some important limitations regarding predictive tool adaptation to PDAs. First, predictive models yield only a probability of outcome (e.g., risk of disease, likelihood of benefit from therapy). Establishing thresholds for purposes of diagnostic and therapeutic decision making is a matter of clinical judgment.

Second, a prediction model should be evaluated carefully before it is used in any form. However, proper evaluation is often limited by poor reporting by the author. Bender et al investigated logistic regression in several journals (*BMJ*, *JAMA*, the *Lancet*, and the *New England Journal of Medicine*) from 1991-94. They found that goodness-of-fit was rarely assessed. Of 111 papers, only seven papers reported a valid assessment of the adequacy of their regression model.[17] Other studies have shown similar need for improvements in the reporting and perhaps conducting of multivariable analysis.[12] Violations included overfitting of data, a lack of testing for conformity of variables to a linear gradient, no report of testing for interactions, and unspecified coding or selection of independent variables. In the critical care literature, 65% of published articles properly reported coding of pertinent independent variables; 12% referenced whether effect modifications were examined; 1% tested for colinearity; 16% included a goodness-of-fit analysis; and 39% may have overfitted the model, leading to potentially unreliable regression coefficients.[16] In the obstetrics and gynecology literature 51.8% of articles inadequately described the process of variable selection, 85.1% did not report assessment of conformity to linear gradient, only 6.8% tested for goodness-of-fit, and interactions between variables were not assessed in 86.4% of articles.[13]

Part of the problem with the application of multivariate statistical methods is proper understanding by the study author of these procedures. To this end, editorial guidelines for reporting would improve the ability to interpret a study. If strict reporting guidelines were in place, the methodological flaws in a particular study as well as limitations of model output could be better appreciated.[18] Detailed and complete reporting and peer review of such research as well as informed analysis by the clinician evaluating the paper is necessary. The publication of study alone should not ultimately prompt a change in your clinical practice without proper examination of that study.

PDA spreadsheets formatted as predictive tools have been used successfully within our residency for over five years. Our residents have found this to be an effective way to incorporate evidence-based medicine into daily clinical practice. Once created, these tools can be readily shared with other physicians and are easily modified and/or updated as new research is published.

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APPENDIX

PDA Spreadsheet Applications

This section provides a step-wise method for adapting a predictive model, derived using multiple logistic regression, to an easily applied spreadsheet format. The following discussion and examples use formula syntax contained in Documents To Go® spreadsheet software designed for Palm® OS systems.

1. First, a simple spreadsheet is formatted (Figure 1). The darkly outlined cells in column B indicate the areas for data entry by the user. The cells in column C will be used for entering formulae which carry out calculations used in arriving at the final probability of the outcome, contained (in this case) in cell C5. (In the following discussion, cell addresses will be referred to using capital letters, e.g., "C1", "B2", etc. Regression constants and coefficients will be referred to using lower case letters, e.g., "a", "b_1", "b_2", etc.) The formulae used for these calculations take advantage of the "IF" function standard to most spreadsheet applications. This function takes the following general form:

= IF(condition, action 1, action 2)

This function prompts the program to first evaluate the condition you specify within the formula. If the terms of the condition are met, then action 1 is carried out; otherwise action 2 is carried out. The results of the action are then entered in that cell. An action may be simply a value, in which case that value is entered in the cell.

▼	A	B	C
1	**Independent Variable 1**		
2	**Independent Variable 2**		
3	**Independent Variable 3**		
4			
5	Probability of Outcome Variable		

Figure 1. Sample spreadsheet format for a predictive model

Use of the "IF" function allows for simplified data entry, especially when using dichotomous variables. Data entered in the outlined cells may also be continuous (e.g., lab values, weight, blood pressure, etc.) or ordinal (multiple ranked categories). Note that units are not entered in the data entry cells, only numerical values.

Dichotomous predictive variables are generally given a value of 1 if present and a value of 0 if absent. However, using the formulae below further simplifies data entry in that *any* character (e.g., an "x") placed in the appropriate cell in column B is taken as 1; if no character is in the cell in column B then the value is taken as 0. The appropriate value is then multiplied by the regression coefficient for that variable and the result is automatically placed in the cell. For example, for the three variables in the sample spreadsheet, the following formulae could be entered:

Cell C1: = IF (B1 < > "", (1)*b_1, (0)*b_1)
Cell C2: = IF (B2 < > "", (1)*b_2, (0)*b_2)
Cell C3: = IF (B3 < > "", (1)*b_3, (0)*b_3)

The above formulae take advantage of the spreadsheet's ability to distinguish an empty cell from one with a character contained in it. The "< >" indicates "not equal to" and the double quotes (with no space between them) denote an

empty cell. The symbol "*" denotes multiplication. These expressions can be more simply written as:

Cell C1: = IF (B1 < > "", b_1, 0)
Cell C2: = IF (B2 < > "", b_2, 0)
Cell C3: = IF (B3 < > "", b_3, 0)

In plain terms, the last formula (in cell C3) instructs the program to do the following:

> "Evaluate cell B3. If it is *not* empty (i.e., contains a character) then enter the value for b_3 (the regression coefficient for that variable) in cell C3. Otherwise, if cell B3 *is* empty, enter a zero in cell C3."

With the above formulae entered in cells C1, C2 and C3, if an "x" is entered in cell B1, then the value for b_1 is automatically entered in cell C1. If the "x" is removed from cell B1, a zero is entered in cell C1.

If the value for the third variable were continuous, then the following formula would be entered in cell C3:

= IF (B3 < > "", B3 * b_3, 0)

This instructs the program that if a numerical value is entered in cell B3, that value is to be multiplied by its regression coefficient and the result entered into cell C3. If no value is present in cell B3, then a zero is entered in cell C3.

2. Returning to our basic formula:
Ln(odds) outcome = a + (b_1)(value of variable 1) + (b_2)(value of variable 2) + (b_3)(value of variable 3) = a + C1 + C2 + C3
This formula may be entered in cell C4 as follows:

= a + SUM (C1:C3)

where "a" is the regression constant, hopefully also supplied by the author. (The term "C1:C3" is spreadsheet shorthand signifying "all the cells in column C, from C1 to C3, inclusive.")

The value calculated in cell C4 is equal to the natural logarithm of the odds of the outcome variable, i.e.:

ln (odds) = C4

3. Next, taking the antilog of each side of the equation yields:

antilog [ln(odds)] = antilog (C4)

and since the antilog of the logarithm of a number is the number itself:

odds = antilog (C4)

which is equivalent to:

odds = $e^{(C4)}$

In the language of the spreadsheet, the natural antilog of term x is found by the formula:

e^x = EXP (x)

or, for our example:

$e^{(C4)}$ = EXP (C4)

4. To convert odds to probability, use the relationship:

Probability = odds / (1 + odds)

As a shortcut, steps 3 and 4 above can be combined in cell C5 as the following expression:

= EXP (C4) / (1 + EXP (C4))

This calculation in cell C5 yields the probability of disease, given the presence or absence of the independent variables listed. It is expressed in decimal form. To convert it to percentage, simply reformat the cell to percentage format.

Example

Using our example from the article by Shapiro, et al,[8] setting up the predictive model on a PDA spreadsheet proceeds as follows. First, create the layout as shown in Figure 2. Enter the following formulae in column C (recall that the "< >" indicates "not equal to" and the double quotes denote an empty cell):

In cell C1 enter: = IF (B1< >"", 1.8, 0)
In cell C2 enter: = IF (B2< >"", 0.98, 0)
In cell C3 enter: = IF (B3< >"", 0.98, 0)
In cell C4 enter: = IF (B4< >"", 0.93, 0)
In cell C5 enter: = IF (B5< >"", 0.82, 0)
In cell C6 enter: = IF (B6< >"", 0.77, 0)
In cell C7 enter: = IF (B7< >"", 0.66, 0)
In cell C8 enter: = IF (B8< >"", 0.62, 0)
In cell C9 enter: = IF (B9< >"", 0.50, 0)
In cell C10 enter: = SUM(C1:C9) - 5.45
In cell C11 enter: = EXP(C10) / (1 + EXP(C10))

▼	A	B	C
1	Terminal illness (<30 days)		
2	Tachypnea or hypoxia		
3	Septic shock		
4	Platelets <150,000		
5	Bands >5%		
6	Age >65		
7	Lower respiratory infection		
8	Nursing home resident		
9	Altered mental status		
10			
11	Probability of death in 28 days		

Figure 2. Format for Predictive Model for Severe Sepsis [From Shapiro et al[8]]

Now, when the user enters an "x" in the appropriate data entry cells, the values for this patient would appear as shown in Figure 3.

▼	A	B	C
1	Terminal illness (<30 days)		0
2	Tachypnea or hypoxia	x	0.98
3	Septic shock	x	0.98
4	Platelets <150,000		0
5	Bands >5%	x	0.82
6	Age >65	x	0.77
7	Lower respiratory infection	x	0.66
8	Nursing home resident	x	0.62
9	Altered mental status		0
10			-0.62
11	Probability of death in 28 days		35%

Figure 3. Example Data Entry and Resultant Cell Values

Combining Ketamine and Propofol ("Ketofol") for Emergency Department Procedural Sedation and Analgesia: A Review

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INTRODUCTION

Emergency physicians must be comfortable and confident in providing safe and effective procedural sedation and analgesia (PSA). Goals of PSA include providing an adequate level of sedation while minimizing pain and anxiety, maximizing amnesia, minimizing the potential for adverse drug-related events, controlling behavior, and maintaining a stable cardiovascular and respiratory status. The ideal pharmacologic agent for PSA would accomplish all of these goals, and would have a quick onset and offset, be safe in all age groups, be inexpensive, and be equally efficacious in multiple routes of administration. Unfortunately, at this time no single agent exists that has all of the aforementioned qualities, so physicians must use combinations of different drugs at varying does to achieve as many of the desired goals as possible. The most recent PSA combination to be described in the literature is that of low-dose ketamine and propofol ("ketofol"). In this article we attempt to describe the postulated benefits of using these two agents together and examine the safety and efficacy of the combination.

Background

Ketamine was developed in the 1960s as a safer and more predictable anesthetic than its precursor phencyclidine (PCP). It is a unique agent in procedural sedation and analgesia (PSA) in that it is a "dissociative" anesthetic that functions by blocking communication between the thalamic and limbic regions of the brain, thereby preventing the brain from processing external stimuli.[1] It provides excellent amnesia and analgesia, and preserves muscle tone maintaining protective airway reflexes and spontaneous respiration.[2,3] Despite its obvious advantages over other agents, some practitioners are hesitant to use ketamine alone secondary to its propensity to cause vivid and frightening emergenct reactions.[4] Additional significant adverse effects include sympathomimetic effects and vomiting when administered in sedating doses.[5]

Propofol is a non-barbiturate sedative hypnotic developed in Europe in the 1970s and was gradually utilized by anesthesiologists in the United States over the next two decades. Relatively recently its use has spread into the Emergency Department (ED) as a part of PSA. Its popularity as a PSA agent is growing rapidly due mainly to its favorable pharmacokinetic profile as the lipid solubility confers a quick onset and short recovery time.[6] It also has the advantages of functioning as an antiemetic, an anticonvulsant, and an amnestic agent.[7] Although extremely effective and potent, propofol use is limited by a relatively high incidence of dose-dependant hypotension and respiratory depression.[7,8,9]

It is postulated that combining these two agents for PSA may preserve sedation efficacy while minimizing their respective adverse effects. This is due partly to the fact that many of the aforementioned potential adverse effects are dose-dependant, and when used in combination the doses administered of each can be reduced.[10] Also, the cardiovascular effects of each are opposing in action, thus theoretically balancing each other out when used together. This theoretical advantage of ketofol producing a more stable hemodynamic and respiratory profile was tested and found to be true in a group of healthy patients receiving general anesthesia.[11] Although there is a significant amount of literature describing the use of ketofol in infusion form, in this article we attempt to review all the published literature describing the use of ketofol in bolus form as would be applicable for PSA in the ED.

METHODS

Both MEDLINE and Pubmed were searched using ketamine, propofol, ketofol, conscious sedation, and procedural sedation as search terms. This resulted in the identification of 31 abstracts. All abstracts were reviewed and those that described the use of the combination of ketamine and propofol in intravenous bolus form were included for review. Those that described studies in animals, in healthy volunteers, or that described the administration of propofol and ketamine either in isolation, in infusion form, or for general anesthesia were excluded. An ancestral search of

the references of all included articles was performed using the same inclusion and exclusion criteria to ensure that no relevant articles were missed.

LITERATURE REVIEW

Six studies met inclusion criteria and are further discussed (Table).

Ketofol versus Propofol

There are two published trials in pediatric patients comparing propofol monotherapy to ketofol. The first is a randomized double-blind study in 60 patients between one month and 13 years of age undergoing cardiac catheterization who received sedation with propofol (1.5 mg/kg) monotherapy or propofol (1.5 mg/kg) plus ketamine (0.5 mg/kg).[12] Mean arterial pressure (MAP), heart rate, respiratory rate, and peripheral oxygen saturation were recorded at pre-determined time intervals. Time to recovery and adverse events were also noted. They found a significant (defined a priori as >20%) decrease in MAP in 11 patients in the propofol monotherapy group and three patients in the ketofol group. No other significant differences in recorded vital-sign measurements were found. Time to recovery was almost identical in the two groups, and the number of adverse events was not statistically different. These findings led the authors to conclude that the addition of low-dose ketamine to propofol preserved MAP without prolonging recovery or increasing the incidence of adverse events.

In the second pediatric study propofol (1.5 mg/kg) monotherapy was compared to propofol (1.5 mg/kg) plus ketamine (0.5 mg/kg) in a non-randomized trial in 60 patients between one and 13 years of age undergoing auditory brainstem response testing.[13] Sedation was maintained with repeat boluses at half the original doses at the discretion of the treating physician. Blood pressure, respiratory rate, and peripheral oxygen saturation were recorded at pre-determined time intervals. Desaturation was defined as a 10% decrease in peripheral oxygen saturation when compared to baseline, and apnea was defined as cessation of respiration for 15 seconds or more. The investigators noted that a repeat dose of medication was needed in 21/30 patients in the propofol group and in 8/30 in the ketofol group. There were no cases of desaturation in the ketofol group, but in the propofol group 4/30 experienced desaturation and 6/30 had apnea. At both the three and five-minute time intervals blood pressure and heart rate were significantly lower in the propofol group than in the ketofol group. In summary, the authors concluded that the addition of low dose ketamine to propofol reduced the risk of respiratory depression and the need for repeat medication administration.

In adults there is only one study comparing propofol monotherapy to ketofol. In this randomized double-blind study, 70 elderly patients receiving retrobulbar nerve blocks for cataract extraction were assigned to receive either propofol in small boluses or propofol in small boluses with the addition of ketamine (30 mg) in the first bolus.[14] They found that patients in the ketofol group had a significantly shorter time until sedation (164 +/- 67 s) when compared to the propofol group (235 +/- 137 s). Also, two patients in the propofol group needed ventilatory assistance compared to zero patients in the ketofol group. This led these researchers to conclude that adding ketamine to propofol resulted in faster onset of sedation while decreasing respiratory compromise. It is important to note that the authors did not assess other important adverse events including emergence reactions and sympathomimetic effects, which are of special importance in elderly patients.

Ketofol versus Propofol-Fentanyl

Another popular drug combination for PSA consists of propofol and fentanyl, and there are two studies that compare ketofol to this combination. In a randomized double-blind study performed in 40 adult patients undergoing endometrial biopsy, the combination of propofol (1 mg/kg) plus fentanyl (1 ug/kg) was compared to the combination of propofol (1 mg/kg) plus ketamine (0.5 mg/kg).[15] Heart rate, systolic and diastolic blood pressure, respiratory rate, peripheral oxygen saturation, adverse events, time to recovery, and time to discharge were recorded. Although respiratory depression was five times more frequent in the ketofol group, neither this difference nor any other difference in vital signs was found to be statistically significant. Time to recovery was similar; however time to discharge was longer in the ketofol group secondary to the increased presence of adverse events including nausea, vertigo, and visual disturbances. In a post-procedure phone follow-up interview conducted 24 hours after discharge 95% of patients in the propofol plus fentanyl group stated they were satisfied and would like the same combination in the future, versus only 60% of patients in the ketofol group. These authors concluded that although both regimens seem safe, ketofol had more adverse events leading to a longer time until discharge and had a lower overall patient satisfaction.

The second is a randomized double-blind study, in which 90 total patients having a laryngeal mask airway (LMA) placed received propofol (2.5 mg/kg) with either ketamine (0.5 mg/kg), fentanyl (1 ug/kg), or placebo normal saline.[16] When measured vital signs and pre-determined time points and ease of LMA insertion, they found the ketofol group had a significantly higher systolic blood pressure than the other two groups and the incidence of prolonged apnea (>120 s) was higher in the fentanyl group (23.1%) than in either the ketofol group (6.3%) or the normal saline group (3.3%). They concluded that ketofol provided equivalent LMA insertion conditions while maximizing hemodynamics and minimizing apnea. Even though efficacy was assessed in this study, no attempt was made to qualify important adverse events such as emergence reactions.

Table 1.

Author/Journal	Agents	N	Patients	Study Design	Setting	Comments
Akin A. Pediatr Cardiol 2005	Ketofol vs. Propofol	60	Children 1 mo to 13 years	Randomized double-blind	Cardiac catheterization	Improved MAP preservation without prolonging recovery or increasing adverse events in the ketofol group.
Akin A. Int J Pediatr Otorhinolaryngol 2005	Ketofol vs. Propofol	60	Children 1 mo to 13 years	Non-randomized	Auditory brainstem response testing	Decreased need for repeat dosing and decreased respiratory depression in the ketofol group.
Frey K. Anesth Anag 1999	Ketofol vs. Propofol	70	Elderly	Randomized double-blind	Cataract extraction	Faster onset of sedation and decreased respiratory depression in the ketofol group. No mention of emergence reactions or sympathomimetic effects.
Akin A. J Clin Anesth 2005	Ketofol vs. Propofol + Fentanyl	40	Adults	Randomized double-blind	Endometrial biopsy	Respiratory depression five times more frequent in the ketofol group but not statistically significant. Adverse events including nausea, vertigo, and visual disturbances more common with ketofol resulting in longer time to discharge. Patient satisfaction lower with ketofol.
Goh PK. Anaesth Intensive Care 2005	Ketofol vs. Propofol + Fentanyl	90	Adults	Randomized double-blind	LMA insertion	Higher SBP less episodes of prolonged apnea (6.3%) with ketofol when compared with the Fentanyl group (23.1%)
Willman EV. Ann Emerg Med 2007	Ketofol	114	Adults	Prospective descriptive	ED mainly orthopedic procedures	No hypotension. One patient needed BVM ventilation. Three patients had an emergence reaction. No vomiting. Procedural success rate 96.5%. Median time till recovery 15 minutes. Median satisfaction score of 10.

Ketofol in the Emergency Department

There is only one published prospective study using ketofol for PSA conducted in the ED setting. In this descriptive study 114 patients requiring PSA for mainly orthopedic procedures were given a 1:1 mixture of propofol (10 mg/ml) and ketamine (10 mg/ml) in 1 to 3 ml aliquots titrated at the discretion of the treating physician.[17] They recorded dose administered, vital signs at pre-determined intervals, presence or absence of adverse events, procedural success, time until recovery, and physician, nurse and patient satisfaction. The mean dose of medication administered was 0.75 mg/kg of ketamine and 0.75 mg/kg of propofol. No patient became hypotensive or had evidence of poor perfusion. Transient hypoxia occurred in 2.6% of patients (95% CI 0.6 to 7.5%) and of these one (0.9%; 95% CI 0.02 to 4.8%) required bag valve mask ventilation. Three patients (2.6%; 95% CI 0.6-7.5%) had an emergence reaction, one of whom received midazolam. No patient had vomiting or aspiration. Procedural success rate in this study without the use of adjunctive medications was 96.5%. Median time until recovery was 15 minutes (range 5 to 45 minutes) and median physician, nurse, and patient satisfaction scores were 10 on a 1-to-10 scale.

DISCUSSION

The combination of ketamine and propofol has been used with great success in anesthesiology for many years,

but only recently has it begun to spread into other fields of medicine. Because ketofol is a relatively new idea for most practitioners, there is very little in scientific literature on its use in bolus form for PSA. The studies that have been conducted are small in size and thus lack the power to detect significant differences in all of their stated endpoints. Although most studies do attempt to evaluate safety as measured by respiratory and cardiovascular status, very few look at the frequency of other adverse events such as emergence reactions which, if present, may cause practitioners to veer away from ketofol and use another regimen that is found to be equally efficacious. Additionally, in the reviewed literature several different dosing regimens are used, making it hard to reconcile the results of the various studies.

In the two pediatric studies discussed in this review the authors chose to compare ketofol to propofol monotherapy. It would have been more useful look for an efficacy difference between ketofol and ketamine monotherapy, which is used far more frequently than propofol monotherapy in children.[12,13] Importantly, only one study was actually conducted in the ED setting with ED procedures using bolus dose ketofol.[17] The authors found ketofol to be both safe and efficacious, but this study was purely descriptive and therefore cannot be used to conclude that the combination is better than either agent as monotherapy. It is unclear if the conclusions of the rest of the reviewed studies describing the use of ketofol in other clinical settings and types of procedures can be generalized to its use in the ED.

CONCLUSION

Although all but one of the published studies reviewed in this article conclude that the combination of ketamine and propofol in bolus form provides safer and more efficacious sedation, larger randomized, prospective studies conducted in the ED with sufficient power to use stability of vital signs and procedural success as endpoints are needed. From the literature reviewed one can conclude that ketofol appears to be safe and efficacious for use in the ED for PSA. However, as the reviewed studies are small, reporting of adverse events is often limited, and the only study conducted in the ED is not a randomized trial, the literature is not strong enough to definitively conclude that ketofol is better than either agent alone or than either agent used in combination with a different agent.

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Ten Solutions for Emergency Department Crowding

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INTRODUCTION

Over the past decade, emergency department (ED) crowding has occurred and progressed. It has become a major topic of discussion at emergency medicine (EM) conferences, such as those held annually by the Society for Academic Emergency Medicine and the American College of Emergency Physicians. There has been much recent media coverage, such as the *Newsweek* article, "Code Blue for the ER."[1] Recently the Institute of Medicine published an extensive report on the topic.[2] While there is no question that many EDs are crowded, the myriad causes of and solutions to crowding have been widely debated. In our opinion, multiple factors contribute to ED crowding, and the relative contribution of each factor varies between EDs. Circumstances differ between urban and rural hospitals, as well as between county, academic, and private hospitals.[3] We believe multiple simultaneous steps are necessary to solve ED crowding. We present 10 putative solutions with commentary on actions at our institution to counter the problem.

1) Expand Hospital Capacity

In 1946, at the end of World War II, the United States Congress addressed concerns with deficiencies in hospital bed capacity and health services by passing the Hill-Burton Act.[4] This provided billions of dollars for hospital construction across the country, with the goal of five inpatient beds per 1,000 persons. This wave of hospital construction attracted more people to careers in healthcare. Major funding ended in 1966, when the Medicare and Medicaid programs became law. By providing increased hospital capacity for its citizens, communities successfully attracted physicians, nurses and ancillary staff.

Since 1970, the ratio of inpatient hospital beds per population has declined in the U.S. Unfortunately, with increasing numbers of uninsured and a requirement that hospitals run profitably, the number of hospital beds per 1,000 persons has diminished over the past 20 years. According to the California Healthcare Association, 70 hospitals closed in California between 1993 and 2003. California's population grew by 13% during that time while acute care hospital bed capacity dropped by 14%. Today in California there are only 1.9 beds per 1,000 persons.[5] As a result, many hospitals are perpetually full with admitted patients boarded in the ED. Boarding of inpatients in the ED is unquestionably the leading cause of crowding. At times the ED at the University of California, Davis has more boarded patients than new, ambulatory patients. We have contacted legislative staff locally and nationally about resurrecting the Hill-Burton Act to expand hospital capacity. This might be more appealing to Americans rather than radical reform of the healthcare system, advocated by some. Many health systems would welcome federal support to make this possible.

Some might argue that increasing the number of hospital beds is not needed because of decreased length of stay for patients admitted to hospital more recently. We believe this is offset by the aging population and the number of complex medical conditions not considered and/or treated shortly after World War II. These includes chronic renal failure/dialysis, transplants, Hepatitis C, Acquired Immune Deficiency Syndrome, cancer chemotherapy, acute coronary syndrome and coronary artery bypass grafts, pacemakers, and many others. Many patients who would have died quickly or at home decades ago are kept alive for days to months, only to die in hospitals today.

2) Stop regulating hospitals to the extreme

Legislative mandates in California have decreased flexibility of hospital's ED operations. In California, AB 394, mandated a fixed patient:nurse ratio of 4:1 in the ED in 2004. In our opinion, enforcement of this fixed ratio has been harmful rather than helpful to ED patients. In the past, during periods of extreme crowding, ED patients might have been "doubled up" in some treatment areas to provide the safest environment for monitoring. Now, with a rigid 4:1 patient: nurse ratio, patients are placed in hallways with no direct nursing observation during periods of crowding. Indeed, some patients who are very ill must remain in the waiting room. We believe this rule should be relaxed when applied to the ED to allow for flexibility during periods of crowding. Some hospital administrators have promised to "float" more nurses

down to the ED during periods of crowding. However, this has not been consistent, as it depends on nurses' acceptance. Most inpatient nurses refuse to work in the ED out of personal preference. Other mandates have placed undue emphasis on certain medical conditions at the expense of others. For example, the requirement of early administration of antibiotics for patients with pneumonia is notable.[6] Naturally this results in more focus on patients with pneumonia; however, an elderly person presenting with abdominal pain or potential sepsis may be pushed further to the back of the triage line as a result. Finally, requirement of state approval of construction projects within hospitals results in increasing delay and expense. Small changes in a hospitals physical structure to enhance patient flow are made prohibitively expensive because of a gauntlet of lengthy state reviews. Furthermore, attempts to modify existing parts of an ED to enhance capacity trigger comprehensive review by the Office of Statewide Planning and Development. This, in turn, requires the entire department to be brought up to current code standards, making minor modifications difficult or impossible because of added expense.

3) Provide care only to patients with emergencies

Prior to the Emergency Medical Treatment and Active Labor Act (EMTALA) in 1986, many individuals with bona fide medical emergencies were turned away from the ED or transferred with incomplete care because they did not have insurance. As a result, EMTALA was created to ensure all patients with true emergencies were appropriately evaluated and stabilized. Over the past 20 years, this intent has been progressively over-interpreted by numerous regulators throughout the Centers for Medicare & Medicaid Services (CMS) districts in the United States. The requirement that all patients presenting to an ED must have a medical screening exam has been interpreted by many as all patients must be treated as well. With many of the population aware of such a mandate, patients who have no access to general primary medical care are now utilizing the ED, despite long waits. Some might debate whether the "Safety Net" philosophy of the ED has increased the number of patients in the ED, while in our experience this has definitely been the case.

We believe that EDs should exist for true emergencies, similar to the notion that fire departments exist to extinguish fires. We think a more cost-effective, appropriate, and efficient method of treating non-emergent medical problems occurs in urgent or primary care clinics, provided these are available. At one time, our ED actually referred out persons who presented with non-emergent medical conditions. At our ED, we devised a system whereby over five years we referred over 32,000 patients to ambulatory clinics after a medical screening exam (MSE) by the triage nurse that determined these patients did not have an emergency medical condition.[7] In subsequent years after the implementation of this referral system, referral clinics accepting non-funded patients became nearly nonexistent, making it difficult to refer patients out. We have also conducted a survey on how the general public defines a bona fide emergency and concluded most believe the ED should be reserved for patients with true emergencies.[8] In order to successfully treat non-emergent patients, additional primary care clinics must be built within most communities. These clinics must be able to provide services for patients with and without health insurance in order to share the patient load that currently leans heavily on the ED. A number of Federally Qualified Health Centers (FQHC)-designated clinics have opened in communities to assist with this effort, but many more are needed.

4) Provide alternatives for primary care of the uninsured

Many county health departments do not have adequate ambulatory clinic facilities for their uninsured patients. It is common knowledge these patients will receive care in the local ED. Many uninsured and/or indigent patients do not even bother using these clinics, but instead use the ED for primary care. With their less acute triage categories these patients frequently have waits as long as 12 hours. We have attempted to form a healthcare consortium of the major health systems in the Sacramento area with the assistance of our county health department to provide appropriate clinic facilities and care for patients without insurance.

5) Stop boarding admitted patients in the Emergency Department

Limited hospital bed capacity results in the boarding of admitted patients in the ED. Patients are placed in hallways, storage rooms, and annexes. Some of these ED hallway patients are sicker than admitted patients already occupying inpatient beds. Boarding of patients in the ED results in significant ED congestion and is associated with poor outcomes.[10-12]

In some academic centers "door to floor" time exceeds 21 hours for 90% of admitted patients. It would make sense then to move admitted patients from ED hallways up to the hallways of the inpatient areas when the hospital is full. Such a proposal is not novel and, in fact, is used extensively on the East Coast. This has been championed by Dr. Peter Viccellio of the State University of New York at Stony Brook.[9] In that model, during periods of ED crowding patients are automatically moved to inpatient hallways. One of the benefits is that inpatient staff quickly accommodates these patients into appropriate inpatient beds as soon as these become available.

6) Use evidence-based guidelines to address imaging over utilization

When we first began practicing EM, the availability of computed tomography (CT) was limited to patients with severe head and thoraco-abdominal trauma. Today it seems

we collectively order CT scans on 50% of all patients during a shift, including those with minor head trauma, abdominal pain, headache, and soft tissue complaints. We do believe the increased availability and speed of CT has resulted in improved outcomes. However, a number of studies have suggested that focused use of CT scans and other imaging tests can be achieved without a negative impact on outcome.[13] Indiscriminate ordering of CTs may even be deleterious. It has been estimated that one cancer death occurs for every 1,000 CTs performed on children.[14] Patients waiting for abdominal CT with oral contrast can occupy an ED bed for an additional four to six hours in some institutions.

This is progressing now with routine magnetic resonance imaging (MRI) for patients with symptoms of transient ischemic attack and/or cerebrovascular accidents. Patients are now queued up for our MRI scanner, further occupying beds and increasing waiting time for those not yet evaluated. We believe careful criteria should be established for imaging, in particular the use of abdominal CT for non-specific abdominal pain.

7) Change admitting patterns

One means of decreasing demand for scarce hospital and intensive care unit (ICU) beds is to change admitting patterns. Some hospitals have established services to provide specialty evaluation of patients with chest pain who otherwise might be admitted. These patients may undergo same-day exercise treadmill testing and be sent home if their results are normal. Intravenous (IV) antibiotic infusion centers and home health nursing care may also help decrease admissions. Additional measures may help preserve an even greater shortage of telemetry and ICU beds. Some hospitals have adapted criteria that standardize telemetry and ICU admissions. In addition, some patients who may have required ICU care at the initial onset of the ED presentation may, in fact, need lower level of care after ED treatment and stabilization. Many changes in admission patterns have occurred in the past 20 years, but some of these do not help the flow of ED patients. For example, in years past, most patients with asthma were admitted, whereas now patients often receive intensive treatment in the ED for six to 12 hours. This again prolongs the time to be seen for patients in the waiting room.

8) Expand the role of ancillary ED staff and hallway care

A number of plans have sought to increase productivity of ED staff, including physicians, nurses, and technicians, to counter crowding. An increase in physician hours and coverage has limited benefit because the rate-limiting factor has been nursing coverage. Strict adherence to the 4:1 patient:nurse ratio obviates any advantage to increased physician coverage. Increasing nursing coverage during a nursing shortage is difficult. Expanding utilization of licensed vocational nurses (LVN) may be helpful. Not all hospitals use LVNs, and nursing organizations have argued that nurses provide better patient safety. The addition of family nurse practitioners and physician assistants to the ED staff could also help reduce crowding. At our ED we now use the hallway as a major patient-care area. To not do so would result in complete gridlock of the ED when designated ED patient-care areas are filled with admitted patients and the hospital is full. Patients who have been waiting hours to be seen are often grateful to be evaluated regardless of location. However, in our opinion and experience, hallway evaluations are by nature less complete for lack of privacy and space and may have the potential for poor outcomes.

9) Call the nurse first

A number of companies, agencies, and healthcare institutions have developed nurse assistance phone services to help triage patients to the ED or clinic. A number of studies have shown these services are efficient and safe.[15] However, these services are expensive to operate. A study group from Kansas City showed that in a closed point-of-service population, potential ED visits were diverted, thereby saving the health system money even when the cost of the service was factored in.[16] A large multi-city study of mixed patient populations would be helpful to determine the utility of this approach to ED crowding. If it is acceptable to advise a patient over the phone that ED care is not necessary, why is so difficult to allow a registered nurse in ED triage to assess a patient personally, and make the same conclusion?

10) Prevent disease and injury

What is the role of the ED in the global view of public health? A patient's visit to the ED is often at the end of a cascade of adverse health events, many of which are preventable. Regular visits to primary care could mitigate the number of patients presenting to the ED for uncontrolled diabetes, hypertension, obesity, and hyperlipidemia. ED physicians regularly treat patients with sexually transmitted diseases, prenatal, and perinatal problems, which could more easily be addressed at ambulatory clinics. Coronary artery and neurovascular disease is related to lifestyle and smoking, as well as genetics, and national education campaigns have been helpful to educate the public. The incidence of cancer is increasing; often a new diagnosis of cancer is made by the ED physician in their evaluation of patients with common complaints. Routine screening for colorectal, breast, cervical and ovarian cancer, among others, should be expanded. One example of positive change has been safety improvements in automobiles such as seatbelts, airbags, dashboards, and frame design. These changes have prevented death and disability for patients involved in motor vehicle collisions. The role of alcohol in vehicular trauma is well recognized,

and recent interventions to reduce impaired driving have had limited success. Trauma patients with serious injuries have the potential to consume enormous ED resources. Intubation, chest tubes, fracture management, and wound care performed in the ED often takes hours to complete. Imagine how crowded our EDs would be without these improvements?

CONCLUSION

In summary, a number of different solutions to ED crowding should be considered and applied. Eliminating ED crowding will take the collective involvement of healthcare workers, business leaders, politicians, the press, and the public.

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Wide Complex Tachycardias: Understanding this Complex Condition
Part 1 – Epidemiology and Electrophysiology

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INTRODUCTION

Patients presenting to the emergency department (ED) with electrocardiograms (ECGs) indicating wide complex tachycardias (WCTs) are difficult to manage. Furthermore, these ECGs are often challenging to interpret.[1,2] Patients typically have ongoing chest discomfort, with or without symptoms of dyspnea, lightheadedness, nausea, and diaphoresis. Accurate interpretation of ECGs demonstrating WCTs assists clinicians who must treat patients presenting with this condition. Despite step-wise approaches and numerous criteria suggested to interpret WCTs, physicians (including cardiologists) often fail to agree on a surface electrocardiographic diagnosis.[3,4] Understanding the etiology of WCTs not only helps identify the cause of this condition, but also prevents its mismanagement, significantly reducing morbidity and mortality.[5,6,7]

This is the first of two manuscripts designed to remove the "complex" from wide complex tachycardia identification (part 1) and management (part 2). Information is provided to help clinicians interpret ECGs demonstrating WCTs, including descriptions of the electro- and pathophysiology behind their development. Several examples of WCTs are provided with detailed interpretations. Diagnostic criteria from current literature and their relative accuracy are presented. In part 2, the most recent 2005 American Heart Association (AHA) guidelines for the treatment of WCTs are discussed, and management strategies for various WCTs are described given their underlying etiologies.

Wide Complex Tachycardias (WCTs) are also known as Broad Complex or Wide QRS Complex Tachycardias. It is easiest to understand this nomenclature by considering these terms independently. *Wide* refers to a QRS complex duration (width) of greater than or equal to 0.12 seconds (120 msec), corresponding to three small boxes on the ECG paper. There are many reasons for QRS complexes to be widened (see Table 1). Any cause of a widened QRS complex can result in a sustained or nonsustained wide complex tachycardia if the rate is greater than 100 beats per minute. Etiologies of various WCTs are listed in Table 2, with schematic diagrams to better appreciate the conduction pathways and electrophysiology behind WCTs provided in Figure 1. The *QRS Complex* is the electrical stimulus on the ECG tracing as it passes from the AV node down the ventricular conduction system, terminating in the ventricular myocardial cells.[8] This definition, however, proves to be rather limited, as the electrical stimulus that results in the QRS complex may travel in either the forward or backward direction (*anterograde* or *retrograde*) using various pathways as part of the conduction circuit (*orthodromic* or *antidromic*). The direction of and pathway used by the electrical impulse greatly affects the duration of the QRS complex, which may impact the heart rate achieved. *Tachycardia* is generally defined as any heart rate or pulse greater than 100 beats per minute, whether or not this is sustained.

Table 1. Etiologies of a wide QRS Complex*[9]

Nonspecific intraventricular conduction delay
Aberrant ventricular conduction (Bundle Branch Block)
Ventricular ectopic beat
Ventricular excitation syndromes (Wolff-Parkinson-White Syndrome)
Left ventricular hypertrophy
Hyperkalemia
Hypermagnesemia
Pacemaker-generated beat
Hypothermia
Drug Toxicities (tricyclic antidepressants, cocaine, phenothiazines, lithium, diphenhydramine, or other drugs having sodium channel blockade or quinidine-like effects)

** Any of these causes of a wide QRS complex may result in a WCT, given concomitant tachycardia.*

Table 2. Electrophysiologic and/or metabolic causes of WCTs[9]

Supraventricular tachycardia (SVT) with pre-existing BBB
Supraventricular tachycardia (SVT) with rate-related BBB
Supraventricular tachycardia (SVT) with aberrant conduction
Atrial fibrillation (AFIB) with Wolff-Parkinson-White Syndrome (WPWS)
Ventricular tachycardia (VT)
Polymorphic VT (Torsade de pointes)
Pacemaker-mediated tachycardia (PMT)
Drug overdose (digitalis, TCAs, lithium, [10] cocaine, [11,12,13] diphenhydramine[14])
Sodium channel blocking agents[15]
Hyperkalemia
Post-resuscitation
Malingering[16] and/or ECG artifact[17]

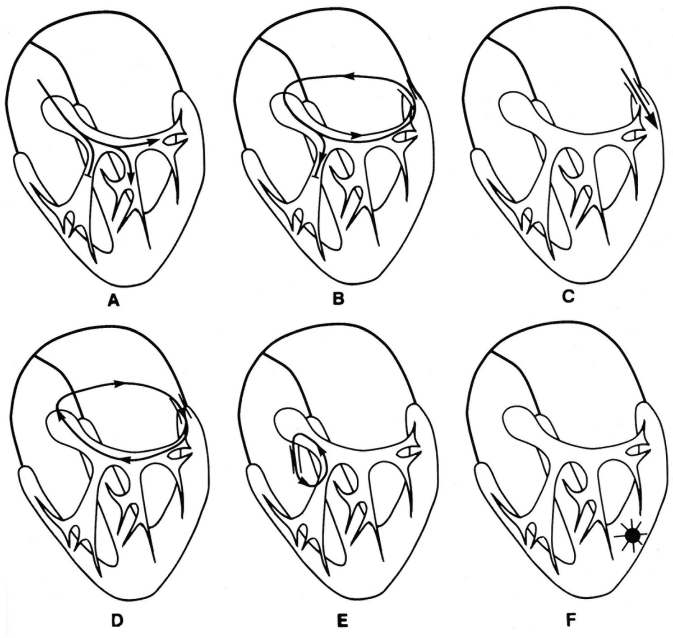

Figure 1. Illustrations showing different etiologies of WCTs using electrophysiological representations. (Wellens HJJ, Conover MB. The ECG in Emergency Decision Making. W.B. Saunders Co. Philadelphia, PA, 1992, p. 39). Used with permission.
A: SVT (sinus tachycardia, atrial tachycardia, atrial flutter, atrial fibrillation, AV nodal reentry tachycardia) with pre-existent or tachycardia-related BBB. B: Circus movement tachycardia (CMT) with AV conduction over the AV node and VA conduction over an accessory pathway in the presence of pre-existing or tachycardia-related BBB. C: SVT with AV conduction over an accessory AV pathway. D: CMT with AV conduction over an accessory AV pathway and VA conduction over the AV node. E: Tachycardia with anterograde conduction over a nodoventricular (Mahaim) fiber and retrograde conduction over the bundle of His. F: Ventricular tachycardia

Before reviewing diagnostic criteria recommended for the interpretation of ECGs demonstrating WCTs, clinicians must first recognize the importance of an individual's presenting symptoms associated with this WCT. The initial assessment of the airway, breathing, and circulation (ABCs) is critical, as these determine the approach taken in treating the patient. However, these *may or may not* assist the clinician's ability to identify the underlying condition responsible for the WCT. Oxygen and intravenous access should be started as soon as possible. Cardiac rhythm and blood pressure monitoring should be initiated immediately. A focused history and physical examination must be performed during this initial period, not only to gather additional information about this individual, but also to allow consideration for alternative diagnostic possibilities.

There are several aspects of the medical history that contribute to a clinician's ability to identify the etiology behind a WCT. Individuals with previous myocardial infarction (MI) or known coronary artery disease (CAD) are approximately four times more likely to present with ventricular rather than supraventricular etiologies of their WCT. Stated another way, approximately 80% of all patients presenting with WCT will be diagnosed having VT as the cause.[18] This figure may be higher than that seen in patients presenting to the ED, due to referral bias at specialty centers and the repeated citation of older literature.[19] One small retrospective study found that histories of prior myocardial infarction (MI), congestive heart failure (CHF), and recent angina pectoris all had positive predictive values for VT greater than 95%, but sensitivities were low to moderate.[20] None of these clinical characteristics was strongly predictive for SVT; the best was age less than or equal to 35 years (positive predictive value of 70%). In fact, this study concluded that for patients presenting with WCTs, there are no ECG findings or clinical variables highly suggestive of SVT with aberration. Previous Holter or electrophysiologically-proven VT, or medications used to treat VT may be helpful historically, as they make the diagnosis of VT more likely. However, neither is conclusive for VT as the etiology of the presenting WCT. Previous electrophysiologically-proven SVT does not exclude the diagnosis of VT, nor does it confirm the diagnosis of SVT, as individuals with a previous episode of SVT may present with an episode of VT. Positive responses to medications with prior episodes of "palpitations" or WCTs may not determine the etiology, as several medications work on blocking cardiac conduction both above and below the ventricle, and the etiology for the present rhythm disturbance may differ. Finally, previous adverse responses to cardiac medications may identify which medications to avoid in the management of an individual, regardless of the etiology of their presenting symptoms or ECG.

During a careful physical examination, identifying signs of atrio-ventricular (AV) dissociation strongly supports the

diagnosis of VT. *AV dissociation* occurs due to independent activity of the atria and ventricles, a characteristic occurrence in VT. Physical signs include irregular cannon A waves, varying intensity of the S1 heart sound, and beat-to-beat variability in systolic blood pressure (SBP). Irregular cannon A waves occur when the atria contract against AV valves that are closed because the ventricles are simultaneously contracting. These waves are the result of brisk blood backflow in the jugular veins. They do not occur with each cardiac cycle, and may be variable in quality because atrial contraction may occur when the AV valves are open or in differing stages of closure. This results in irregularity and varying quality of the cannon A wave intensity, when and if these waves occur. Varying intensity of the S1 heart sound is related to the timing of AV valve closure at the onset of ventricular systole. The beat-to-beat variability of the first heart sound's loudness is due to the varying positions of the AV valves at the onset of ventricular systole. Beat-to-beat variability in SBP is due to the changing amount of blood in the ventricle during ventricular contraction, the result of varying diastolic filling times. On the ECG or rhythm strip tracings, the P waves and QRS complexes classically lack any relationship (i.e., there is no association between them), as demonstrated in Figure 2. This may be difficult to identify on ECGs demonstrating WCT, due in part to the tachycardia itself, as well as the morphology of the QRS complex. The absence of AV dissociation neither excludes the possibility that the WCT is ventricular in origin (VT), nor confirms that the WCT is supraventricular in origin. Vagal maneuvers, such as cautious carotid massage, gagging or coughing, and valsalva can slow the ventricular response in many tachycardias of supraventricular origin, allowing atrial activity to be more apparent. These maneuvers tend to be ineffective in tachycardias of ventricular origin.

The most important point to consider when evaluating and treating individuals presenting with WCTs is their hemodynamic status. An individual's hemodynamic status does not help determine the etiology of the WCT. A survey of physicians published in *JAMA* in 1985 demonstrated this fact was commonly misunderstood.[1] The determination of whether or not a WCT is unstable is based on the effect it has on end-organ perfusion. Neither the patient's heart rate nor QRS width determines hemodynamic stability. Symptoms providing evidence of unstable WCTs include hypotension, pulmonary

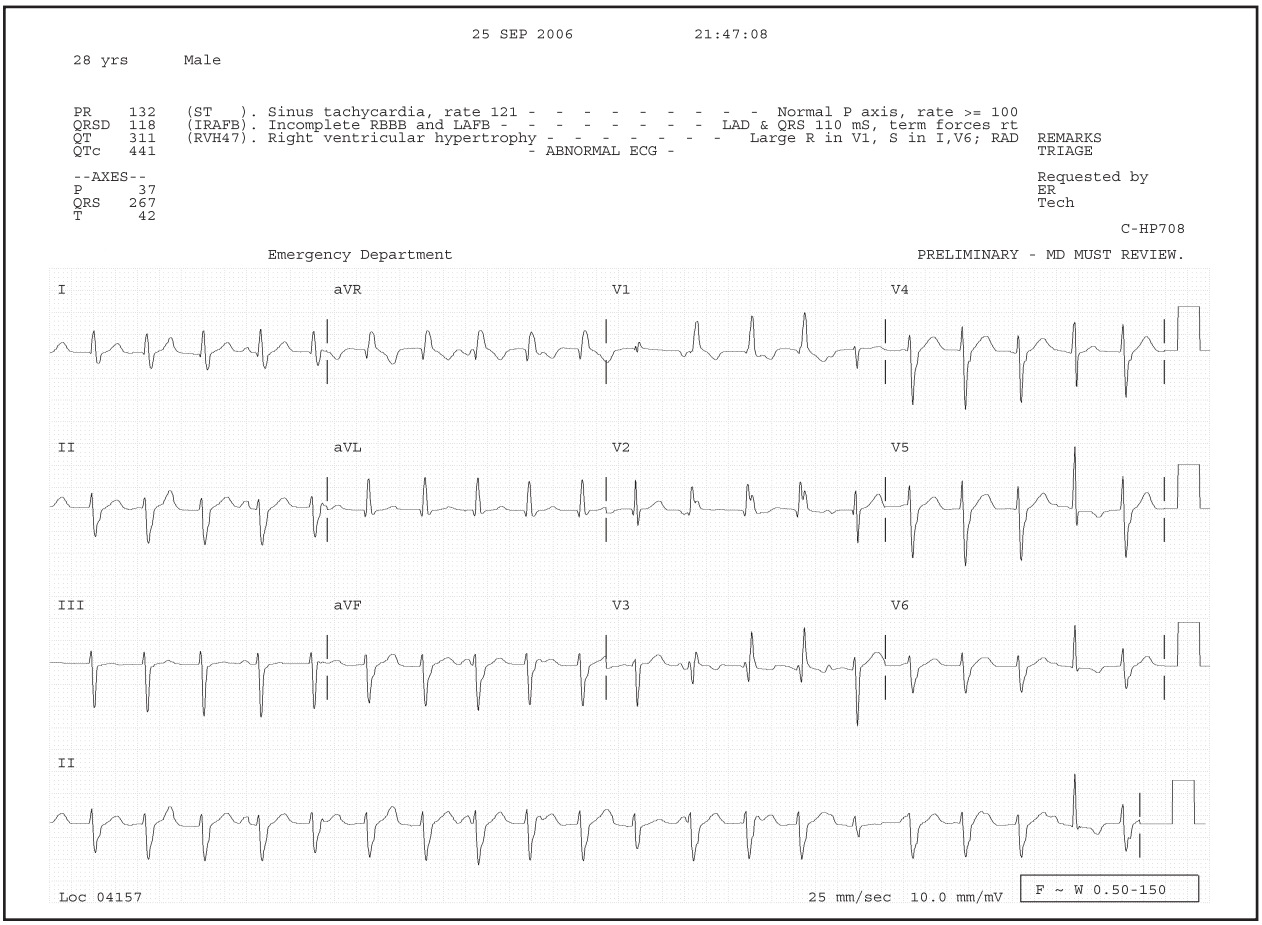

Figure 2: Lead II rhythm strip from a 12-lead ECG demonstrating AV dissociation in a patient with confirmed VT. Note that P waves march out independent of the QRS complexes, best seen in beats 2 – 10. Some of these P waves fall within or before the T wave, modifying its appearance. Also identified in lead II are *fusion beats* (QRS complexes #11, 15, and 20), and a narrow complex *capture beat* (next to last QRS complex #19).

edema, confusion, and angina. Skin color, temperature, and moisture may also be considered as somewhat reliable predictors of end-organ perfusion. Many individuals with WCTs (or any tachycardias) will exhibit one or more of these symptoms to varying degrees, especially chest discomfort (angina). There is likely to be overlap between one or more of these symptoms as well, making bedside clinical judgment in the management of patients presenting with WCTs essential. An approach in which clinicians err on the side of considering someone hemodynamically "unstable" is most prudent. It is incorrect to consider that only VT can be unstable, or that SVTs of any etiology do not cause hemodynamic compromise.

Many patients with known cardiac histories (especially those with rhythm or conduction problems) take antidysrhythmic medications. These agents have various effects on cellular electrophysiology and are divided accordingly using the Vaughan-Williams international classification system. Most of these agents prolong the duration of various portions of the ECG (including the QRS complex), which may lead to the misinterpretation of WCTs. Furthermore, several of these agents are pro-arrhythmic because of their effects on conduction at the cellular level. Therefore, it is important to obtain a thorough medication history.

The age of an individual presenting with a WCT does not help determine its origin. Although WCTs in older individuals are more likely to be ventricular in origin (due to an increased incidence of previous MI or underlying CAD), the age of an individual is neither sensitive nor specific. Furthermore, an individual's gender is not useful in determining the etiology of a WCT. Males are, however, more likely than females to have ventricular etiologies for their WCT, likely due to their increased incidence of prior structural cardiac disease and MI.

Neither the heart rate nor the width of the QRS complex in a single patient presenting with a WCT can definitively determine the origin of the rhythm disturbance. Many references state that a faster heart rate is more likely found in WCTs of supraventricular origin than in those of ventricular etiology. Ranges of heart rates that occur in SVT with aberrant conduction or VT are often given in a table, for example. However, presenting this information in this manner gives the illusion that there is a distinct heart rate above which VT does not occur. This is not true, as the range of heart rates found in SVTs and VTs overlap, depending on the underlying condition, medications, and physiological reserve of individuals experiencing these rhythms. Overall, the heart rate of WCTs due to aberrantly-conducted SVTs *tend to be* slightly faster than the rates due to VTs, but in a single individual at a given time, heart rate is not useful in determining the etiology of the WCT.

For patients with a permanent pacemaker, part of the physical examination diagnostics includes careful placement of a pacemaker magnet over a pacemaker generator. In patients presenting with a WCT, the magnet converts the pacemaker's pulse generator from the synchronous (demand) to asynchronous (fixed or "magnet" rate) mode of response. This action may allow identification of atrial activity. If this WCT is pacemaker-mediated, the magnet is likely to terminate the abnormal rhythm.[21]

In addition to historical and physical examination clues, several diagnostic criteria exist using the rhythm strip and 12-lead ECG to help determine the etiology of a WCT (see Tables 3 - 7). In terms of the electrophysiology of the abnormal rhythm, a very regular rhythm *tends* to favor the diagnosis of SVT with aberrant conduction as the cause of the WCT. However, VT is generally considered as resulting in a regular wide complex rhythm. A markedly irregular rhythm favors atrial fibrillation (AFIB) with aberrant conduction, such as a preexisting Bundle Branch Block (BBB) or Wolff-Parkinson-White Syndrome (WPWS). Previous ECGs may provide essential information, such as prior rhythm patterns (normal sinus, AFIB, SVT, or VT) or previous QRS complex morphologies (BBB patterns, PVCs, fusion or capture beats during prior WCTs, electrical axis, evidence of WPWS, or structural heart disease). AV dissociation, although not commonly identified, and/or ventriculoatrial (VA) block, apparent in approximately 1% of ECGs demonstrating WCT, are very sensitive for VT. Fusion and capture beats are helpful in diagnosing VT, but are neither always present nor always reliable. *Fusion beats* are hybrid QRS complexes resulting from simultaneous supranodal (atrial) and infranodal (ventricular) activation of ventricular tissue. They are therefore intermediate in morphology and width from either a capture or ventricular beat. *Capture beats* are QRS complexes resulting in ventricular activation originating from supranodal tissue, using electrical conduction pathways above the ventricle. These are therefore narrow and are similar (or identical) to a "normal" QRS complex (see Figure 2). *Precordial concordance* means that the QRS "direction" on the ECG in all the precordial leads is consistent. Positive precordial QRS concordance may occur during VT or SVT using a left posterior accessory pathway for AV conduction. Therefore, positive precordial concordance does not discriminate between VT and SVT with aberrant conduction. Negative precordial concordance is nearly always VT, because antidromic circus movement tachycardia never has negative precordial concordance. According to Wellens, this is true since accessory pathways over which anterograde conduction leads to completely negative QRS complexes in all the precordial leads do not exist.[22] However, a recent report of a 17-year-old male demonstrated that this "rule" is not perfect, as his underlying pectus excavatum and SVT with left BBB resulted in a WCT with negative precordial concordance due to SVT with aberrant conduction. This observation led the authors to conclude that "… no diagnostic technique is 100% correct and that there are always exceptions to the rule."[23,24]

Similar to the uncertainty of the history and physical examination in establishing the etiology of WCTs, ECG findings may create doubt as well. The duration (width) of the QRS complex is not very helpful in differentiating between supraventricular and ventricular etiologies of WCTs. A common misconception is that a QRS duration exceeding 0.14 second is present only if the rhythm is ventricular in origin (VT). However, in left BBB (V1-negative) WCTs, the QRS complex duration is often greater than 0.14 second even though the rhythm originates above the ventricles (i.e., supraventricular in origin). Even further misleading is that many antidysrhythmic agents cause QRS widening beyond 0.14 second, even if the rhythm originates above ventricular tissue.

Transesophageal atrial "pill" electrodes are used by electrophysiologists in an attempt to determine the etiology of underlying wide complex conduction abnormalities. These pills are "easily" swallowed by the patient, are secured adjacent to the atria, and may prove diagnostic.[25] These electrodes record atrial activity (contraction) as large P wave spikes, which allows for easier identification of P waves and their relationship to QRS complexes. This may help identify AV dissociation or 1:1 VA conduction. A combination Esophageal Pill Electrode and Pacing Electrode may have a role in terminating certain tachydysrhythmias, such as atrial flutter, by overdrive pacing. The pill electrode has an unlikely role in the emergency department identification and management of WCTs due to its cost, availability, ease of use, safety, and lack of emergency physician experience using them. These pills are not indicated for patients experiencing hemodynamic compromise. The role of transesophageal electrocardiography in the diagnosis of WCT has received much attention (although little in the EM literature) as a safe, easy method for evaluating a WCTs' mechanism.[26,27,28] One case report describes the ease of bedside placement of a transesophageal lead in the ED in a patient with an uncertain WCT unresponsive to a number of medications. A diagnosis of VT was confirmed using this recording device, which demonstrated marked disparity between atrial and ventricular rates, with the ventricular rate exceeding that of the atrial rate.[29]

Research is ongoing using signal-averaging ECG technology, which may gain future acceptance assisting with the electrophysiological diagnosis of WCTs. There are reports of transcardiac lead systems, modified precordial lead use, and ice mapping of the AV node (reversible cooling of this tissue to test function prior to ablation) for identification of the etiologies of WCTs in electrophysiology laboratories.[30,31,32] Presently, these technologies have limited roles in the ED.

Bedside ECG Diagnostic Criteria

Not all individuals presenting in a WCT are hemodynamically unstable. This is for the clinician to determine at the bedside. Once an individual has been deemed clinically stable, the ECG and rhythm strip should be reviewed closely for diagnostic clues to the etiology of the WCT. The "final" determination of the WCT should be considered an "academic exercise" and not of the utmost importance even for a stable patient in the ED. It is perfectly acceptable for an emergency physician to provide a final interpretation of the abnormal ECG demonstrating a WCT as "wide complex tachycardia of uncertain (undetermined) etiology." In fact, this may result in better patient care, as the focus of a patient presenting in a WCT should be on the patient's hemodynamic status and management, not the "correct" interpretation of the ECG.

A WCT can occur in any individual presenting with tachycardia for any reason, such as fever or dehydation, if he or she has a pre-existing wide QRS complex. Other tachycardias that create or result in wide QRS complexes will by definition be WCTs. The best approach when considering the etiology of a WCT is to determine whether or not the rhythm and its associated tachycardia originate from above the ventricle (supraventricular), the ventricle itself, or is due to metabolic causes.

Several diagnostic criteria exist to assist clinician determination of the WCTs' etiology. Much research has been published debating or, in some cases, modifying these criteria, in an effort to prove or discredit them as being the most accurate, reproducible, or easiest to use.[33,34,35] Some researchers claim that the QRS axis helps determine the etiology of a WCT. ECG leads placed on the body create Einthoven's triangle, which can be used to determine the overall electrical axis of a patient. The quadrant in which the QRS axis is found may provide additional support that the WCT pattern is due to VT (see Table 3).

Table 3. Electrocardiographic axis and WCTs

1. Abnormal QRS axis supports VT (particularly if newly abnormal)
2. Northwest axis (-90 degrees to +/- 180 degrees) strongly suggests VT
3. In V1-negative WCT, RAD strongly supports VT

The three most well-accepted criteria for the interpretation of WCTs based on the 12-lead ECG are the Wellens' criteria (Table 4), Kindwall's 4 electrophysiologic criteria for VT in LBBB (Table 5), and Brugada's 4-step approach to regular tachycardias with wide QRS complexes (Table 6). Also included is a table using morphologic criteria of the ECG and its associated bundle branch pattern (positive and negative deflections) of the QRS (Table 7). The classification schemes based on QRS morphology are essentially the same; both are included because some individuals prefer classifying WCT ECGs as RBBB-like or LBBB-like, while others prefer to

Table 4. Wellens' Criteria (VT favored in the presence of)[38]

1. AV Dissociation
2. Left Axis Deviation
3. Capture or Fusion Beats
4. QRS generally greater than 140 msec
5. Precordial QRS concordance
6. RSR' in V1, mono- or biphasic QRS in V1, or monophasic QS in V6

Table 5. Kindwall's ECG criteria for VT in LBBB[39]

1. R wave in V1 or V2 of >30 ms duration
2. Any Q wave in V6
3. Duration of >60 ms from the onset of the QRS to the nadir of the S wave in V1 or V2
4. Notching on the downstroke of the S wave in V1 or V2

Table 6. Brugada's 4-step Algorithm Approach[40,41]
This step-wise approach is performed as a series of questions. If the answer to any of these questions is "YES," VT is identified and no further steps are made. If the criteria are not met for that step, the next question is asked

1. If RS complex absent from all precordial leads, then VT
2. If RS present, and the longest precordial RS interval > 100 msec in one or more precordial lead(s), then VT
3. If atrioventricular dissociation present, then VT*
4. If morphological criteria for VT present both in precordial leads V1-2 and V6, then VT. If morphologic criteria for VT not present, then the diagnosis of SVT with aberrant conduction is made by exclusion.

*Step (Question) 3 was modified in a paper published three years later by many of the same authors at the same research facility to "more QRS complexes than P waves" (if yes, then VT).

consider WCT ECGs according to V1(V2)-positive or negative classification schemes. The Brugada criteria are perhaps slightly favored by clinicians and/or cardiologists, although this may be because they are the most recent. All of these papers have generated further research and commentaries suggesting modification of these criteria, supported by examples demonstrating inappropriately classified WCTs when using these criteria. None of these approaches is favored, as each diagnostic set has inherent limitations resulting in ECG misidentifications.[36,37] It is therefore prudent to be comfortable with more than one of these classification schemes, although many feel it is better to be very confident with just one approach.

Table 7. Morphological criteria favoring VT

A. RBBB-like QRS:
   monophasic R, QR, or RS in V1
   R/S ratio less than 1.0, QS or QR in V6
   * triphasic QRS in V1 or V6 supports SVT with aberrant conduction

B. LBBB-like QRS:
   R > 30 msec, >60 msec to nadir S, or notched S in V1 or V2
   QR or QS in V6
   *monophasic R in V6 not helpful

C. Using V1(V2)-positive and V1-negative QRS morphology characteristics:
   1. V1(V2)-positive:
      V1: mono- or biphasic QRS = VT
      Rabbit ear sign with first peak > second (L > R) = VT
      rSR' (triphasic) = SVT + RBBB
      V6: QS or deep S (R/S ratio < 1.0) = VT
      qRS (triphasic) with R/S ratio > 1.0 = SVT + RBBB
   2. V1-negative:
      V1,2: broad r > 0.04 sec and/or slurred or notched S resulting in prolonged interval from beginning QRS to S nadir = VT
      *narrow r wave and quick S wave downstroke = SVT + LBBB
      V6: any q wave = VT

An interesting commentary published in 1989 following an article describing yet another set of criteria for identifying WCTs stated that "… knowing the specific criteria for diagnosis may not be that important." The academic emergency physician who wrote this recommended instead that appropriate therapy should be dictated by a three-step protocol (Table 8).[42] This simplified three-step protocol focuses on clinical criteria rather than electrophysiologic ones, which more closely resembles 2005 AHA guidelines. When in doubt, VT should be considered the default diagnosis in WCTs.[43]

Table 8. Three-step clinical protocol to WCTs[42]

1. If the patient is asymptomatic, or minimally symptomatic and hemodynamically stable, … call an experienced electrocardiographer or look up the criteria … while observing the patient….
2. If the patient is hemodynamically unstable, immediate synchronized graded cardioversion … is indicated. Subsequent pharmacologic therapy can be guided by experienced physicians.
3. If the patient is symptomatic … but is otherwise hemodynamically stable, then controlled graded cardioversion or pharmacologic therapy [sic] … may be tried.

UNDERSTANDING THE ECG IN WCTs

Understanding the electrophysiology behind ECGs with WCT assists clinicians with decision analysis and the explanation for abnormal conduction. Situations often exist during which a "normal" pathway of cardiac conduction does not occur. When this happens, the QRS complexes may appear different, having an increased duration or width. One such situation occurs during *pre-excitation* of the ventricle. Here, the normal electrical impulse originating from the atria reaches ventricular tissue earlier than expected by means of an accessory pathway. This impulse bypasses the AV node, which eliminates AV nodal delay and allows for earlier activation of the ventricle. The three most common accessory pathways identified are the Kent bundle (AV bypass tracts), responsible for the Wolff-Parkinson-White Syndrome (WPWS), the James' fibers (atrio-His fibers), responsible for the syndrome known as Lown-Ganong-Levine, and the Mahaim bundles (nodoventricular fibers). These accessory pathways each result in ventricular tissue receiving activation from a supraventricular source earlier than expected. This premature ventricular activation results in a shortened PR interval (the time from the beginning of atrial depolarization to the onset of ventricular depolarization). WPWS, which uses the Kent accessory bundle, is important because the QRS complex in individuals with this accessory pathway is widened to more than 0.10 seconds when this pathway is used.[44,45] This QRS complex widening occurs due to premature activation of the ventricle, not because of delayed activation (which occurs in BBB). WPWS has a slurred initial upstroke of the QRS known as a delta wave, the result of partial premature activation of ventricular tissue from the Kent accessory bundle combined with the majority of ventricular activation via the normal conduction pathway.[46] This delta wave is therefore analogous to a fusion beat.

Reentry may be defined as an alternative pathway for cardiac conduction, with pre-excitation being one of its manifestations. These alternative pathways generally result in faster activation of ventricular tissue. They have varying periods of refractoriness, which is important when considering reentrant tachycardias. The Kent bundle, for example, is composed of faster conducting tissue than the AV node, but it has a longer refractory period. AV Nodal Reentry Tachycardias (AVNRTs) are tachycardias that use two distinct pathways within the AV node, having different refractory periods and conduction velocities. Circus Movement Tachycardias (CMTs), on the other hand, are reciprocating tachycardias that demonstrate either narrow or wide QRS complexes depending on the direction of reentry. An orthodromic reentry tachycardia means that AV conduction occurs in the normal direction (over the normal pathway). In antidromic CMTs, impulse conduction over the "expected" pathway occurs in the reverse direction. Here, an accessory pathway is used for anterograde (forward) conduction and the AV node or other accessory pathway is used in the retrograde (backward) direction as part of the conduction loop (see Figure 1). This results in wide QRS complexes, and therefore a WCT if the heart rate is greater than 100 beats per minute. Anterograde and retrograde are descriptive terms of convention; by themselves, they do not provide information about the configuration of the QRS complex nor the etiology of the WCT.

WPWS is the most common form of pre-excitation, using the Kent bundle as the accessory pathway for conduction. Left free wall pathways account for the majority of locations of the Kent bundle, although other locations for this accessory pathway exist in WPWS. Common ECG features of WPWS include short PR intervals (< 0.12 seconds), delta waves, and prolonged QRS intervals (> 0.10 seconds). Inverted T waves and increased precordial voltage may also be seen. Three types of WPWS are determined based on the location of the accessory pathway; however, they have little clinical significance other than identifying this syndrome. Type A WPWS has its accessory pathway in the inferoposterior portion of the LV, which results in a dominant R wave in lead V1 and Q wave in the inferior leads (the ECG configuration is therefore RBBB-like). Type B WPWS has its accessory pathway in the inferoposterior region of the RV. This results in an rS or QS pattern in lead V1 (the ECG configuration is therefore LBBB-like). Type C WPWS has its bundle in the posterolateral region of the LV, which results in negative or isoelectric delta waves in leads V5 or V6. The ECG exhibits small Q waves in leads I and aVL, commonly referred to as the pseudoinfarct pattern of WPWS.

WPWS is important because greater than 50% of individuals with these accessory pathways for AV conduction are predisposed to supraventricular tachydysrhythmias via reentry. Atrial fibrillation occurring in individuals with WPWS may be extremely dangerous, as the Kent bundle may allow fast, chaotic atrial impulses to pass to ventricular tissue without delay at the AV node. Ventricular rates (identified as R-R intervals) may reach as high as 300 beats/minute in this situation. A clue to this is the presence of rapid, wide, and irregularly-spaced QRS complexes on the ECG.[47,48,49] In this situation, clinicians must not administer agents that slow conduction through the AV node, as this makes conduction via the accessory pathway more likely. Therefore, antidysrhythmic agents that block AV nodal conduction or preferentially increase conduction through an accessory pathway in the situation of a WCT due to AFIB and WPWS can result in immediate hemodynamic collapse, ventricular fibrillation, or death.

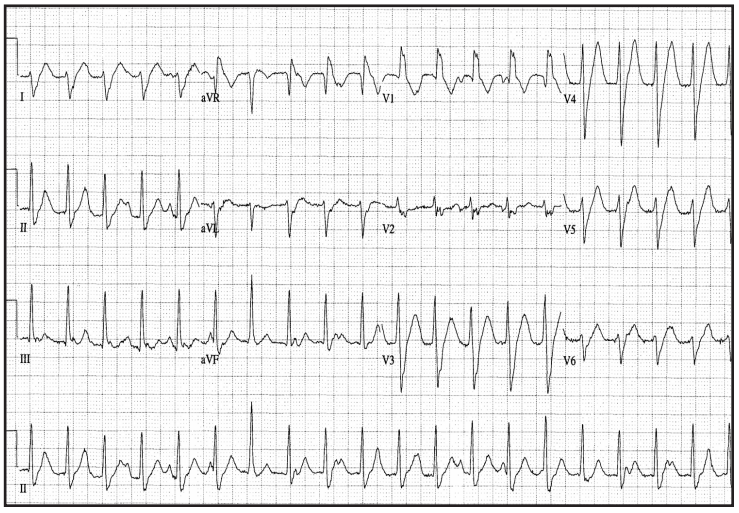

Figure 3. ECG demonstrating AV Dissociation (see lead II rhythm strip, in which P waves march independently of wide QRS complexes). This RBBB-like patterned ECG with delayed ("notched") upsloping of the S wave was subsequently confirmed to be VT (image courtesy Amal Mattu, MD). Used with permission, ACEP.

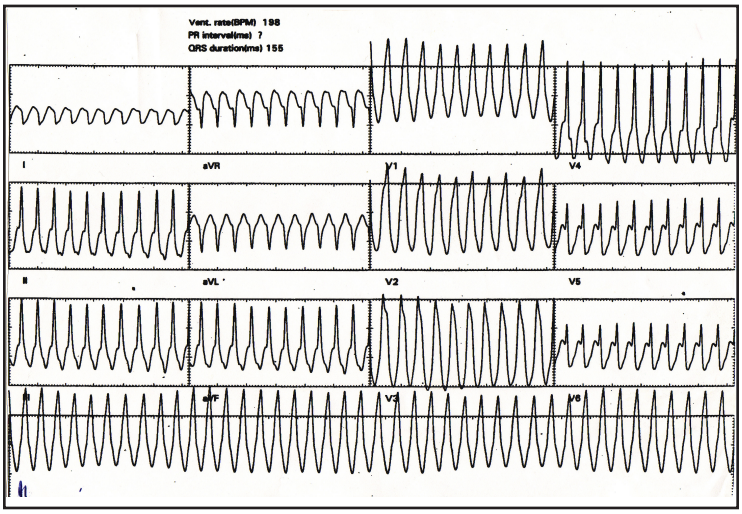

Figure 4. ECG demonstrating WCT (rate just under 200 bpm). It appears quite regular. The QRS duration is 155 msec, and its morphology is V1-positive (RBBB-like). Although positive precordial concordance is present, this WCT is due to SVT with aberrant conduction. An AV nodal reentry mechanism was confirmed during subsequent EP testing.

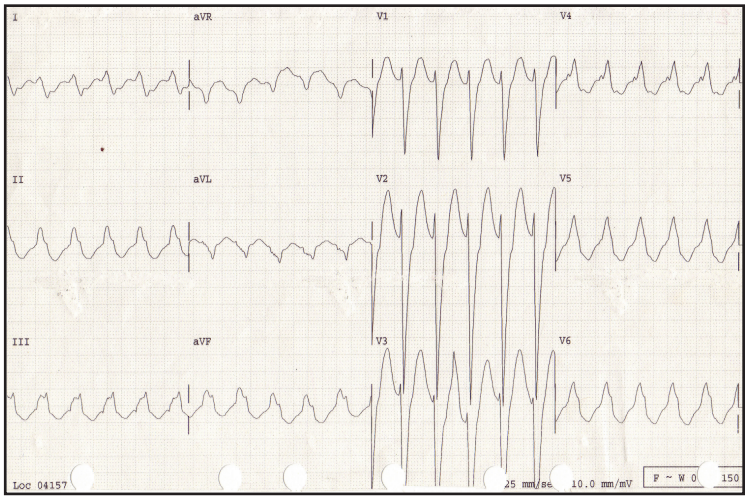

Figure 5. WCT with a rate of 140 bpm. The QRS duration is just less than 200 msec, with a V1-negative (LBBB) QRS morphology. There is a very narrow R wave (less than 40 msec) in V1 and V2, with a quick, near-vertical downward deflection to the S wave nadir. The RS duration is less than 80 msec. This ECG demonstrates SVT with LBBB conduction, a pattern present during old ECG tracings. This tracing does not meet any of Brugada's 4-step algorithm for VT.

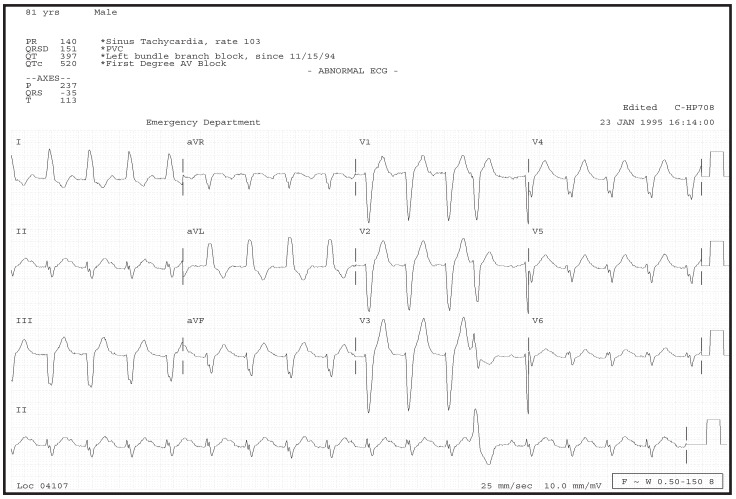

Figure 6. WCT due to SVT with a preexisting BBB in an 81 year-old male. This patient has known structural heart disease, including prior LBBB and 1st degree AV block, which makes the diagnosis of VT more likely. Previous ECGs demonstrated a LBBB pattern with identical QRS morphology. Note the PVC has different QRS morphology from the other beats, best seen in the lead II tracing. Due to its originating location, it appears similar to the QRS complexes in leads V1 and V2. However, this differing appearance of this PVC does not provide conclusive evidence that the WCT is being generated above the ventricle.

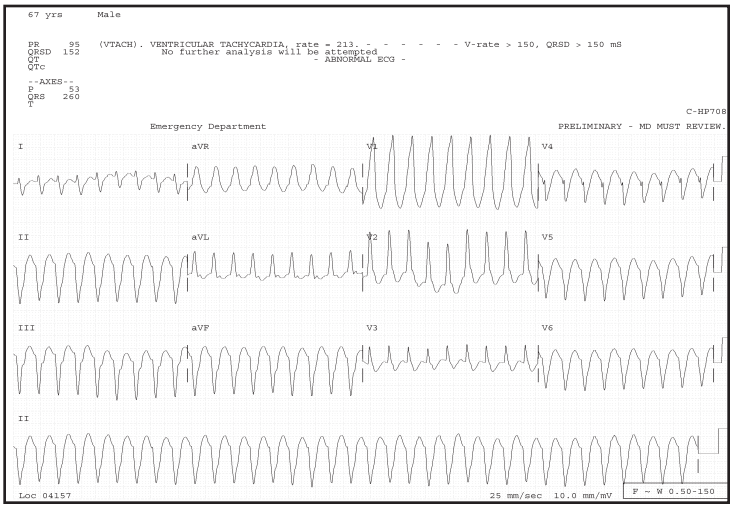

Figure 7.12-lead ECG demonstrates classic VT.

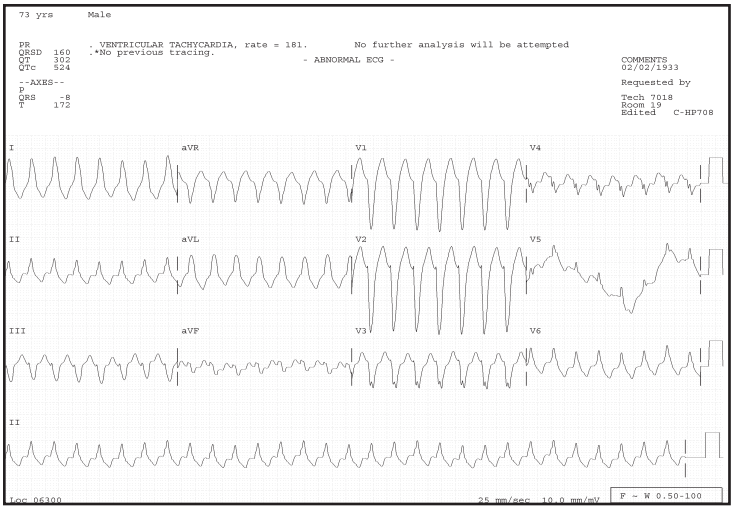

Figure 8. Another example of VT, although this ECG's axis differs from the previous example. Previous ECGs in this older patient with a prior MI demonstrate PVCs identical in morphology to these QRS complexes. Lead V5 has baseline wander due to a poorly adherent lead.

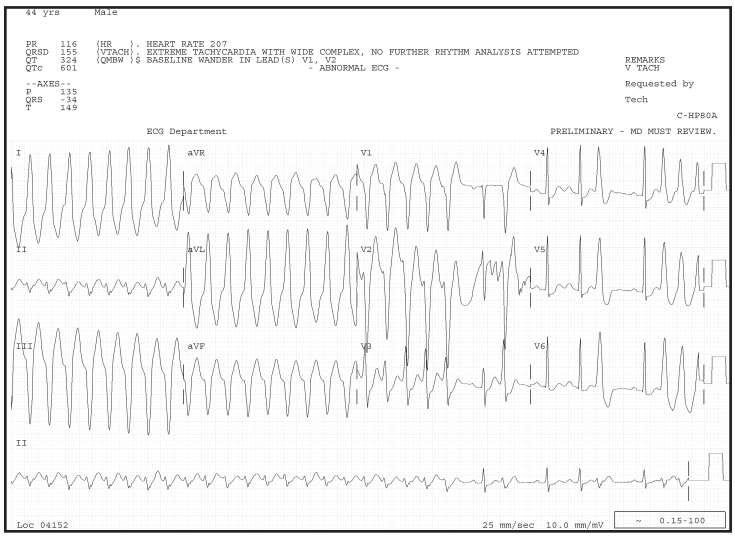

Figure 9a. Episodic VT following an exercise treadmill test in a 44 year-old male with atypical chest pain. It is unusual to capture both VT and sinus activity on a 12-lead ECG. AV dissociation is noted in first part of lead II and the lead II rhythm tracing. A post-conversion ECG (next image) demonstrates normal sinus rhythm and PVCs, without significant ischemic changes (image courtesy of Eleanor Levin, MD).

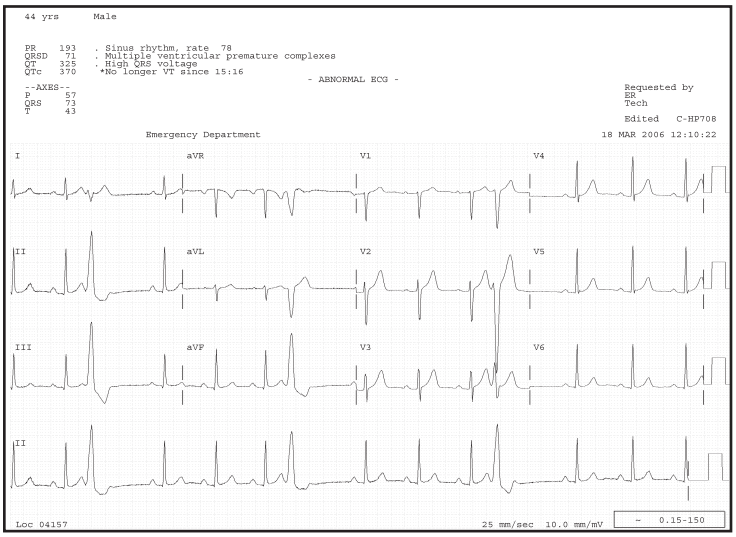

Figure 9b. Same patient as previous ECG, following spontaneous conversion of exercise-induced VT. Several PVCs are present throughout the tracing; the PVC in lead V2 is nearly identical to that seen in lead V2 in the previous tracing.

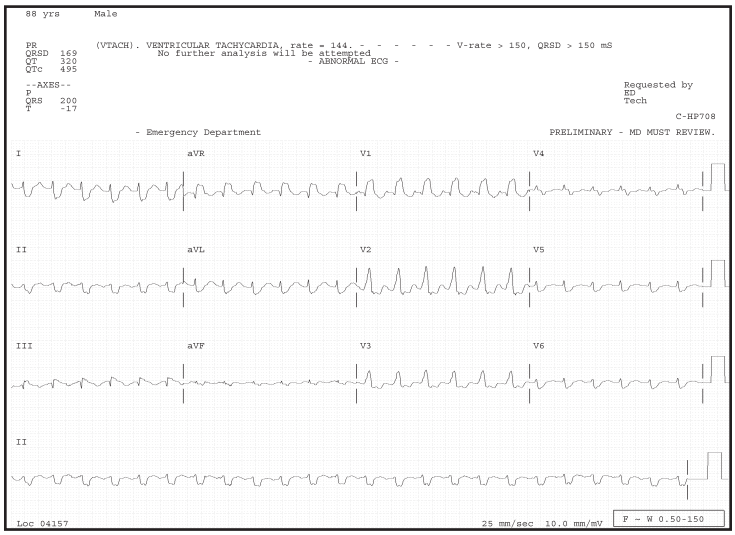

Figure 10a. ECG incorrectly interpreted by the computer as VT. This is a regular WCT with a RBBB/LPFB configuration. In this 88 year-old patient, the correct clinical interpretation, however, is VT. In most tracings with a rapid heart rate, it becomes difficult to appreciate irregularity in the rhythm, or it may disappear completely. A subsequent ECG tracing (next image) demonstrates AFIB with the identical QRS morphology, including RBBB and LPFB.

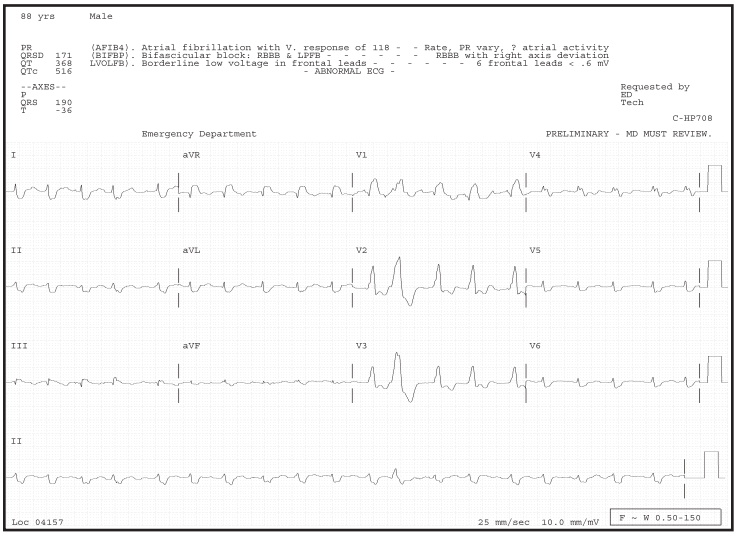

Figure 10b. Subsequent ECG from the previous patient demonstrates AFIB with an irregularly irregular wide complex QRS having RBBB and LPFB morphologies. An isolated PVC (beat #12) has a different morphological quality than the QRS complex. This does not exclude VT, although VT is more likely if PVCs are identical to the QRS morphology in a previous (or subsequent) WCT.

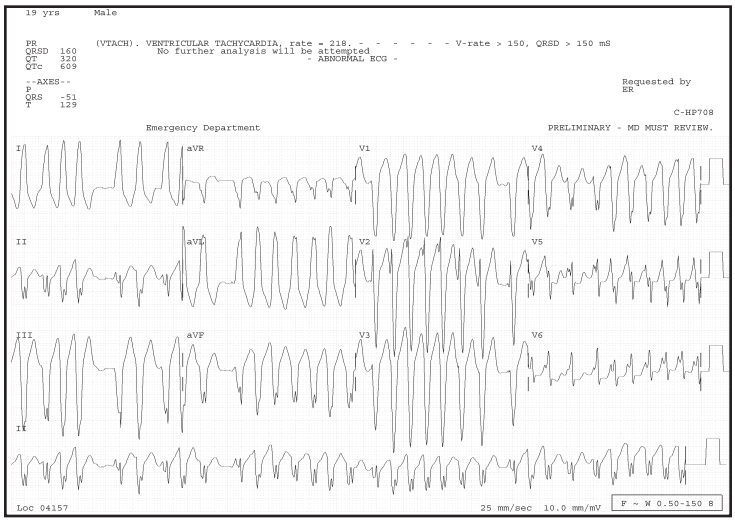

Figure 11a. 19 year-old patient with a WCT ECG, incorrectly interpreted by the computer as VT. On close inspection, the R-R intervals are irregularly spaced, several approaching 300 msec (best seen in beats 3-4 in lead I and beats 3-5 in lead V2, V3). When the R-R interval is that narrow, atrial fibrillation in a patient with an accessory pathway (bypass tract) must be considered. The QRS morphology in lead V6 gives the impression of a delta wave (slurred upstroke). The diagnosis is an irregularly irregular WCT, which is due to AFIB and WPWS (image courtesy of Charlie Young, MD).

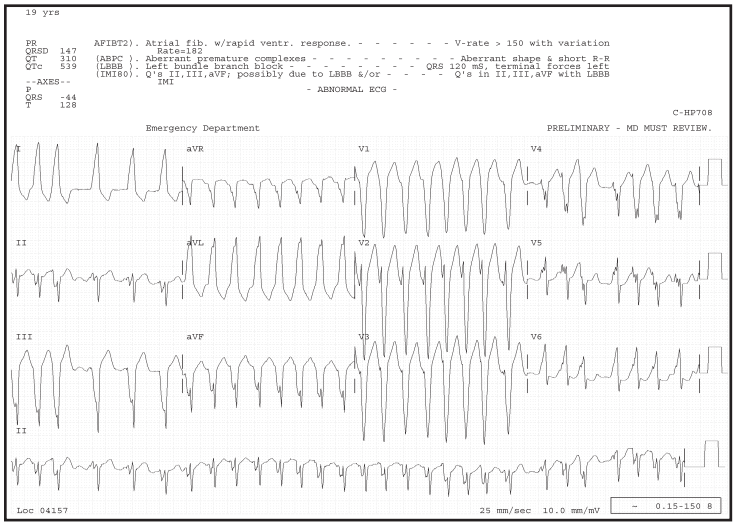

Figure 11b. The same 19 year-old patient with an irregular WCT that returned more than one hour later. In this tracing, it is somewhat easier to see the irregular irregularity of the QRS complexes, and to identify the delta waves in lead V6 that have a slightly different appearance from the previous tracing. The computer correctly identified this WCT.

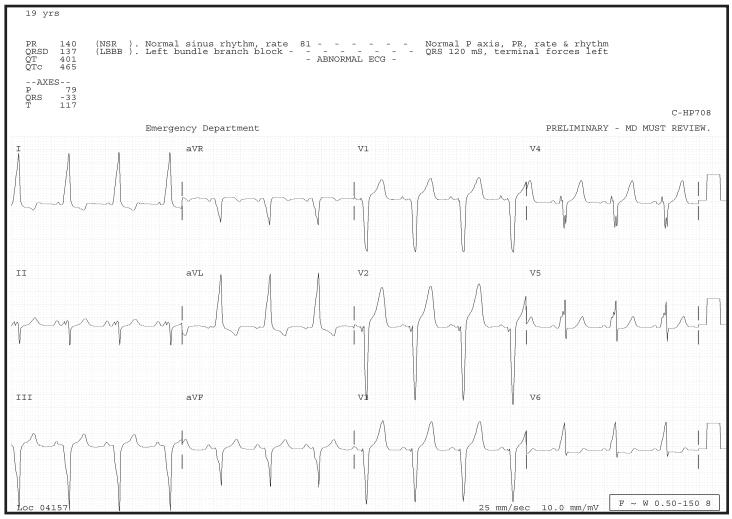

Figure 11c: Previous patient post-conversion in normal sinus rhythm, demonstrating WPWS (Type B). There are negative QRS complexes over the right anterior precordium (leads V1-V3), resembling a LBBB pattern, and some associated ST-T wave abnormalities. A right posterolateral AV accessory pathway was identified on EP studies, mapped near the tricuspid annulus.

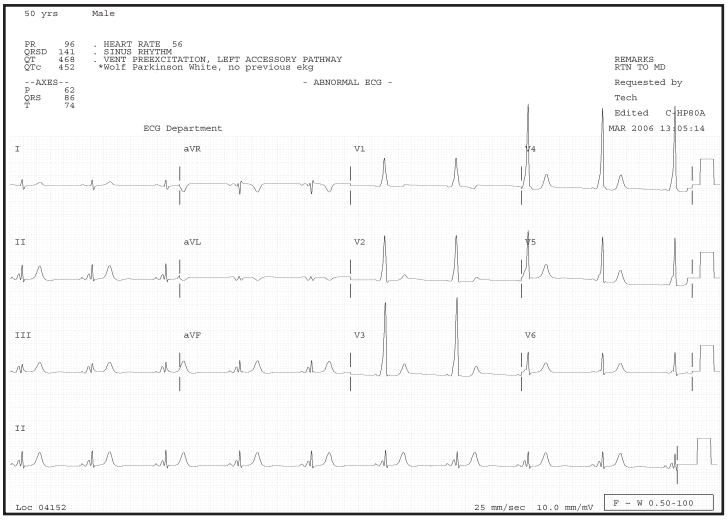

Figure 12: ECG representing Wolff-Parkinson-White syndrome (WPWS), Type A. There is a dominant R wave in V1 (RBBB pattern). Note the classic delta waves (slurred upstroke of the QRS complex) and the short PR intervals. The delta wave causes a slightly widened QRS morphology. The cause of this patient's pre-excitation pattern was determined to be due to a left-sided accessory AV pathway during EP studies.

SUMMARY

WCTs are particularly challenging for clinicians to correctly identify. This is especially true given that most patients presenting to an emergency department with ECGs demonstrating WCTs are uncomfortable or have some hemodynamic distress. Correct interpretation of the WCT should not be the primary concern of emergency physicians; treating patients without doing harm takes precedence. Appropriate treatment approaches, including a detailed discussion of pharmacologic therapies, as well as additional (miscellaneous) causes of WCTs will be described in a forthcoming article.

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EKG Criteria for Fibrinolysis: What's Up with the J Point?

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INTRODUCTION

Reading EKGs is an integral skill in Emergency Medicine, especially given the fact that determining the presence and amount of ST segment elevation (STE) is one of the key factors to initiating fibrinolytic eligibility. STE is generally measured in reference to the J point (the end of the QRS segment and the beginning of the ST segment). However, it may not be clear in clinical practice where the J point starts, where one measures ST segment elevation in relation to the J point and finally what the exact degree of elevation of the ST segment makes one a candidate for thrombolysis. Further complicating the issue are numerous other causes of J point and ST segment elevation that are not myocardial-infarction related. This short review will focus on identifying the J point in order to determine an accurate measurement of ST segment elevation and its relationship to fibrinolytic eligibility.

The J Point: Where is it?

One standard text defines J point elevation as: "the point where the QRS ends and the ST segment begins."[1] Where exactly that "point" resides is rarely stated. One of the more specific descriptors states that the J point is the "first point of the ***inflection*** on the upstroke of the S wave."[2] This description gives one at least some hope of finding a specific point from which to measure. However, we know of no study that has specifically determined the interrater reliability of J point measurements. Studies of the interrater reliability of degree of STE have been performed and generally show considerable disagreement.[2,3] Since this "point" may be subtle and depend on a variety of factors (the investigator's vision for example), it may be surmised that the interrater reliability of J point measurement may be less than perfect (Figure 1).

STE and the J point

In theory the ST segment is normally neither elevated nor depressed. STE should be measured from the upper edge of the P-R segment (not the T-P segment) to the upper edge of the ST segment at the J point.[4] In most patients, however, the T-P segment and P-R segment lie on the same plane.[5] Likewise, ST segment depression should be measured from the lower edge of the P-R segment to the lower edge of the ST segment at the J point. If the ST segment is measured with reference to the T-P segment, atrial repolarization with a prominent negative T wave may result in an inaccurate measurement.[4] (See Figure 2).

It is unclear whether STE measured at the J point or 60

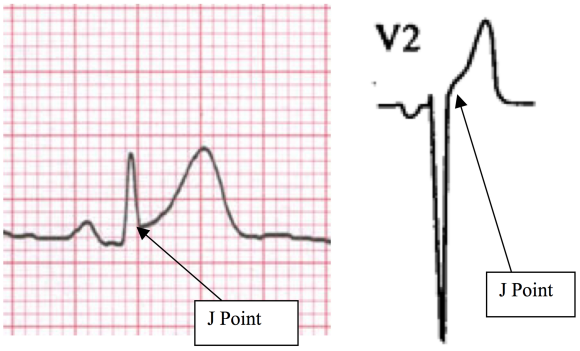

Figure 1. Examples of J point determination

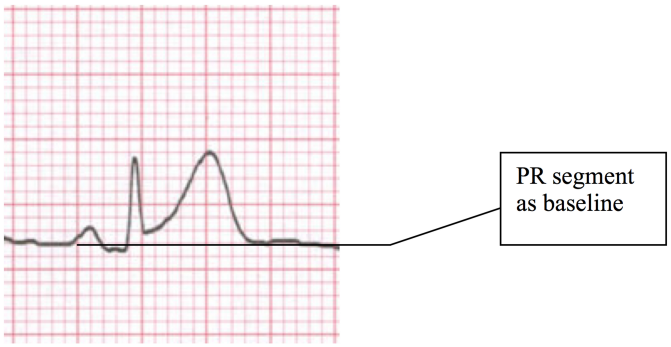

Figure 2. The ECG Baseline

Table 1. ECG Entrance Criteria in Select Mega-Trials

Study	Publication Year	Duration of Symptoms Required	Maximum Time to Onset Prior to Presentation	EKG Change Requirements	Other Requirements/Modifiers
ISIS - 1 (13)	1986	-----	12 hr	None	MI suspected by MD
ISIS - 1 (14)	1988	-----	24 hr	None	MI suspected by MD
GISSI - 2 (15)	1990	-----	6 hr	1) STE > 1mm in any limb lead 2) STE > 2mm in any precordial lead	
ISIS - 3 (16)	1992	-----	-----	None	MD thought there was a "clear" indication for Fibrinolytics
GUSTO (17)	1993	20 min	6 hr	1) STE > 0.1mV in 2 or more limb leads 2) STE > 0.2mV in 2 or more contiguous precordial leads	
GUSTO III (18)	1997	30 min	6 hr	1) STE > 1mm in 2 or more limb leads 2) STE > 2mm in precordial leads 3) BBB	
ASSENT - 2 (19)	1999	-----	6 hr	1) STE > 0.1mV in 2 or more limb leads 2) STE > 0.2mV in 2 or more contiguous precordial leads 3) LBBB	
InTIME - II (20)	2000	30 min	6 hr	1) STE > 0.1mV in any 2 contiguous limb leads 2) STE > 0.2mV in any 2 contiguous precordial leads 3) STE > 0.2mV in V4R 4) STE > 0.2mV in 2 contiguous posterior leads 5) New or presumed new LBBB	
ASSENT - 3 (21)	2001	-----	6hr	1) STE > 0.1mV in 2 or more limb leads 2) STE > 0.2mV in 2 or more contiguous precordial leads 3) LBBB	
GUSTO V (22)	2001	30 min	6hr	"EKG criteria for STEMI or New LBBB" (with references to GUSTO, GUSTO III & ASSENT – 2)	

milliseconds after the J point is superior when evaluating fibrinolytic or PTCA criteria.[6,7,8,9,10] A recent retrospective study showed that fewer EKGs met enrollment criteria when based on STE at the J point versus at 60 ms after the J point. Fewer EKGs met an ST score (sum of STE in leads V1-V6) of 6 mm when measured at the J point versus J point plus 60 milliseconds (70% vs. 88%).[6] This controversy is not likely to be resolved any time soon and, in most cases, is probably not important. It is a reminder, however, that criteria that appear to be set in stone, well defined, and closely followed by all experts, are in fact open to interpretation and bias.

What Degree of STE Equals Fibrinolytic Criteria?

Marriot's criteria states that cardiac injury is present when the J point is either elevated by 1 mm or greater in two or more limb leads (or pre-cordial leads V_4 to V_6), by 2 mm or greater in two or more pre-cordial leads V_1 to V_3, or is depressed by 1 mm or greater in two or more pre-cordial leads V_1 to V_3.[5] Recently, there has been a move away from requiring a 2 mm elevation in the anterior pre-cordial leads. The American College of Emergency Physicians (ACEP) Clinical Policies Committee's 2000 revision states that fibrinolytic criteria includes "ST-segment elevations greater than 0.1 mV in two or more contiguous leads that are not characteristic of early repolarization or pericarditis, nor of a repolarization abnormality from LVH or BBB in patients with clinical presentation suggestive of AMI."[10] This was a level "B" recommendation, and the review notes that the fibrinolytic trials have used different criteria. This move to a 1 mm elevation in any lead is supported by Pope and colleagues who found that a full 30% of patients who have ST-segment elevation of 1 mm or greater had a final diagnosis of AMI in their multicenter study. Alarmingly, the authors also note a small but important incidence (11%) of failure by the ED clinician to detect ST-segment elevations of 1 to 2 mm in the EKGs of patients who had AMI.[11]

It is interesting that many of the largest mega-trials used quite different criteria for fibrinolytic eligibility (Table 1). Indeed some of the mega-trials used no explicit ST segment criteria. The current criteria are derived from retrospective analysis of a combination of mega-trials and therefore have been open to interpretation. The use of 1mm in any 2 contiguous leads has also been deemed acceptable by the American College of Cardiology/American Heart Association (ACC/AHA) guidelines.[12] Regardless, it is best to interpret the ST segment in relation to the clinical history. The higher the pre-test probability of AMI the more comfort one should have in accepting 1mm versus 2mm of ST segment elevation as the criteria for thrombolysis.

SUMMARY

The exact location of the J point, as well as its use for determining STE is open to some debate. Even the exact place to measure ST segment elevation for fibrinolytics is a point of contention, as is the degree of ST segment elevation that warrants consideration of fibrinolytic therapy. Interpreting ST segment elevation must be made in the context of the clinical setting. Like any test, the pre-test probability of the disease (myocardial infarction in this case) is essential in interpreting the results of the test (degree, type and amount of ST segment elevation).

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Loss of Digits after Trauma in a Patient with Systemic Lupus Erythematosus

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A 19-year-old female with Systemic Lupus Erythematosus (SLE) presented with ischemia of her left hand following trauma. Medical therapy was initiated but failed to improve her symptoms, and revision amputation was ultimately performed. The patient's final diagnosis was digital ischemia due to secondary Raynaud's Phenomenon (RP). The authors discuss diagnosis, complications, and treatment of this relatively uncommon disorder. The authors report this case in order to discuss how secondary RP can be complicated by ischemia and the multidisciplinary approach that needs to take place to prevent the latter from occurring. [*West*JEM.2008;9:43-45.]

INTRODUCTION

Raynaud's phenomenon (RP) presents as a challenging disease for Emergency Physicians (EP) due to its variability in presentation, largely variable medical treatments, and risk of significant morbidity. The disease is described as an episodic vasospasm of peripheral arteries, causing pallor, cyanosis, and at times, subsequent ischemia. It was first described by Maurice Raynaud in 1862 as a localized "syncope."[1] Primary RP is idiopathic, and secondary RP occurs in association with an underlying disease, usually a mixed connective tissue disorder (MCTD). The diagnosis is based solely on the clinical presentation since there are no specific tests to detect primary RP. Prevalence is estimated between 3-5% in the general population.[2] Despite its high frequency, the majority of available therapies have not been validated in randomized controlled trials (RCT).

CASE REPORT

A 19-year-old female was admitted to the hospital because she had ongoing ischemia to her left index and small fingers. Forty hours before admission, the patient suffered trauma to her fingertips when she caught her hand in a car door. Thirty-five hours before this presentation, the patient was seen in another emergency room and was noted to have a bluish discoloration to her fingertips with a history of systemic lupus erythematosus. She was diagnosed with RP and given amlodipine and aspirin. A few hours later, without relief of her symptoms and worsening pain, the patient was transferred for higher level of care to a second emergency department.

Upon arrival, the patient was afebrile with stable vital signs, including a temperature of 98°F, blood pressure of 125/92 mmHg, pulse of 113, respiratory rate of 18, O2 saturation of 97% in room air. She was very emotional and anxious and expressed a pain level of 10 out of 10. Her left hand showed a purplish-blue discoloration and edema to the fourth and fifth digits, accompanied by bullae on the ulnar surface of her small finger (Figure 1). She was tender to palpation along the flexor sheath, but both flexor digitorum profundus and superficialis were intact. Pulse oximetry to the affected digits was zero, and she had decreased perception to light touch.

The patient was given benzodiazepines and pain medication. Orthopaedics was quickly involved on the case and an angiogram ordered. Rheumatology upon consultation added solumedrol, and the patient was started on an epoprostenol drip.

Left upper extremity angiogram findings included a patent left axillary, brachial, ulnar, radial, deep and superficial palmar arches, common and proper digital arteries 1-3. There was complete occlusion of proper digital arteries for the fourth and fifth digits. There was no response to intra-arterial vasodilator and the patient was deemed an unlikely candidate for lytic therapy secondary to the distal nature of the occlusion.

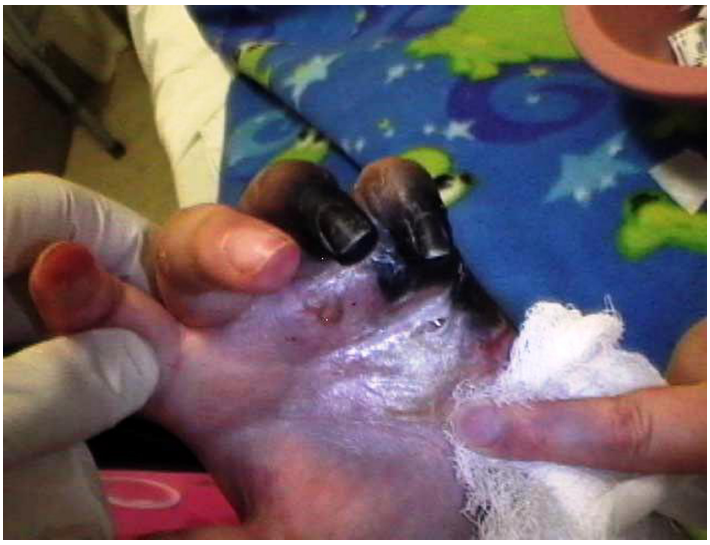

Figure 1. Necrotic fourth and fifth digits, five days after presentation of SLE patient with secondary Raynaud's phenomenon

After five days of epoprostenol drip with minimal improvement in her symptoms, the patient was scheduled for revision amputation. Final pathology diagnosis was necrosis, mixed inflammation consistent with gangrene due to secondary RP.

DISCUSSION

Secondary RP is less common than primary RP and occurs in association with an underlying disease, typically connective tissue, neurovascular, hematological, or drug-induced disorder.[3] While primary Raynaud phenomenon (RP) rarely leads to complications, secondary RP, when associated with a mixed connective tissue disease (MCTD), can quickly progress to catastrophic ischemic events resulting in the loss of fingers, toes, and even limbs.[4] Timely therapeutic intervention is therefore required. Primary and secondary RP appear to be in a continuum. In one study, as many as 20% of participants followed prospectively were later diagnosed with a MCTD.[5] Determining the root cause of a Raynaud crisis can be difficult, and emergent treatment may be challenging due to lack of clearly effective therapy. Therapeutic measures have included a range from avoiding triggers to vasodilator drugs or anti-platelet aggregation drugs to spinal cord stimulation and surgery. Treatment should be individualized for every patient depending on disease severity.

Conservative treatment for RP includes warming and stress reduction,[2] however, we found no satisfactory RCTs on the effects of warming. Six small RCTs found that nifedipine reduced the frequency and severity of attacks over 4-12 weeks compared with placebo, and was rated by participants as more effective than placebo in improving overall symptoms. The participants experienced an average of 2.8 to 5.0 fewer attacks per week and a 33% reduction in severity. It was found that nifedipine was associated with higher rates of adverse effects compared with placebo, causing several participants to drop out of every study. Adverse effects include flushing, headache, edema, and tachycardia.[6]

The use of aspirin and dipyridamole in patients with secondary RP has been studied in at least two controlled trails. Neither demonstrated any significant effect.[7,8] Grader-Beck and Wigley recommend that patients with MCTD be placed on anti-platelet therapy with 81 mg of aspirin daily, unless there is a contraindication. They also recommend the use of heparin for 24 to 72 hours for patients who have rapidly advancing ischemic disease, but do not recommend chronic anticoagulation, despite the fact that this has not been studied.[2] A recent study demonstrated the benefit of low molecular weight heparin for symptomatic improvement in primary and secondary RP.[9]

When ischemia progresses rapidly and fails to respond to standard vasodilatory therapy, intravenous iloprost, alprostadil, or epoprostenol may be given.[2] Similar results in a meta-analysis were obtained for intravenous infusions of iloprost in patients with secondary RP associated with systemic sclerosis. In addition, intravenous infusions of iloprost improved healing of fingertip ulcers in patients with systemic sclerosis.

Small single randomized controlled trials include angiotensin II-receptor type 1 antagonists (losartan), the calcium channel blockers felodipine and amlodipine, serotonin-reuptake-inhibitors (fluoxetine) and phosphodiesterase-V-inhibitors (sildenafil, vardenafil). However, the results for these promising substances have to be confirmed in long-term trials with larger patient numbers.[10,11,12, 13]

When medical therapy fails, several surgical interventions can be considered. These include proximal or distal (digital) sympathectomy and arterial reconstruction. Distal sympathectomy is associated with a lower complication rate than proximal sympathectomy, but the long-term outcome has not been well-documented.[14,15] As with other vasodilator therapy, sympathectomy is less effective in patients who have secondary RP.[2,16] Amputation of digits appears to occur infrequently and is usually reported as individual cases.[17,18]

If there is evidence of larger vessel occlusive disease, such as has been reported at the level of the ulnar or radial arteries, vascular reconstruction can be performed successfully with vein grafts.[4] Therefore, all patients who present with a critical ischemic crisis should have a careful assessment to detect any correctable macrovascular disease. To further define the magnitude of larger vessel disease in these cases, arterial doppler studies, magnetic resonance angiography, or angiography can be used.[2]

When associated with MCTD, RP requires aggressive diagnostics and initial therapy to decrease arterial vasospasm. Management of this disease requires a multidisciplinary effort in the coordination of a sound treatment plan for without this focus, even minor trauma may result in digital amputation.

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Welcome to the Resident/Student/Fellow Section of *West*JEM!

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It is with great pleasure that I take this opportunity to welcome you to the Resident/Student/Fellow Section of *West*JEM! Our mission is to support, publicize, and highlight the academic work done by residents and medical students in the western states of the country in the areas of emergency medicine research and education with the ultimate goal of enhancing emergency care.

The Resident Section will emphasize high quality work and accept a variety of different types of submissions including original research, evidence-based educational models, case reports, case series, and evidence-based reviews. *You are invited to* submit educational algorithms created by you or your institution, in which you attach an evidence-based approach to learning a certain topic. (See "Clinical Emergency Medicine Algorithms: Vaginal Bleeding Less Than 20 Weeks" in this issue.) Submission of your institution's resident research projects in abstract or paper form would also be appropriate for this section.

I encourage all of you to submit to the Resident/Student/Fellow Section of *WestJEM*, allowing us to be your venue to highlight your excellent work in academia, with the common goal of providing optimal care of emergency patients through an evidence-based clinical practice. As all of our published articles are available worldwide via the internet, *West*JEM is the premier open-access, peer-reviewed emergency medicine journal for the western states. Address any questions, concerns, or suggestions regarding this section to lalehmd@gmail.com.

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Clinical Emergency Medicine Algorithms: Vaginal Bleeding in Early Pregnancy (Less than 20 weeks)

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INTRODUCTION

"Clinical Emergency Medicine (EM) Algorithms" was born out of my frustration with the educational process in medicine. Throughout medical school, professors teach us by a disease-based system. We read textbooks and learn about Takayasu's Arteritis and *Diphyllobrohtium latum*. We then enter our clinical rotations with such confidence that we know the minutiae about the most uncommon disease processes, and that is when it hits us--patients don't walk into the hospital saying they are having acute mesenteric ischemia in the distribution of their superior mesenteric artery; they say their stomach hurts. This is when we learned of the "differential diagnosis," which lists the diseases that cause a certain symptom. This is just what I needed, a patient with low back pain and I see zebras like Scheurmann's disease on the same list next to common entities like Spondylolisthesis, which is next to emergent entities like Abdominal Aortic Aneurysm. I am no better off in my understanding of how to approach these complaints. What I need is an algorithm but when I look through different textbooks for algorithms, I become even more confused.

Algorithms seem so complicated with arrows in every direction. This is where the concept of "Clinical EM Algorithms" was born. The goal was to structure them in a way that an emergency physician thinks about a patient's complaint. They are very simple in their structure and comply with the EM mantra of "worst first." In constructing them, I have found that each complaint is approached in its own unique way and that "one size does not fit all." They are not meant to be all-inclusive, but rather to provide a framework upon which to build future knowledge. They are ideal for those new to medicine or just beginning emergency medicine training. They can even help more experienced practitioners to be more thorough and more efficient.

The Approach

There is no set structure for each algorithm, much like an emergency physician will approach each chief complaint (Chest pain, Syncope etc.) differently. While each algorithm is structured based upon how an emergency physician thinks about each complaint, there are some general guidelines. The primary boxes in black ask general questions about the complaint, usually starting with ABCs and primary resuscitation. The secondary boxes in gray expand on questions from the primary boxes. For many complaints, you rule out life-threatening disease processes using the History & Physical. These aspects are portrayed in the boxes with the darkened outline. At certain points throughout the algorithm there are numbers in brackets. These refer to the numbers on the accompanying text page that will expand on that item. For example, in the vaginal bleed algorithm, the number [4] next to the *(+)Ectopic* refers to the ultrasound findings in ectopic pregnancy and statistics. The text page includes evidence-based explanations along with encountered pitfalls. The goal of the algorithms is to provide a basic framework upon which to build. It starts with a very simple broad algorithm but allows the reader to delve into controversial evidence-based decisions.

Vaginal Bleeding Algorithm

The approach to vaginal bleeding in early pregnancy can be broken down into five basic steps (black boxes). The first step, as in most algorithms, is the initial resuscitation including ABCs and consideration of transfusion. The aggressiveness of resuscitation is based on the clinical comfort of the individual emergency physician, and can vary widely. The next step is to rule out ectopic pregnancy, which is done by obtaining a pelvic ultrasound and ß-HCG level (gray boxes). The algorithm can then diverge based on the ultrasound results. If there is an ectopic, Gynecology will need to be involved for either surgical or medical management. If the ultrasound is indeterminate, the ß-HCG level will classify the ultrasound results further into non-diagnostic or abnormal pregnancy. This is done by comparing the ß-HCG level to the discriminatory zone

(DZ), which is the ß-HCG level in which we would expect to see an IUP on ultrasound. If the ß-HCG is less than DZ, the results are indeterminate and serial ß-HCGs must be obtained to determine viability of the pregnancy. If the ß-HCG is greater than the DZ, the pregnancy can be classified as abnormal and Gynecology would again need to be involved for determination of medical or surgical management. If there is an intrauterine pregnancy (IUP), then there is no longer concern for ectopic pregnancy and the patient can then be evaluated for spontaneous abortion (SAB). SAB can be classified into four types, depending on the cervical OS and location of the products of conception (POC) on physical exam (gray). Further management and gynecology consultation would then depend on the type of SAB. The final steps are to consider RhoGAM if the mother is Rh negative and evaluate for other more benign causes of vaginal bleeding.

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Pregnant Vaginal Bleeding <20 Weeks[1]

I. General

1. **The approach**: 5 basic steps (double-lined boxes). Start with initial resuscitation and ABCs. Then rule out ectopic pregnancy using pelvic ultrasound and HCG level (dashed boxes). If ultrasound shows IUP and no concern for ectopic, then evaluate for SAB based on os and POC on exam (dashed boxes). Final steps are to consider RhoGAM and other benign causes for vaginal bleeding.

II. R/O Ectopic

2. R/O Ectopic**:** based on results of U/S→3 possibilities: If U/S shows **ectopic**, call gynecology. If U/S shows **IUP** and no concern for heterotopic, evaluate for SAB. If U/S is indeterminate, classify into non-diagnostic or abnormal pregnancy based on ß-HCG level.[1]

3. **U/S criteria** for **IUP** (see below for normal u/s appearance in pregnancy)
   - Gestational sac + "double decidual sac" sign is earliest sign of pregnancy, although some believe it is the yolk sac.
   - Table 1: Normal ultrasound findings and ß-HCG levels compared to gestational age.[2]

Gestational Age	Transabdominal Landmarks	Transvaginal Landmarks	**B-hCG Level** (mIU/mL)
4–5 weeks	± Gestational sac	Gestational sac	1000
5 weeks	Gestational sac ± yolk sac	Gestational sac with yolk sac, ± fetal pole	1000–2000
6 weeks	Yolk sac and fetal pole	Yolk sac and fetal pole with cardiac activity	10,000–20,000

   - **Pitfall**: Pseudosacs are false sacs that can be confused with gestational sacs; pseudosacs can occur in 10-20% of ectopic pregnancies (centrally located) compared to eccentric location of true gestational sacs.[2]

4. **U/S** signs suggestive of **ectopic** pregnancy[2]
   - Definite: Extrauterine embryo with cardiac activity (seen in 15-20% of EPs)
   - Suggestive: Free pelvic/Intraperitoneal fluid, tubal ring, complex adnexal mass

5. Incidence of heterotopic in[1]
   - general population: 1:4,000-30,000
   - Incidence in assisted reproduction: 1 in 100, therefore cannot exclude ectopic and further work-up needed in this population[1]

6. **Discriminatory zone** for ß-HCG for transvaginal U/S is usually 1,000-1,500 (depending on institution)[1]

7. Indeterminate U/S below DZ: **Non Diagnostic**[1]
   - Ddx: early viable IUP vs nonviable IUP vs ectopic
   - If pt stable: can d/c home, obtain serial ß-HCG, repeat U/S when ß-HCG above DZ after GYN consult
   - **Pitfall**: U/S should still be obtained if ß-HCG is below discriminatory zone because may still be able to diagnose both IUP and ectopic (Level C ACEP Recommendation)[3]

8. Indeterminate U/S above the discriminatory zone: **Abnormal pregnancy**[1]
   - Ddx: recent spontaneous AB or ectopic pregnancy is likely (86-100%)
   - Indeterminate U/S + ß-HCG> 2,000 virtually diagnostic of ectopic pregnancy[4]
   - Ectopic pregnancy can resolve spontaneously by tubal abortion or regression, but >90% of women with ectopic and ß-HCG>2,000 will require surgery.[5]
   - Follow-up needed in abnormal pregnancy because of increased likelihood of ectopic (Level B ACEP Recommendation)[3]

9. **Thinking 2 steps ahead**: Standard approach for **serial ß-HCG** is looking for a rise of 66% of 48hours, considered normal, although:
   - A normal rise may be seen in up to 15% of ectopics[6]
   - An abnormal rise (<66%) may be seen in 15% of IUPs

10. **Serial ß-HCG** values at 48h[1]: (Level B ACEP Recommendation)[3]

• **66%:** IUP, EP(15%)	• **Plateau**: nonviable IUP, EP
• **<66:** EP, SAB, nl IUP (15%)	• **Decreasing**: SAB, tubal AB

III. Evaluate for SAB

11. Evaluate for spontaneous abortion in the patient with an IUP and vaginal bleeding
    - Classify into type of SAB based on OS and POC

12. Incidence of miscarriage:[7]
    - 21% bleed before 20th wk
    - 57% of those will miscarry
    - 80% of those will miscarry before 12 weeks

13. After detection of fetal cardiac activity, <5% of pregnancies with normal sonographic appearance will abort.[3]

14. RhoGAM 50 mcg for Rh(-) women at loss of first trimester pregnancy (Level B ACEP Recommendation) [3]
    - No recommendations for after first trimester, but standard dose is 300 mcg IM

15. Other Dx
    - Molar pregnancy dx by U/S showing "snowstorm" pattern or cystic structures
    - Implantation bleeding is spotting from implantation of embryo around the time normal period occurs.

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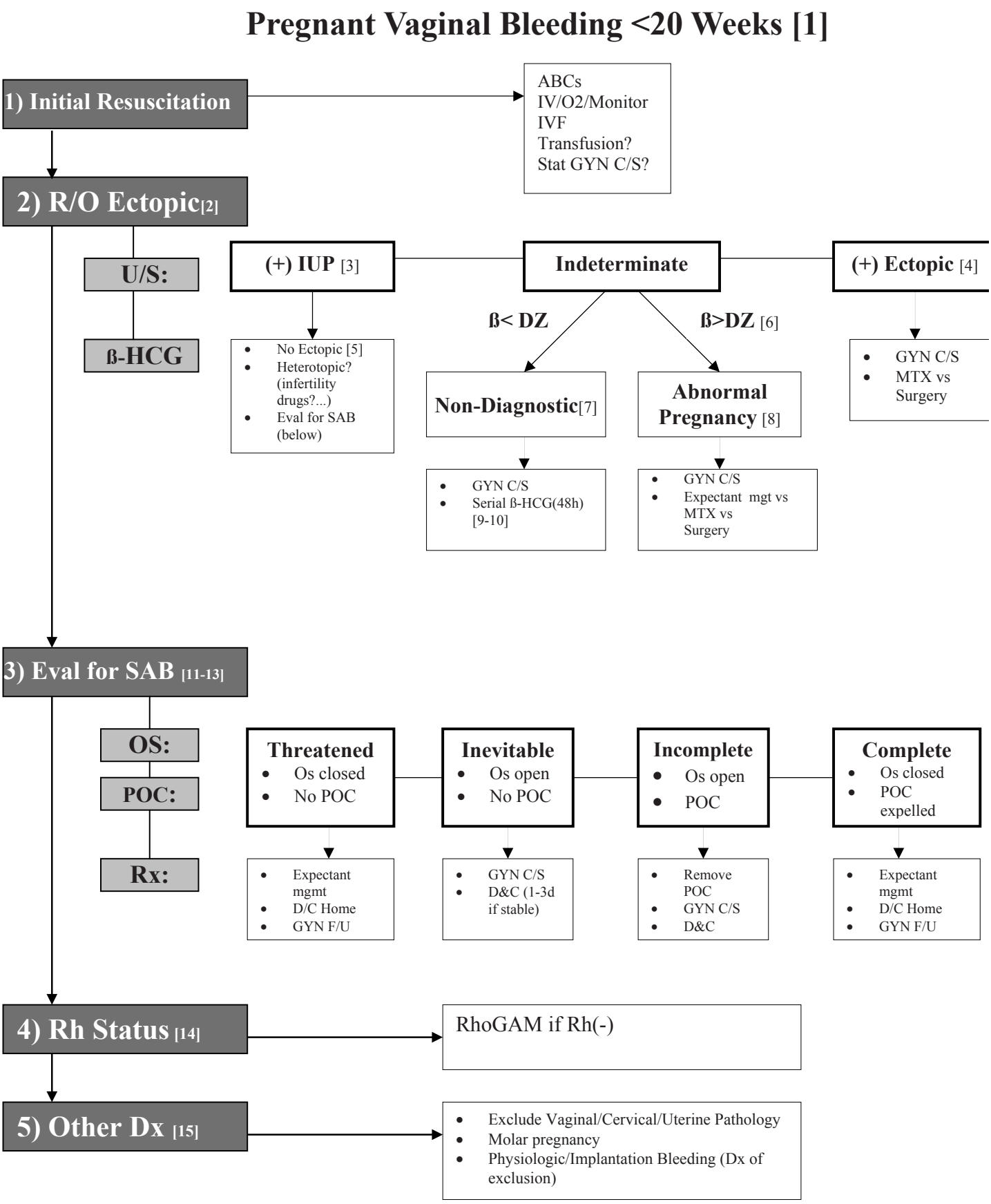

Abbreviations: DZ=Discriminatory Zone, IUP=intrauterine pregnancy, SAB=spontaneous abortion, POC=products of conception, r/o=rule-out, C/S=consult, GYN=Gynecology, Dx=diagnosis, MTX=methotrexate, D&C=dilation and curettage, w/u=work-up, r/o=rule-out

Images in Emergency Medicine : Aortic Dissection

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A 42-year-old patient presented with chest pain and shortness of breath. The pain was atypical for cardiac disease, started suddenly, occurred at rest and was non-radiating. Initial vital signs were normal and although the patient was in mild distress, the physical examination was normal. A Wells score was calculated and the patient was found to be in the moderate risk group for pulmonary embolism. A computed tomography pulmonary angiogram (CTPA) was performed (Figure 1).

The aortic flap seen (arrow) was unexpected but diagnostic. The patient was treated with beta-blockade and nitroprusside in the emergency room and went emergently to the operating room where the Stanford A aortic dissection was successfully repaired.

Aortic dissection is a relatively rare cause of chest pain but comes with high morbidity and mortality. Caused by stress on the aortic wall, the most common cause is long-standing systemic hypertension. Multiple indicators of dissection may be present during the physical exam, most characteristically the description of a "tearing" pain that radiates to the back. Other classic findings include a pulse deficit (25-30%), neurologic findings (5-17%), or a history of syncope (8-13%). While most patients are hypertensive, the presence of hypotension should raise the concern that the dissection may extend backwards into the pericardium.

Classic findings on chest x-ray include mediastinal widening, obliteration of the aortic knob, right-sided deviation of a nasogastric tube, depression of the left mainstream bronchus, or a small left-sided pleural effusion. In the stable patient, contrast CT scanning will show the extent of the dissection and pericardial and pleural effusions. However, CT scan does not precisely localize intimal tears, reliably demonstrate side branch involvement, or define aortic regurgitation. In the unstable patient, bedside transesophageal echocardiography (TEE) is used to find proximal aortic dissections and assesses for aortic insufficiency, pericardial effusions, and myocardial infarction. However, TEE requires an experienced operator and does not allow for evaluation of the entire descending aorta or side branch arteries.

Treatment of aortic dissection is dependent on the anatomy of the dissection, and two classification schemes are used. The Stanford classification labels the dissection as "A" if the ascending aorta is involved or "B" if the descending aorta is involved. The DeBakey classification system assigns labels of I for involvement of both the ascending and descending aorta, II for ascending aorta involvement, or III for descending aorta involvement. Treatment begins with controlling blood pressure with short acting, titratable medications. β blockade is used to decrease the stress the systolic pulse places on the aorta, and nitroprusside can be used to control hypertension. In the case of ascending aortic dissection, surgical replacement of the dissected segment is necessary. During this procedure, aortic insufficiency and coronary insufficiency can be corrected as well. In the case of a descending aortic dissection, treatment utilizes intensive blood pressure control but may become surgical should uncontrollable hypertension, rupture, or involvement of a major aortic branch with subsequent end-organ

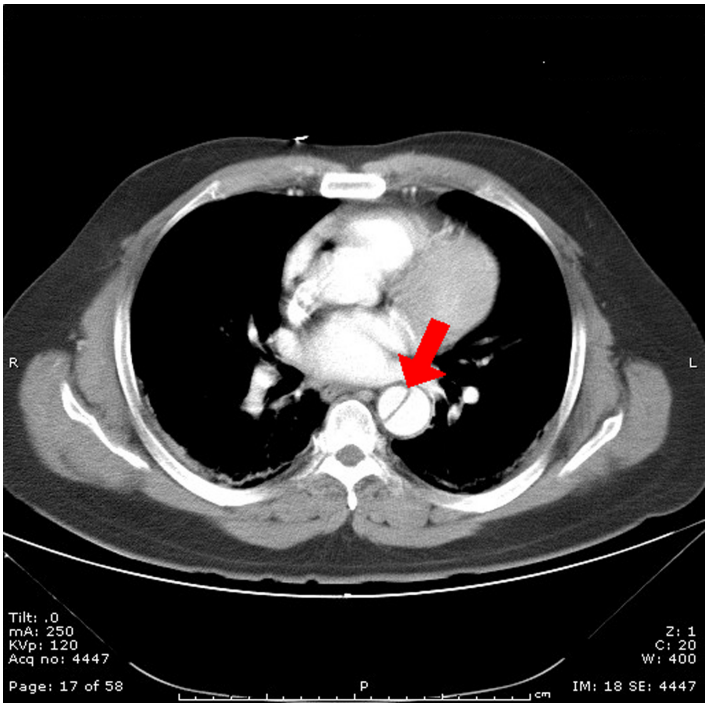

Figure.

ischemia occur. Another option for treating descending aortic dissections is stent-graft therapy, which provides an alternative that has been shown to be safer than surgery.

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Images in Emergency Medicine : Retinal Detachment

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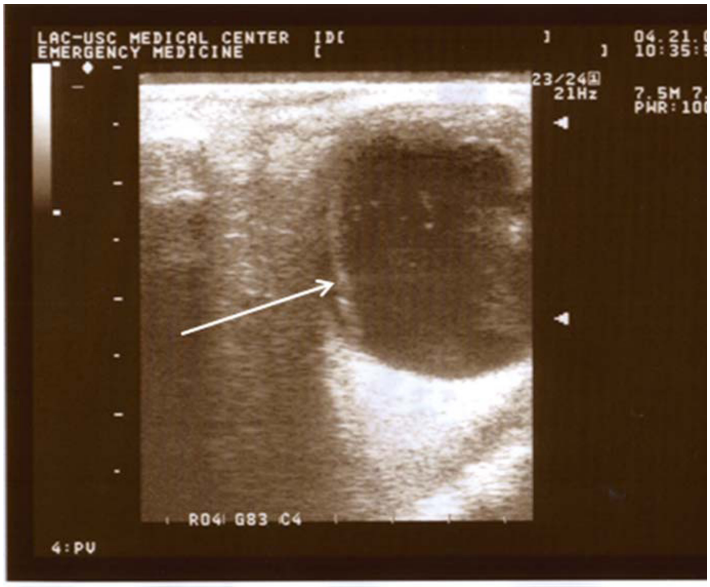

Figure. Medial Retinal detachment taken with an Aloka SSD1400 linear probe

A 62-year-old Asian male with a past medical history significant for diabetes mellitus, hypertension, and prior surgical correction of a retinal detachment of the right eye presented to the emergency department (ED) for further evaluation of an abnormal examination by his optometrist. The patient denied any acute visual changes. On examination, corrected visual acuities measured 20/40 in the left eye and 20/100 in the right eye. Sclera, cornea, anterior chamber, and visual field examinations were unremarkable for both eyes, and retinal examination of the left eye was normal by undilated direct opthalmoscopy. ED ultrasound of both eyes revealed significant findings. In the right eye, a curved hyperdensity along the lateral aspect of the retina consistent with a prior surgically corrected retinal detachment was observed. In the left eye (Figure), a medial retinal detachment was noted. These images were generated by applying the 10 MHz linear ultrasound probe with water soluble gel directly on the closed eyelid. Picture quality and interpretation can be greatly improved by placing the probe slightly lateral on the eye, directing the beam medially in line with the optic nerve. Asking the patient to move his closed eye medial and lateral also allows the differentiation of a taught retinal detachment from a more freely moving vitreous hemorrhage.

This image demonstrates another emerging use for ultrasound in the ED: the evaluation for and diagnosis of a retinal detachment. As noted above, some patients with a retinal detachment may present with minimal visual complaints and subtle physical exam findings. Furthermore, direct ophthalmoscopy itself has limitations, especially when the pathology is distant from the macula. Diagnosing retinal detachment while the macula is still attached is particularly important, as permanent vision loss increases dramatically once this occurs. The improving resolution and increasing availability of ultrasound may assist emergency physicians in diagnosing this potentially devastating cause of vision loss.

Literature concerning ED ultrasound diagnosis of ocular pathology consists predominately of case reports[1] with one prospective observational study[2] showing ED physicians agreeing with a criterion standard on 98% of the cases. More studies concerning the accuracy of ED ultrasound diagnosis of retinal detachment are needed.

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Images in Emergency Medicine : Retropharyngeal Abscess

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A 40-year-old female presented to the emergency department with a one-week history of URI symptoms and a one-day history of more severe throat pain and swelling. Upon physical examination the patient was afebrile and although she did not demonstrate any signs of respiratory distress, examination of her neck revealed fullness on the right. A lateral plain film of the neck showed soft tissue swelling anterior to the vertebral bodies (Figure 1) and a CT scan demonstrated fluid in the retropharyngeal space and an abscess. Fiberoptic laryngoscopy was performed and the airway was found to be swollen and compromised. The patient was taken to the operating room for an awake tracheostomy, the abscess was incised and drained, and she was admitted for overnight observation.

Despite the advent of antibiotics and improvement of dental hygiene, deep space neck infections persist as a cause of morbidity and mortality. Retropharyngeal abscess (RPA) is an ENT emergency due to the possibility of life-threatening airway complications.[1] Patients with RPA typically have localized symptoms of dysphagia, voice changes, odynophagia, trismus, and neck/jaw pain.[2] Generalized symptoms of fever, chills, and loss of appetite may be present as well. Indicators of RP abscess during the physical exam are stridor, shortness of breath, drooling, cervical lymphadenopathy, and bulging of the pharyngeal wall.[3] Lateral radiographs will manifest with preveterbral air/fluid levels or abnormal widening of the prevertebral soft tissue, normally 5 – 7 mm wide at the level of the second cervical vertebrae.[2] Treatment in the Emergency Department should focus primarily on ensuring a patent airway. Oral intubation may be compromised by a large abscess or in turn may lead to rupture of the abscess, so ENT should be consulted for emergency tracheostomy. Antibiotic choices include high-dose penicillin plus metronidazole, piperacillin/tazobactam, ampicillin/sulbactam or ticarcillin/clavulanate.[2]

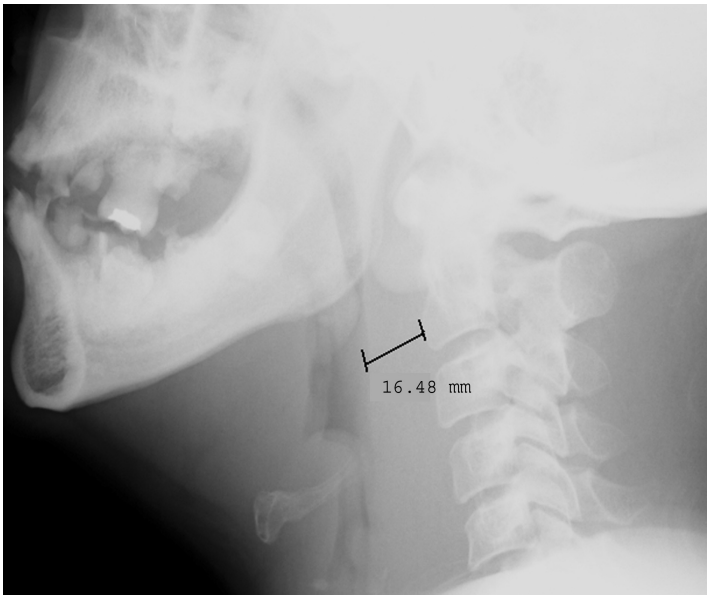

Figure.

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Images in Emergency Medicine : Lisfranc Fracture-Dislocation

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Patient Presentation

A 22-year-old intoxicated male presented to the emergency department after jumping from a second-story window, landing on his right foot. He was able to ambulate with a great deal of pain across the dorsum of his foot. Physical examination revealed significant tenderness to palpation over the second metatarsal with minimal edema.

Final Diagnosis/Relevant Teaching Points

Radiographs of the foot reveal a fracture-dislocation of the tarsometatarsal or Lisfranc joint. A diastasis between the proximal 1st and 2nd metatarsals is seen and indicates an unstable injury (Figures 1 & 2). A bone fragment is present in this area due to an avulsion of the Lisfranc ligament. In addition, the lateral edge of the medial cuneiform does not align with the lateral aspect of the first metatarsal. This malalignment can be the only indication of injuries to the Lisfranc joint in more subtle presentations, which can easily be missed.

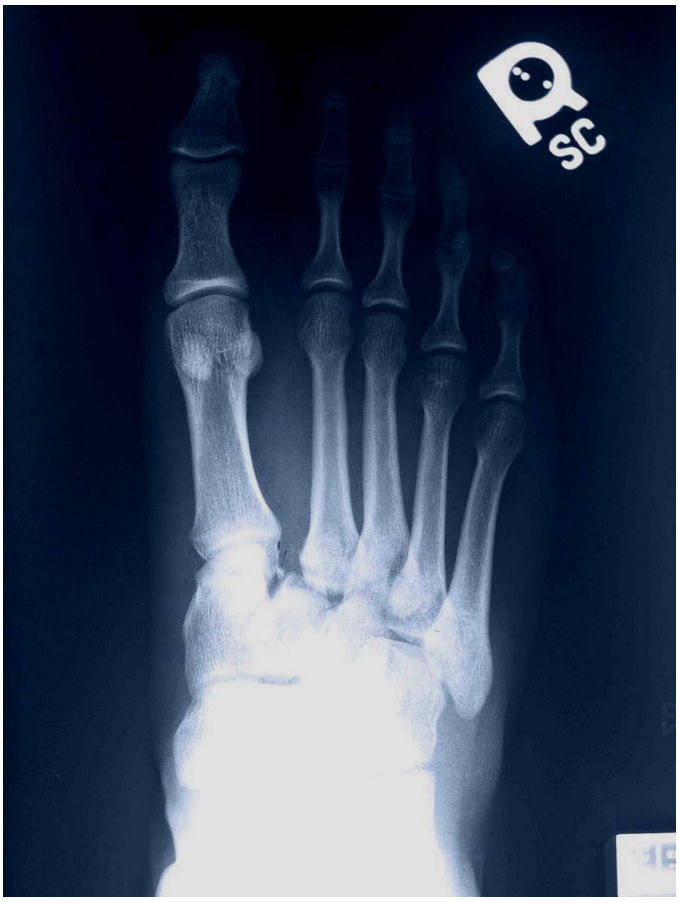
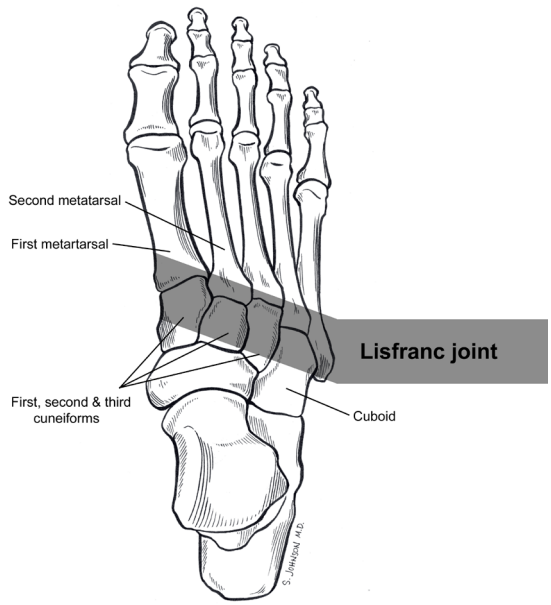


Figure 1.



With thanks to Sonia Johnson, MD for her illustration of the Lisfranc joint.

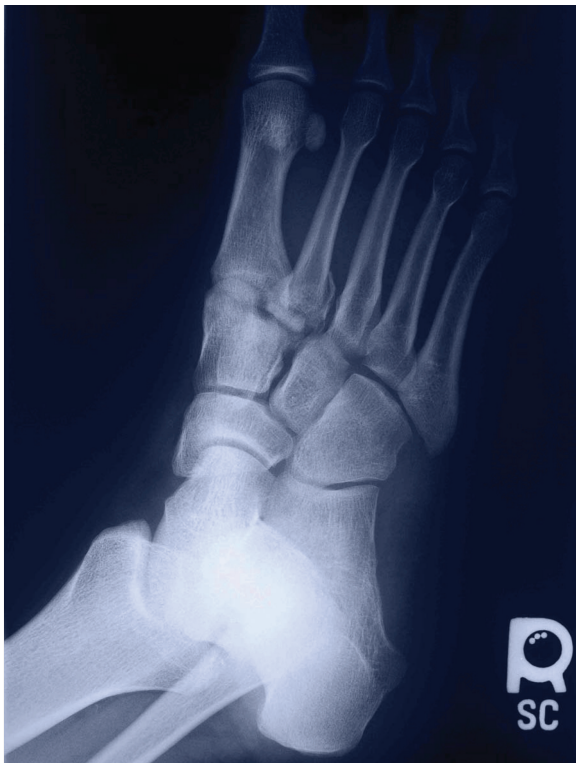


Figure 2.

Lisfranc fracture-dislocations are uncommon, but should be suspected in high-energy injuries, such as motor vehicle collisions and falls, as well as sports involving fixation of the forefoot (horseback riding, windsurfing). They can be caused by lower energy mechanisms, such as trips and falls.[1] Any suspected Lisfranc fracture-dislocation requires orthopedic consultation as the treatment requires operative fixation.

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Interpretation of Traumatic Lumbar Puncture in the Setting of Possible Subarachnoid Hemorrhage: Who Can Be Safely Discharged?

Gorchynski J, Oman J, Newton T. Interpretation of traumatic puncture in the setting of possible subarachnoid hemorrhage: who can be safely discharged? *WestJEM*. 2007; 8:3-7.

To the Editor:

When I first saw the title of the study by Julie Gorchynski et al in the February 2007 issue of the *Western Journal of Emergency Medicine*, I thought, "Eureka!" We surely have to reason our way through a great many decisions for which we have no highly reliable evidence to guide us. But the question of how to proceed with the patient with a history suspicious for subarachnoid hemorrhage (SAH), but with a negative CT and with CSF that has several hundred or more red cells, has always been one of the most vexing to me and my colleagues. What a minefield - a disease with very low prevalence, affecting patients usually in the primes of their lives, with potentially catastrophic outcomes for a missed diagnosis, and with even the potential for some harm if we over-diagnose. While an evaluation by LP with or without CT has become the standard, a strategy for interpreting abnormal CSF with high sensitivity and specificity has been lacking.

The paper represents a landmark for finally supplying some data and analysis. Unfortunately, as reported, it's hard to determine exactly how reassuringly the study answers the question, "How do you distinguish a patient with traumatic tap from one with CT-negative SAH?" Ideally we would need to know the answer to this question to know whom we can safely discharge. The authors are careful to explain the limitations of the study, and, indeed, it is impossible to know for sure that all of the patients whom the authors have to call negative (at times, referred to as "radiographically normal") are truly negative for SAH. The lack of clinical follow-up (this could be enough to answer the question more completely, but admittedly would be difficult to obtain) and/or definitive evaluation for aneurysm in all patients could significantly affect the conclusions of the study. Of course, even an angiogram can be a false-negative, if there is vascular spasm, or a false-positive, in someone with an asymptomatic aneurysm and a headache for another reason, but the fact that some of the subjects only had a negative CT to define them as being negative for SAH brings us back to "square one" for those patients - probably over 200 of them in this study - in terms of the method many of us use to evaluate them. It is still unclear how confident we can be that a negative CT and an RBC count below 500 rules out SAH.

It seems very likely that there is a spectrum of presentations, CT findings, and CSF RBC counts that correlate with different degrees of SAH at different times after the event. Considering all of these variables, our ultimate goal would be to determine the difference between the RBC count (and particularly the lowest limit of this) and RBC clearance for those who are truly SAH-positive vs. SAH-negative. Though I sense that we'll probably never know the complete answer, the work of Gorchyniski et al gives us a better understanding than we had before. Iapplaud and thank the authors for their efforts and analysis. And while a larger sample size, as they suggest, would be nice, as it is with most observational studies, the devil is in the denominator, and defining what we don't know is as important as determining what we do know. We'll just have to look forward to a well-designed prospective study and, in the meantime, at least understand that a negative CT does NOT finish the evaluation in someone with a suspicious history for SAH. And if there are RBCs in the CSF.....well, as they say, that's why they pay us the big bucks!

J. Toscano, MD
San Ramon Regional Medical Center
San Ramon, CA

In reply:

The comments by J. Toscano are applicable to this difficult question that emergency medicine physicians continue to face: Who can we safely send home with a normal head CT and red blood cells in the CSF? Dr. Toscano's appraisal of the paper is valid and well articulated. His suggestion for future studies in defining with certainty what patients truly have a subarachnoid hemorrhage (SAH) with a reported "radiographically normal CT" and red blood cells in the CSF are defensible. I question if an exact cutoff value or specific range of CSF red blood cells are required to diagnose a SAH that is clinically insignificant.

While future prospective studies may be able to define exactly what constitutes a traumatic tap versus one consistent with a SAH as supported by MRI/MRA or angiography the next critical question would be the clinical significance of the SAH. A prospective observational study in those patients who have a radiographically normal CT with CSF red blood cells who are discharged home or admitted for observation with six month follow up may answer this question. If those patients who truly had a SAH were sent home with a radiographically normal CT and red blood cells in the CSF, was the SAH of clinical significance? And is there a need to utilize expensive and invasive imaging modalities to find evidence of a SAH that is of no clinical importance?

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Society for Academic Emergency Medicine Western Regional Abstracts

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The following abstracts, which are published here with author permission, were presented at the Western Regional Society for Academic Emergency Medicine Research Form in Portland, Oregon on March 16, 17, 2007.

1 Declining Rate of Venous Thromboembolism in Patients Evaluated for Pulmonary Embolism in Two United States Emergency Departments and Low Rate of Empiric Anticoagulation

Kristen E. Nordenholz, MD; Alice M. Mitchell, MD MS; Jeffrey A. Kline, MD.
University of Colorado Health Sciences Center, Denver, CO; Carolinas Medical Center, Charlotte, NC

Hypotheses: The current prevalence of venous thromboembolism (VTE) among patients evaluated in United States emergency departments (EDs) is lower than the 24-30% reported by others. Physicians seldom use empiric heparin therapy, even when clinical suspicion for VTE is high.
Objective: To determine the prevalence of VTE among ED patients evaluated for pulmonary embolism (PE).
Methods: Patients undergoing a D-dimer or imaging study for PE were prospectively enrolled at two academic EDs (consecutive sample at institution #1 and random sample at institution #2) between August 2005 and April 2006. Patients were enrolled prior to completion of diagnostic testing and had structured telephone and medical record follow up at 90 days. The outcome of VTE (either PE or DVT) was based upon adjudicated agreement of two of three blinded, physician reviewers.
Results: We enrolled 350 patients, mean age 46+/-20 y, 65% female, 58% Caucasian. The prevalence of VTE was 24/350 (7%, 95% CI: 4 to 10%). The prevalence of VTE was 17/225 (8%, 4 to 12%) at institution #1 and 7/125 (6%, 2 to 11%) at institution #2. The first diagnostic test was more commonly an imaging study rather than D-dimer among VTE+ patients (75%) than VTE- patients (34%, 95% CI for the 31% difference: 20 to 55%). The evaluating physician reported that PE was more likely than an alternative diagnosis in 12/24 VTE+ patients (50%, 29 to 71%) compared to 54/326 VTE- patients (17%, 13 to 21) with a sensitivity, specificity and likelihood ratio positive of 50% (29 to 71%), 83% (79 to 87%) and 3.0 (1.8 to 4.6), respectively. Physicians started heparin prior to imaging in 1% (0 to 2%) of VTE- patients and 4% (0 to 21%) of VTE+ patients.
Conclusions: The overall prevalence of VTE was significantly lower (7%) than in previous reports. Physicians were able to correctly identify VTE as the leading diagnosis in a greater percentage of VTE + patients, and often ordered imaging initially, but seldom treated with heparin prior to imaging.

2 Tandem Measurement of D-Dimer and Myeloperoxidase Decreases Unnecessary Pulmonary Vascular Imaging in Emergency Department Patients Evaluated for Pulmonary Embolism

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Background: The D-dimer (DD) has become a standard method of screening patients for pulmonary embolism (PE), but is limited by a high false-positive rate (FPR) leading to a high rate of unnecessary imaging. Hypothesis: The tandem measurement of myeloperoxidase (MPO) following a positive (+) DD will significantly decrease the rate of unnecessary pulmonary vascular imaging.
Objective: 1) Determine the potential of MPO to decrease unnecessary imaging in emergency department (ED) patients evaluated for PE with a +DD. 2) Determine the appropriate threshold for MPO in this application.
Methods: A consecutive or random sample of patients

undergoing evaluation for PE was enrolled at two academic EDs between April 2005 and April 2006. Patients were enrolled and a serum sample was obtained prior to the results of diagnostic testing or therapy. Patients were followed for 90 days for the outcome of venous thromboembolism (VTE, either PE or deep venous thrombosis), which required the consensus of two of three blinded physician reviewers. A DD was measured in all patients and considered + if ≥500 ng/mL and MPO was measured on patients with +DD.
Results: We enrolled 305 patients, 21 with VTE (7%, 95% CI: 4-10%) within the follow-up period. One hundred sixty-six (55%) had a –DD, none with VTE (sensitivity 100%, 84-100%). Among the 139 patients with +DD, 39 (28%, 21-36% of +DD patients and 13%, 9-17% of total) had a MPO <22 ng/mL, none had VTE (sensitivity 100%, 91-100%). Thus, tandem measurement of DD and MPO would have decreased unnecessary subsequent pulmonary vascular imaging from 45% to 32% (95% CI for difference of 13% = 5-30%).
Conclusion: The tandem measurement of DD and MPO would have significantly decreased unnecessary pulmonary vascular imaging compared with DD alone. This finding should be validated prospectively.

3 Agreement of Medical and Undergraduate School Counselors about the Ways an Average Student Can Improve His Application to Medical School

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Background: This year more than 39,000 students applied to medical school. For the average applicant, advice on strengthening one's application to medical school is quite varied. There is little data that compares how a Medical School Admissions Office (MSAO) judges an applicant's activities compared with what pre-medical counselors (PMC) advise their undergraduate students to do.
Objective: To determine whether or not a disparity exists between the advice PMC offer undergraduate students and what the MSAO believes would improve an average student's application to medical school.
Methods: A survey was sent out to 100 undergraduate PMC and 123 MSAOs. The survey asked participants to rate 10 different activities on a scale of 1 to 10 that might increase an average student's chance of admittance to medical school. We stated that the hypothetical average student achieved a 30 MCAT score and an undergraduate GPA of 3.7 from a midlevel university. The list of activities was presented in a varied fashion to ensure no bias in the order of the survey. It was completed by 56 undergraduate schools and 72 medical schools. Those schools that did not respond to the first survey were queried a second time.
Results: Overall there was good agreement between the two groups with regard to the value of community service, volunteering in any medical setting, and obtaining a MPH or other graduate degree. PMCs tended to overvalue the importance of work in research, both clinical (7.34 vs. 6.14, $p<0.002$) and labratory(6.6 vs. 5.3, $p<0.003$) compared to MSAOs. PMCs also undervalued retaking the MCAT and joining a service organization such as the Peace Corps.
Conclusion: There is general consistency given student applicants for medical school. Both PMCs and MSAOs agreed that volunteering in a medical/clinical setting is a highly valued activity. Participants similarly agreed that the least important activity was working in a non-medically related job to gain "real world" experience.

4 Validity of Self-Reported Hypertensive Status in the Multiethnic Cohort

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Background: In large cohort studies, data is most practically collected from self-reported surveys. However, the validity of the self-reported data is brought into question when it is verified with medical records.
Objective: To determine the accuracy of self-reported hypertensive status by comparing it with the diagnosis of hypertension (HTN) by a physician in a multiethnic population.
Methods: Study subjects were chosen from among the African American and Latino participants of the Multiethnic Cohort Study (MEC), a cohort of 215,251 individuals from the five main ethnic groups in California and Hawaii. MEC participants received a comprehensive 26-page questionnaire upon enrollment in which subjects reported their hypertensive status and indicated if they were taking anti-HTN medication. Three years later a second questionnaire was sent and subjects again reported their hypertensive status. We then contacted the subjects' health care providers to ascertain the subjects' hypertensive status, medication history, as well as representative blood pressures from the past four years.
Results: Of the 32 subjects self-reported as non-HTN, the PMD confirmed HTN in 50%. Of the 21 subjects self-reported as having HTN and taking anti-HTN meds, 85.7% were indeed hypertensive according to their physicians. Among non-HTN subjects (physician confirmed), the average systolic blood pressure (SBP) was 127 and among the self-reported HTN subjects (non-HTN per their physicians), the average SBP was 118. In self-reported non-hypertensive subjects who were diagnosed hypertensive by their physician, the average SBP was 137. Within hypertensive subjects (physician confirmed), the average SBP was 141.
Conclusion: The self-reported data for the absence of chronic

disease such as HTN is not accurate, suggesting the need for validation (either through medical record review or direct measurement) to ensure accuracy.

5 Low-dose Ketamine for Analgesia in the Emergency Department: A Retrospective Review

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Background: Pain is a common complaint and is often poorly treated in the emergency department (ED). Low-dose ketamine is a known analgesic, but no reports of its use in the ED are present in the literature.
Objectives: To determine the safety and efficacy of low-dose ketamine for analgesia in the ED.
Methods: A retrospective chart review was performed to identify all adult patients receiving low-dose ketamine for analgesia in our ED. Cases were identified by pharmacy record of ketamine administration, and cases of low-dose ketamine administration were identified by review of the medical record. Low-dose ketamine was defined as the administration of approximately 0.1 to 0.6 mg/kg of ketamine for pain control.
Results: Thirty-five cases were identified in which patients received low-dose ketamine in the ED over a two-year period. Doses ranged from 5 mg to 35 mg. Administration was intravenous in 30/35 (86%) and intramuscular in 5/35 (14%) of cases. Opioids were administered, prior to a co-administered low-dose ketamine, in 32/35 (91%) of the cases. Improvement in pain was observed in 19/35 (54%) cases who received low-dose ketamine. Pain scores were not observed to improve in 8/35 (23%) cases. Insufficient data were available to determine effect for an additional 8/35 (23%). Of these latter cases, five (14% of total) had likely benefit and three (9% of total) had no benefit based on disposition. No significant adverse events were identified in any of the 35 cases.
Conclusions: The administration of low-dose ketamine in the ED appears to be safe. Our retrospective case series shows that low-dose ketamine for pain control may be efficacious in some patients in the ED. However, prospective, randomized, controlled trials are needed to determine the efficacy of low-dose ketamine for analgesia in the ED.

6 Incidence of Ovarian Tumor on 1st-Trimester Pelvic Ultrasounds in the ED

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Objectives: Focused emergency department (ED) 1st-trimester pelvic ultrasound (FTPU) examination for symptomatic pregnant patients has evolved to become standard of care at major EDs. Concerns about the risks of overlooking clinically significant incidental findings on organ-specific scans – risks of omission - continue to be used by radiologists to justify the ordering of "formal" ultrasound imaging - complete regional scan performed by ultrasound technicians and interpreted by radiologist ultrasonologists. Using ovarian tumor as an index for this risk of omission, we analyzed the findings on formal pelvic ultrasounds over a five-year period for incidence of ovarian tumor and compared it with that of about 0.1% reported in OB literature.
Methods: 1,520 consecutive formal FTPUs that were performed as part of the ED evaluation of 1st-trimester pregnant patients from May 2001 to May 2006 were reviewed. Patients were included if they had vaginal bleed and/or pelvic pain and < 14 wks pregnant. Pelvic masses seen on ultrasound were recorded and followed for diagnosis of ovarian tumor. In addition, clinically important incidental findings, defined as requiring emergent interventions or definitive follow-up, were also recorded. The hospital is a Level I trauma with an EM residency and an annual census of 43,000 visits/year.
Results: A total of two for an incidence of 0.14% of ovarian tumors was found in this case series. In addition, seven (0.53%) abnormalities were clinically significant: 1 (0.07%) ovarian torsion, 1 (0.07%) kidney stone, 1 (0.07%) angiomyolipoma, 1 (0.07%) gallstones, 3 (0.20%) endometrial/cervical lesion. Sixty-nine (4.54%) abnormalities were considered minor for findings such as subchorionic hematoma or leiomyomata.
Conclusions: The incidence of ovarian tumors seen in formal FTPU ordered from the ED is rare and similar to that in the normal OB population. It is unlikely that emergency medicine physicians performing focused FTPU scans will encounter increased clinically significant incidental pathology.

7 A Sexual Assault Response Team: the South Bronx Experience

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Background: Lincoln Medical Center is the only city hospital serving the South Bronx, the poorest congressional district in the nation. In April 2004, the Bronx Sexual Assault Response Team (SART) was launched to provide specialized care to survivors of sexual assault in this community via a standardized protocol outlined in our paper.
Method: We compared the care received by survivors before and after the inception of SART.

Results: Of the 173 SART patients, 100% were triaged category A. Ninety-five percent were examined within one hour of arrival, as opposed to 63% prior to SART. Colposcopy was done on 87% of SART patients and 27% of pre-SART, with genital injury documented in 55% of SART cases and 28% of pre-SART, and non-genital injury in 56% of SART and 49% of pre-SART patients. 100% of SART patients received STD, HIV, pregnancy, hepatitis and tetanus prophylaxis. No specific records were kept for pre-SART patients. There have been numerous positive incalculable results since the SART was launched including improved relations with Special Victims Unit, the NYPD, and the DA's office; opportunities for leadership roles in the community as survivor advocates; recruitment of SART examiners from our ED staff; increased awareness of the impact of culture on survival from sexual assault; and opportunities for further research.
Conclusion: The South Bronx SART program has resulted in improved health care for survivors of sexual assault and a benefit to the community. This program model has wide implications for care of survivors of sexual assault nationally.

8 Internationalizing the Broselow™ Pediatric Emergency Tape: How Reliable Is Weight Estimation in Indian Children?

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Objective: The Broselow™ Tape is a reliable method of estimating children's weights based on height-weight correlations and can determine standardized medication dosages and equipment sizes using color-coded zones. Our study sought to determine the accuracy and clinical utility of the Broselow tape in the Indian pediatric population.
Methods: We conducted a prospective cross-sectional study of children receiving care at the outpatient department of a government pediatric hospital in Chennai, India, over one month. Actual weight (measured by a standardized weighing device) and estimated weight (determined by the Broselow Tape) were collected for each child. The mean percentage difference (MPD) was calculated to estimate bias. Accuracy was defined as agreement within 10% between the measured and estimated weights, as well as agreement on Broselow color-coded zones. A correction factor was derived using linear regression.
Results: 548 subjects were divided into the three weight-based groups comprised of 175 (<10kg), 197 (10-18kg) and 176 (>18kg) children. The MPDs (± 95% CI) were -2.36% (-4.2,-0.5), -11.34% (-12.87,-9.8) and -12.95% (-14.94,-10.95) for each weight-based group. Agreement within 10% was 52.57% (45.17, 59.96) for the <10 kg group, but only 44.67% (37.72, 51.61) for the 10-18 kg group and 33.52% (26.54, 40.49) for the >18 kg group. The Broselow color-coded zone agreement was 70.85% in children <10kg, but only 56.34% in the 10-18 kg group and 37.5% in the >18kg group. Application of a 10% correction factor improved accuracy to 77.15% (71.29, 83.01) for the 10-18 kg group and 63.06% (55.93, 70.19) for the >18 kg group.
Conclusions: The Broselow Tape overestimates weight by more than 10% in Indian children predicted to be >10kg, increasing the risk of medical errors due to incorrect dosing or equipment selection. Applying a 10% weight-correction factor may be advisable. The accuracy and clinical utility of this correction factor requires prospective validation.

9 Use of Therapeutic Hypothermia for Comatose Survivors of Out-of-Hospital Cardiac Arrest in Arizona Emergency Departments

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Background: Improved neurologic outcomes have been demonstrated in patients undergoing mild therapeutic hypothermia after resuscitation from out-of-hospital cardiac arrest. Therapeutic hypothermia was endorsed in 2003 by the American Heart Association, and in 2005 by the International Consensus Conference on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science. Despite widespread acceptance in the scientific community, therapeutic hypothermia may not be routinely used by emergency physicians.
Objective: To evaluate the current use and methods of administration of mild therapeutic hypothermia for comatose survivors of cardiac arrest in Emergency Departments (EDs) throughout Arizona, and to identify barriers to implementation.
Methods: A telephone survey was administered to all ED medical directors in Arizona. Contact information was extracted from the United States Department of Health and Human Services database. Directors were asked about the demographic characteristics of their hospitals and EDs, current use of therapeutic hypothermia, protocols for hypothermia, perceived barriers to use, and potential for future implementation.
Results: Of 61 ED directors, 52 (85%) responded, two (3%) refused, and seven (11%) were unreachable. Therapeutic hypothermia was used routinely in five (10%) of EDs. Two had structured protocols. The most common cooling method used was ice packs and cooling blankets (80%). Two of the EDs using hypothermia were rural and routinely transferred comatose survivors to urban hospitals after initiating hypothermia. Of EDs not using hypothermia, common reasons

given included lack of evidence supporting its use (42%) and cost or lack of trained personnel (35%). 72% of non-users indicated they had no future plans for adoption.
Conclusion: Although considered standard of care by the scientific community, therapeutic hypothermia in cardiac arrest patients remains rarely utilized by most EDs throughout Arizona. Barriers to use include inadequate education regarding the benefits of hypothermia, perceived cost, and lack of training in implementation.

10 EMS Patients Receive More Rapid Care than Ambulatory Patients for Acute Stroke

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Background: It has been demonstrated that the majority of pre-hospital delay occurs from the time of onset of acute stroke (CVA) to the time of the patient's actual decision to seek care. What is less clear is the role of the emergency department (ED) care providers on the pace of the patient's care in the setting of CVA.
Objective: To study the effect of EMS transport on the pace of care of providers in the ED.
Methods: Retrospective chart review of four months of patients with a final ED diagnosis of CVA. Demographic data as well as time to order and time to administration for CT head, aspirin, and neurology consult were examined and compared for patients who presented via EMS vs. those who walked into the ED. Comparisons of the medians (in minutes) were done for each variable examined. We also calculated the odds for CT done in less than one and two hours from arrival.
Results: Fourty-three patients received the final diagnosis of CVA during the four-month period. EMS transported 19 of these (44%). EMS patients had a CT ordered more rapidly (52 vs. 108 minutes), and a neurologist called more quickly (90 vs. 469 minutes) than the ambulatory patient. The EMS patients had an OR of receiving a CT of the head within one hour of 3.09 (95%CI: 0.64,15) and an OR = 3.33 (95%CI: 0.86, 13) within two hours. None of the differences were statistically significant for either the ordering of the therapies or their administration.
Conclusion: In this facility, it appeared that there was a trend to treat patients with CVA who presented via EMS more rapidly than those who walked in. It is unclear the effect this had on outcome.

11 Incidence of Hypokalemia in Patients Presenting to the Emergency Department with Diabetic Ketoacidosis

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Background: Hypokalemia is reported to occur in approximately three to four percent of patients with DKA. To prevent complications of severe hypokalemia, the American Diabetes Association (ADA) treatment guidelines recommend ensuring that serum potassium levels are > 3.3 mEq/L prior to initiation of insulin in the treatment of DKA.
Objective: To assess the incidence of hypokalemia in patients presenting to the ED with hyperglycemia with or without DKA.
Methods: This was a multicenter retrospective study at three urban academic EDs with a combined annual adult census of 150,000. Charts of patients who presented to the ED between January and December 2005 with hyperglycemia (defined as serum glucose > 200 mg/dL) or DKA (defined in accordance with ADA guidelines as serum glucose > 250 mg/dL, serum bicarbonate < 18 mEq/L or anion gap > 15, and evidence of ketonemia or ketonuria) were reviewed. Initial lab values on presentation were assessed for the incidence of hypokalemia.
Results: 800 patients (461 with DKA) were diagnosed with hyperglycemia. The mean potassium level was 4.7 mEq/L (range 3.3 to 8.1, SD +/- 0.8). For those patients diagnosed with DKA, the mean potassium level was 4.9 mEq/L (range 3.3 to 7.5, SD +/- 0.8). Only two cases of serum potassium < 3.5 mEq/L (both 3.3) were found in our DKA patients (incidence of 0.4 percent).
Discussion: Our results suggest that the incidence of hypokalemia in ED patients with DKA may be far less than three to four percent. As the demographics of DKA are changing (e.g. increasing numbers of older patients, patients with renal disease, and patients with congestive heart failure), our ability to depend on IV fluids alone as the initial therapy in DKA may be diminishing. Today's DKA patients may be less likely to tolerate large fluid loads and are potentially more prone to hyperkalemia. The benefits of early insulin administration may outweigh the risk of causing severe hypokalemia.
Conclusion: The incidence of hypokalemia among hyperglycemic patients presenting to the ED with or without DKA appears to be less than prior estimates. Further research is needed to better determine the risks and benefits of administering insulin before obtaining serum potassium values.

12 Development of a Model to Compare Emergency Chemical Decontamination Methods

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Background: Many first responders plan to decontaminate

people contaminated by hazardous substances by drenching the victims with water before removing their contaminated clothing. We examined the possibility that this approach may actually increase skin contamination.
Methods: We experimented with various preparations of a non-toxic contamination simulant, Glow in the Dark Pigment (Risk Reactor, Huntington Beach, Calif.), until we found a reproducible model that reliably stained the surface of a hospital scrub shirt but did not cause significant soak-through and skin contamination. After developing the model, we applied the pigment to the subjects following our model. We confirmed the amount of skin contamination with a UV light. We then decontaminated subjects using a shower until their clothing was thoroughly saturated and evaluated the amount of contamination left on the clothing and on the skin using UV light.
Results: The optimal contamination model was one-half teaspoon of pigment and 15 milliliters of tap water. We had the most success when we applied the simulated contaminant by fingertip to the victim's shirt. We used this model with four different subjects and decontaminated them in a cold water shower, while fully clothed, until they were completely wet and dripping. In every case, pigment was left on the clothing even after decontamination. Additionally, while there was no pigment detectable on the skin before decontamination, we found significant amounts of pigment on the skin after decontamination. Showering the person while clothed spread the contaminants to not only the skin under the shirt but also to the lower extremities.
Conclusion: It may be unsafe to drench asymptomatic people who have been contaminated with a hazardous substance before removing their clothes. We have developed a model that investigators may use for further studies.

13 Does Acculturation Influence End-of-Life Treatment Preferences

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Background: Prior research has evaluated the willingness to accept or refuse life-sustaining therapy but have not included Spanish-speaking populations. These decisions in a clinical setting are often part of the advance directive discussion bringing the importance into the emergency department (ED). Health care disparities exist in this population, and best approaches to discussing end of life preferences are not clear.
Objectives: In this study we sought to identify healthcare decision-making patterns and the effect of acculturation in Latino patients.
Methods: This observational study used the WALT (Willingness to Accept Life Sustaining Treatment) survey to interview subjects at four outpatient clinics (geriatrics, cardiology, HIV and oncology) that served patients with chronic, incurable illnesses. Subjects were asked hypothetical questions regarding their preferences for treatment selected against outcome and burden. The survey was administered in Spanish. This study was IRB approved.
Results: Two hundred and forty Latino subjects were surveyed, but three were excluded due to a lack of a medical diagnosis. The mean age of the subjects was 58. Seventy-seven percent of subjects were primarily Spanish speaking. Subjects spent a mean time in the USA of approximately 23 years. When measuring time in the US and country of origin there was no difference between groups in the decision making process.
Conclusions: Latino patients regardless of country of origin or time in the US were similar in acceptance or decline of life sustaining therapy. Future work should be done with focus groups to identify relevant cultural factors so that physicians can provide a culturally sensitive discussion of advance care plans. Limitations: There is always the potential for referral bias in that the patients willing to participate in the survey may have differed from the non-responders

14 The Epidemiology of Search and Rescue Incidents in the Grand Canyon National Park: Are Preventive Measures Making a Difference?

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Introduction: Grand Canyon National Park (GCNP) has more than four million visitors each year. Each year the park's Search and Rescue (SAR) office responds to more than 400 calls for help. In 1998 in response to this large number of incidents, the park employed a Preventive Search and Rescue (PSAR) program with the aim of decreasing the number of preventable incidents within its boundaries.
Objectives: The goals of this project are to create a comprehensive data base of GCNP SAR incidents that the park may continue to use and to quantify the effect that the preventive program has had on the number and types of these incidents.
Methods: We performed a retrospective review of GCNP SAR incident reports and corresponding emergency medical service reports from 1988 to 2005. For SAR incidents with multiple patients with different injury types, each patient was recorded as a discrete observation. For each observation 23 variables were recorded, including patient age and sex, type and geographical location of incident, mechanism and type of injury or illness, and extent and cost of SAR involvement. The data was compared using a tow-sample T-test.
Results: The data set includes 6843 SAR incidents ranging

from 262 to 474 incidents per year. Visitation during this time ranged from 3.5 million to 4.9 million people per year. The average number of SAR incidents per park visitor has decreased from 9.4 incidents per 100,000 visitors in the 10 years prior to 1998 to 7.6 per 100,000 visitors in the six years following (p=0.02).
Conclusions: The Grand Canyon National Park PSAR program seems to have decreased the incidence of visitor illness and injury, thereby decreasing the need for costly and potentially dangerous SAR responses.

15 A Needs-Assessment Questionnaire of Driving Fitness in Older Adults Presenting to the Emergency Department

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Background: Older adults (65 years and older) represent the fastest growing segment of the population. It is projected that by the year 2024 one in four drivers will be older adults. The Emergency Department (ED) may serve as a site for identifying older adults that need driving fitness evaluation and/or related intervention.
Objective: Conduct a needs assessment for driving fitness-related issues in older adults presenting to the ED.
Methods: A cross-sectional survey was conducted with English-speaking older adult patients presenting to a busy Southern California Level 1 Trauma Center and ED over a 10-month period starting February 2006. Inclusion criteria included medically stable older adults. Exclusion criteria included critically ill patients. Data was analyzed by using univariate descriptive analysis.
Results: Out of the 332 patients surveyed, 186 were 65-74 years, 109 were 75-84 years, 35 were 85 years or older and the age for two patients were not recorded. Thirty-six patients had never driven and were only asked for demographic information. When the 296 patients who had driven were asked who they consider the most qualified person to give driving advice, 33% considered their family/spouse, 24% themselves, and 14% the Department of Motor Vehicles. Only 1% felt the ED physician was the most qualified person to give driving advice. Among the 196 who currently drive, 61% would rate their driving confidence to be at 10 out of 10, 83% would limit their driving, 77% would stop driving if asked by a physician, and 43% would like the ED to refer them for further help with their driving.
Conclusion: Although the majority of patients were highly confident in their driving ability, nearly four out of five patients reported that they would be willing to limit and stop driving per physician recommendation. The discrepancy between the patients' confidence and their willingness to accept driving advice from physicians provides an opportunity for further driving-fitness research.

16 Patient Satisfaction with Routine Rapid HIV Testing in an Urban Emergency Department Using Streamlined Procedures and Pre-Existing Staff for Testing and Counseling

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Objective: To determine patient satisfaction with a voluntary rapid HIV testing program in an urban emergency department (ED).
Methods: Prospective observational study conducted in an urban academic ED. Between April 1, 2005 and March 31, 2006, nursing-initiated HIV screening was offered to eligible patients, beginning with the triage nurse. Exclusions were: age <12 years; acute psychiatric or medical illness and language barrier. Pre-test HIV information and counseling was provided in a brochure. Nurses obtained bedside written informed consent, performed the test (OraQuick Advance, oral swab) and disclosed negative results. For positive patients, emergency physicians or HIV counselors performed counseling and arranged follow-up care. Testing was performed and negative results were disclosed in both private and non-private clinical areas (curtained rooms, hallways), while positive results were disclosed in private rooms. After result disclosure, a satisfaction survey was administered to patients testing preliminary positive and to a convenience sample of patients testing negative. Patients were asked whether or not they felt HIV testing and disclosure was done in a private manner and to rate their overall satisfaction with testing on a 5-point scale.
Results: 6,381 HIV tests were performed with a 1% positivity rate. Fifty-seven of the 65 preliminary positive patients completed the survey (88%). One-hundred and five of the 178 patients testing negative who were approached completed the survey (59%). One-hunred percent (57/57) of patients testing preliminary positive and 99% (104/105) of those testing negative reported overall satisfaction with testing (p=0.50); 96% (55/57) of patients testing preliminary positive and 91% (96/105) of those testing negative felt that their results were disclosed in a private manner (p=0.22).
Conclusions: Perception of privacy was maintained despite testing and disclosure of negative results in a variety of clinical areas. Overall, patients are satisfied with streamlined ED testing procedures.

17 Evaluation of the Use of the TASER and Elevated Force to Control Workplace Violence in a Health Care Environment

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Background: Violent behavior by patients is one of many occupational hazards faced by health care workers. Emergency department (ED) personnel are at high risk for patients carrying weapons, or exhibiting disruptive behavior or psychotic disorders. When systematic approaches to violent persons do not work, public safety officers (PSO) require additional means of elevated force to control dangerous behavior. The use of the electrical stun gun (TASER) offers an option that is more effective than baton but less lethal than a firearm. Its use has recently been criticized because of the association with deaths in custody.
Methods: We describe an approach to control workplace violence in a health care environment that includes staff education for early identification of potentially violent persons and initial approaches but allows for the use of TASER in select situations. We report the incidents of use of force in a Level 1 trauma center university hospital with 40,000 ED census.
Results: There were 107 PRE (12 month) and 149 POST (24 month) uses of force. During the POST, 92% were in clinical, 5 % in general public and 3% in exterior areas. Most involved patients (93%). In clinical areas, 56% were in the ED, 25 % inpatient and 11% outpatient areas. There were 30 displays and seven additional uses of the TASER, including two touches and five firings of probes, 77% for male subjects and 70% for psychiatric or ED patients. All displays or uses were reviewed in detail by multidisciplinary group and determined to be appropriate. There were no serious injuries in either safety personnel or patients that resulted from the use of the TASER. PSOs determined that the display of the TASER was able to de-escalate violent situations without the use of more elevated force.
Conclusions: A comprehensive approach to workplace violence that allows for the selected use of the TASER and requires mandatory reviews of all uses can be effectively implemented to help to control dangerous situations in heath care environments.

18 Risk Perception of US-Mexico Border Crossers

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Background: This study focused on risk perception of US-Mexico border crossers and builds on current research programs at The University of Arizona. No published studies have addressed specific risk processes (defined as perceived risk, intra-border crosser risk communications, Mexican government originated risk communications, and risk control actions) in US-Mexico border crossers.
Objectives: This project seeks to describe, analyze, and interpret border-crosser risk processes; and develop a multidimensional model to describe border-crosser perceived risk and risk communications. Additionally, the main motivation for crossing will be investigated.
Methods: The project used rigorously coded qualitative but anonymous interview data obtained from up to 10 recent border-crossers to elicit information about domains of perceived risk and risk communications that can be incorporated into a proposed model and used for future research and refinement of border-crosser behavior models. Because of the qualitative design, thematic saturation occurred before 10 subjects were entered. Interview data were translated from Spanish to English and data extracted in an attempt to reach thematic saturation.
Results: A model of risk processes was created and suggestions for future behavioral interventions to reduce border crosser heat and injury related morbidity and mortality are presented.
Conclusions: Risk perception of US-Mexico border-crossers can be modeled using a qualitative methodology. Themes derived that were most important included desires of border-crossers to be re-united with family members living in the US regardless of risk and the state of limbo of recently deported border crossers.

19 Behaviors that Influence Crash Injury Risk in Latino Adolescent Males: Analysis of the 2005 National Youth Risk Behavior Survey (YRBS)

Federico Vaca, MD, MPH; Craig Anderson, PhD.
University of California, Irvine

Objective: Motor vehicle crashes remain the leading cause of death for teens. Risk-taking behavior is known to contribute to fatal crashes in young drivers and occupants. The objective of this study was to analyze behaviors that influence the risk of crash injury in Latino adolescent males.
Method: The Youth Risk Behavior Survey (YRBS) is a multistage cluster sample of students in U.S. public and private high schools, with oversampling of Hispanics. Among other risk behavior topics, three questions are directly related to motor vehicle occupant crash injuries: use of seat belts, riding with a driver who had been drinking, and driving when drinking. Analysis was restricted to Hispanic and non-Hispanic Whites age ≥15 (n=8,520). Data were analyzed using Stata survey procedures that account for survey weights and clustering. Differences between groups were tested using linear regression, controlling for age, with post-estimation

tests to compare Hispanic males to Hispanic females and to non-Hispanic White males.
Results: Thirteen percent of male Hispanics in this age group reported that they rarely or never wore a seat belt. The percentage of those who rarely or never wore a seat belt was 4% higher for male Hispanics than for female Hispanics. Thirty-eight percent of male Hispanics age 15-18 years reported riding in the preceding 30 days with a driver who had been drinking (35% of those 15 yrs, 42% of those 18 yrs). The percent who rode with a drinking driver was 11% higher for male Hispanics than for male non-Hispanics. Fifteen percent of male Hispanics reported driving when drinking in the preceding 30 days (9% of 15 yrs. and 24% of 18 yrs). The percent who drove when drinking was 8% higher for male Hispanics than for female Hispanic.
Conclusion: While Latino adolescent males are subjected to the risk of crash injury by their own behavior, the data suggests that they are also subjected to significant risk by their willingness to ride with impaired drivers. These findings have implications for ED-based interventions.

20 Determining the Quality of Comprehensive Care for Non-Traumatic Chest Pain through a Composite Measure

Christopher Colwell, MD; Phillip Mehler, MD; Allison Sabel, MD; Justin Harper, EMT-P; Luke Johnson; Lisa Cassell, MS.
Denver Paramedic Division, Denver Health and Hospitals,Denver, Colorado; University of Colorado at Denver and Health Sciences Center, Denver, Colorado

Background: Comprehensive care for non-traumatic chest pain is becoming increasingly important as a quality indicator for the inpatient setting. These quality measures, which are based on evidence-based guidelines that improve patient outcomes, have not been extended to the pre-hospital arena. Previous studies have indicated that pre-hospital care providers may not adequately utilize aspirin for patients with cardiac ischemia[1]. A potential cause of this oversight could be a lack of appreciation of a cardiac cause to chest pain.
Objective: To determine how well paramedics in an urban, public hospital system delivered high quality care for patients with non-traumatic chest pain.
Methods: Patients with a primary complaint of non-traumatic chest pain between January and March of 2006 were systematically randomized and a retrospective audit was completed. Seven parameters were identified by the medical direction of the Denver Health Paramedic Division. A composite metric was created to assess comprehensiveness of care. The bundle score was considered unmet if any single variable was not present.
Results: Two-hundred and ninety-two patient care reports were evaluated. Overall, 95.4% of the patients were provided with oxygen, 61.2% were given aspirin, 98.6% had lung sounds assessed, 99.7% had vital signs recorded, 85.8% had an IV established, 93.0% received an ECG, and 78.1% were assessed for cardiac risk factors. The overall composite measure was met in 36.5% of the patients. The bundle score ranged from 22.0% in patients 20-39 years old to 42.0% in patients older than 50 years.
Conclusions: In the pre-hospital setting, there was good adherence to individual metrics yet poor adherence to the composite measure. Future studies are needed to determine appropriateness of certain interventions on medical chest pain patients and the implications of the composite intervention on optimizing outcome.
1. McVaney K, Macht M, Colwell C, Pons P. Treatment of suspected cardiac ischemia with aspirin by paramedics in an urban emergency medical services system. *Pre-hospital Emergency Care*. 2005; 9:282-284.

21 Analysis of Ambulance Response for Patients with Medical Chest Pain Based on the Severity of Potential Cardiac Symptoms

Christopher Colwell, MD; Phillip Mehler, MD; Allison Sabel, MD; Justin Harper, EMT-P, Luke Johnson; Lisa Cassell, MS.
Denver Paramedic Division, Denver Health and Hospitals,Denver, Colorado; University of Colorado at Denver and Health Sciences Center, Denver, Colorado

Background: When patients call 911 with a complaint of chest pain, they generally receive an ambulance responding emergently. However, less than 10% of these calls result in an emergent return to the hospital. Studies have shown that emergent response whether to or from a scene results in an increase in ambulance accidents and litigation[1].
Objective: To determine if the implementation of an EMD (Emergency Medical Dispatch) system resulted in a decrease in emergent responses to the source of the 911 call.
Methods: This study is based on a retrospective audit of non-traumatic chest pain calls. A pre-post intervention design was used with the EMD system going into effect on July 1, 2006. Baseline data obtained from the first and third quarter of 2006 represented the post-EMD intervention. Systematic randomization was used within each quarter to select the cases. Calls were identified as being chest pain in nature because of the type of patient that the healthcare provider noted in the patient care report.
Results: Out of the 292 patient care reports reviewed in the first quarter, 262 of the calls (89.7%) were responded to emergently. However, none of these calls (0%) returned to a hospital emergently. From the third quarter, 296 cases were reviewed. Outgoing emergent responses were used in 242

calls (81.7%) and 21 calls (7.1%) returned emergently to a hospital.
Conclusions: Patients complaining of medical chest pain often do not need an outgoing emergent response. Further understanding of when an emergent response is necessary for the patients complaining of non-traumatic chest pain will help to maintain quality patient care and improve the safety of both the pre-hospital care providers as well as the general public.
1. Colwell C, Pons PT, Balanchet J, Mangino C. Claims against an ambulance service: a ten year period. *J Emerg Med.* 1999; 17:999-1002.

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California American College of Emergency Physicians Research Forum Abstracts

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The following abstracts, which are published here with author permission, were presented at the 36th Annual California American College of Emergency Physicians Scientific Assembly held from May 31, 2007 to June 2, 2007 in Newport Beach, CA.

1 Subclavian Central Line Misplacement: Is it Needle Bevel or Guidewire Direction that Influences Line Placement?

Jacqueline Le, MD; Peter Jin, MS; Gregory Guldner, MD, MS
Loma Linda University Medical Center, Loma Linda, CA

Objective: To determine whether it is the direction of the needle bevel, J-tip guidewire, or both that influences the direction of the guidewire in subclavian central line placement.
Methods: A total of 1,200 trials were performed using a plastic tubular model simulating the subclavian, IJV, and SCV junction. The trials were divided into six groups: needle bevel pointed upwards with J-tip directed upwards (n=200) or J-tip directed downwards (n=200), needle bevel pointed downwards with J-tip directed upwards (n=200), or J-tip directed downwards (n=200), and needle bevel position blinded to experimenter with J-tip directed upwards (n=200), or J-tip directed downwards (n=200). Twenty-eight textbooks were also referenced to see what is instructed regarding needle bevel and J-tip positioning in central line placement.
Results: The ultimate direction of the guidewire (up towards the IJV versus down towards the SVC) was entirely dependent on the direction of the J-tip guidewire regardless of needle bevel position in 100% of the trials. The guidewire was directed upwards when the J-tip was oriented upwards and directed downwards when the J-tip was oriented downwards. Ten (36%) of the textbooks we referenced commented on needle bevel orientation whereas only one (3.6%) mentioned J-tip direction. Eighteen (64%) of the textbooks did not mention any recommendations regarding needle bevel or J-tip direction.
Conclusions: Current educational resources that teach subclavian line placement overemphasize the importance of needle bevel direction and fail to mention the much more influential issue of the direction of the guidewire J-tip.

2 Evaluation and Feedback of Medical Students Rotating in Emergency Medicine: A Model for Comprehensive Evaluation and Swift Feedback

Kenny Banh, MD; Lori Weichenthal, MD; Brandy Snowden, MPH
UCSF-Fresno, University Medical Center

Objectives: Evaluating and providing quality feedback to medical students who rotate through the emergency department (ED) can often prove difficult. Unlike many medical school rotations, where students work with a set team of residents and faculty for a month or longer, in the ED students tend to have sporadic exposure to a broad range of physicians. This makes obtaining consistent and meaningful feedback challenging. We hypothesized that by implementing daily written evaluations and utilizing these to give formal mid- and end-rotation feedback, rotating students would have better interaction and evaluation from faculty and receive more useful and timely feedback.
Methods: Starting in the 2006 academic year, we implemented written evaluations of medical students each shift. Formal constructive feedback sessions were arranged mid- and end-clerkship. Surveys evaluating students satisfaction with feedback were compared to 2005. Additionally, surveys of evaluation and feedback satisfaction from medical students and clerkship directors were collected nationwide.
Results: A significant portion of the 60 students and 53 directors surveyed believe there is inadequate evaluation (36.7% and 45.3% respectively) as well as feedback (31.7% and 41.5% respectively) in emergency medicine clerkships.

The 24 medical students that completed a clerkship in EM at UCSF-Fresno during the 2006 academic year rated their experience of receiving adequate feedback higher than the 20 medical students that rotated in 2005 (mean of 5.96 versus 5.15, p=.010). The 2006 students stated that they were highly satisfied with their standardized daily written evaluations (94.1%) and the entire feedback process (94.1%).
Conclusions: The use of daily written evaluations and a mid-rotation formal constructive feedback session improves student perception of receiving adequate feedback. Evaluation and feedback in emergency medicine are perceived as problems by a significant number of both medical students and clerkship directors.

3 Utilization of the Rapid HIV Test in the Emergency Department

Patricia Kahn, DO, MPH; Rodney Borger, MD; Dorian Snyder, MD; Prentice Tom, MD
Arrowhead Regional Medical Center, Colton, CA

Overview: A patient's HIV status can be critical to the quality of their care in the Emergency Department (ED). A majority of hospitals utilize the standard Enzyme Immunoassay (EIA), with confirmation by the Indirect Fluorescent Antibody (IFA). Both of these tests are time consuming and expensive. A rapid HIV test is currently available for use. Many studies have proven sensitivity and specificity of the test, its cost efficiency and preference by patients, resulting in increased testing, early detection and improved patient care. An extensive literature review was completed utilizing the resources from the Centers for Disease Control (CDC) and PubMed, the database for the National Library of Medicine and the National Institutes of Health. In current research, no studies have assessed whether ED physicians are aware of the test, utilize it, or would utilize it if it were available. It is also unknown whether the availability of this test would change their treatment of a patient in the ED, and if so, what cases.
Objectives: 1. Determine the availability of an ED rapid HIV test. 2. Ascertain whether ED physicians would utilize a rapid HIV test. 3. Identify the most common situations in which an ED physician would utilize the rapid HIV test. 4. Determine reasons an ED physician may not use a rapid HIV test in appropriate patients.
Methods: Study Design: Survey sent via electronic mail. **Participants:** Emergency physicians and midlevel providers practicing in emergency departments in California. Timeline: March, 2007. Data Collection and Analysis: SurveyMonkey electronic survey service.
Results: Approximately 1200 practitioners were surveyed with 214 responses for an 18% response rate. The geographical variables showed 72% of the respondents were physicians, 25% physician assistants. The size of the ED was well distributed; half of the EDs reported an annual census of less than 50,000 and the other half a census of 50,000 or longer. Private hospitals were more strongly represented than county facilities at 82% of respondents. A majority of respondents, 84%, do not have the rapid HIV test available to them in the ED. In response to the survey questions, 73% of respondents said they would use a rapid HIV test if it were available, and 53% stated it was difficult to follow up on positive results after the patient is discharged. Currently, 80% said it takes greater than 24 hours to get HIV results. Over half of the respondents stated availability of a rapid HIV test would change their treatment of sexually transmitted diseases, headache, pneumonia and late presentation pregnancy. When asked why they might not use the test, 77% chose post-test counseling.
Conclusions: In our study, a majority of emergency medicine practitioners do not have a rapid HIV test available to them. The test currently available to them does not give results within a 24-hour time frame, and it is difficult to follow up on positive results in their patient population. Practitioners would use the test if it was available to them, and they would consider testing patients with pneumonia, sexually transmitted diseases, headache and late presentation pregnancy.

4 In-car Airway Options for NASCAR Drivers

Jonathan Q. Dyreyes, MD; Jeff Grange, MD; Dustin Smith, MD; Peter Jin, MS; Greg Guldner, MD
Loma Linda University Medical Center, Loma Linda,CA

Background: "Stock car" drivers may require an emergency airway while still helmeted in their vehicle.
Objective: Determine the feasibility of various airway methods utilizing a trapped, helmeted, and apneic stock car driver simulation model.
Methods: Using a NASCAR race vehicle a manikin (Laerdel's Sim-Man) was placed in the driver's seat with a HANS device and typical closed face helmet. Airway options included: bag-valve-mask, laryngeal mask airway, intubating LMA, Combitube, digital intubation, Melker® cricothyrotomy kit, Quicktrach®kit, Pertrach® kit, open cricothyrotomy and a "trumpet airway device" (TAD - a nasal trumpet airway with a 5.5 endotracheal tube lodged in the lumen of the nasal trumpet and used as an extension to a bag valve mask device). Two board certified emergency physicians experienced in motorsports medicine and one senior emergency medicine resident physician attempted to implement each airway method. Each physician independently attempted to use each airway method while accessing the manikin via the driver's side window without removing the helmet or HANS device. The physicians were given 20 minutes to determine if each method was

possible. If none of the physicians could implement a method it was considered non-feasible. If any of the physicians could implement the technique it was considered feasible. Implementation was defined as creating chest rise during a ventilation attempt.
Results: No method other than the TAD could be implemented due to a lack of access to the oropharynx. The TAD could be placed but did not produce significant chest rise.
Conclusion: Most standard airway techniques are not viable in trapped drivers with closed face helmets. The trumpet airway device may help oxygenate such drivers, however, adequate ventilation using this device should be further studied. Motorsports medical personnel should focus on basic airway maneuvers and rapid extrication with helmet removal rather than wasting valuable time attempting more advanced airways in drivers with full face helmets trapped in their race cars.
This project was supported by a grant from the Glen Helen Raceway/Chaparral Motorsports Emergency Trauma Care Fund. Special thanks to Richard Petty Driving Experience and California Speedway for use of the car and venue for this important study.

5 Survey of State Licensure Boards Regarding Inter-state Practice of Sports Medicine

Julia Wang, MD[1]; Rick McPheeters, MD[2]; Daniel Vigil,MD[3]
[1,2] Kern Medical Center, Bakersfield, CA; [3]Kaiser Permanente, Los Angeles, CA.

Purpose: State licensure boards assure the public health, safety, and welfare of their state by providing licensure and regulation of physicians. In the field of sports medicine, duties of team physicians may include traveling out of state with their teams and practicing medicine. Currently, the certification of sports medicine does not address inter-state practice of medicine. The purpose of this study is to see if state licensure boards have addressed this inter-state practice of medicine which is inherent in sports medicine.
Methods: This is an observational study using survey forms sent to each of the 50 state licensure boards. The primary question was whether the state had a provision which addresses the ability of an out-of-state physician to assess and treat a contracted athlete, club, or team while they are in that state. Additional questions addressed the type of provision, limitations and regulations, and means of access. Three separate mailings were made over a total of six months.
Results: Thirty-five out of 50 states responded; 20 states have no provision and require full state licensure for the practice of medicine within their state. One State had no provision, but specifically stated the allowance of visiting team physicians as a courtesy. Fourteen States have some form of provision: within their licensure statute (6), a temporary or emergency license (4), a special event license (2), or a temporary license requiring in-state-physician supervision (2). Thirteen of these states provided further information through websites.
Conclusion: This survey demonstrates that there is no uniform policy regarding the practice of inter-state sports medicine since there are both states with licensure provisions allowing for out-of-state team physicians, as well as states which strictly require in-state licensure. Since only 28% of states have confirmed they allow out of state practice of sports medicine, this is a significant problem. It will only grow worse if not addressed as interstate travel becomes increasingly necessary due to the expansionary nature of national sporting leagues and rise in popularity of younger leagues. This study also reveals that states without provisions in their original medical practice act have in recent years created addendums allowing for event licensure and temporary licensure. These findings encourage us to push for legislative action to allow sports medicine physicians the privilege of inter-state practice of medicine. In the words of our honorable colleagues in North Carolina, "a bill may be proposed in legislative session."

6 Comparing the Evaluations of a Case-Based Reasoning Decision Support Tool by a Single Expert Reviewer with Those of End Users.

Paul Walsh[1,2], Caleb Thompson[1], Dónal Doyle[3], Pádraig Cunningham[3]
[1] Kern Medical Center Bakersfield, CA; [2]David Geffen School of Medicine at University of California, Los Angeles [3]University College, Dublin, Ireland.

Background: The development of decision support tools (DST) requires end-users feedback. This is labor intensive and logistically difficult. These difficulties would be eased if the evaluation of a single expert evaluator accurately reflected that of the end users.
Objective: To determine the agreement between physician evaluation of the performance of a case-based reasoning (CBR) DST with that of a single expert reviewer
Methods: Ten EPs and three midlevel providers were presented with the results of a CBR-based DST designed to predict disposition of children presenting to the ED with bronchiolitis. Each evaluated the predicted disposition, explanatory case, and explanatory dialogue generated by the software using a five-point descriptive scale. The expert reviewer relied on case notes and was blinded to actual disposition. Agreement was measured using the kappa statistic.
Results: The case notes and DST output of 109 patients were evaluated. Where the end user and expert evaluator agreed

on the need for admission, agreement on the DST's prediction of disposition was 88.2% (expected 70.6%) κ 0.585 p< 0.001. Where the reviewer and end user disagreed on disposition, agreement was 61.7% (expected 62.6%) κ -0.026 p=NS. There was only fair agreement on the value of explanation case provided by the software (observed 69.5% (expected 56.7%) κ 0.296 p <0.001). Agreement on the usefulness of the explanatory dialogue was poor of 61.6% (expected 55.4%), κ 0.139 p=0.07.
Conclusions: A single reviewer had moderate agreement with end users when evaluating a DST's predicted disposition. Agreement decreased as the subjectivity of the components being evaluated increased.

7 Pediatric Respiratory Infectious Disease Analysis: UTM-RT versus Flocked Swab Nasal Collections

Paul Walsh[1], Christina Lim Overmyer[2], Larisa Gofman[2], Tuan Anh Nguyen[1], Scott Michaelson[1], James Pusavat[1], Lisa DeSalvia[2], Diana Gonzalez[2], Melanie Feola[2], K. Anthony Nguyen[1], Kathryn T. Iacono[2], Eli Mordechai[2], Martin E. Adelson[2]
[1] Kern Medical Center, Department of Emergency Medicine Bakersfield, CA; [2]Department of Research and Development, Medical Diagnostic Laboratories, LLC, Hamilton, NJ 08690

Background: The collection of anterior nasal washings using saline and a suction bulb has become a standard method for obtaining specimens. Nasopharyngeal swabs and washings are invasive. We measured the agreement for pathogen RNA/DNA detection by PCR between anterior nasal swabs and anterior nasal washings.
Methods: Informed consent was obtained. Children up to 18 months of age with a clinical indication for RSV antigen testing were enrolled. A flocked swab was placed in 25 mm inside the nares and immediately placed in a tube containing 1 ml of UTM-RT. Nasal washings were obtained from the opposite nostril of which 0.5 ml was placed in 0.5 ml of UTM-RT. The side and order in which these were obtained was randomly assigned. The samples were stored at 4°C prior to being frozen to –20°C. Aliquots of the UTM-RT were extracted for DNA (Corbett Robotics X-Tractor Gene System) and RNA (Qiagen QIAmp Viral RNA Isolation Kit). DNA extractions were assayed for *Bordetella pertussis* (B. para) and *Bordetella parapertussis* (B. pert) by Real-Time PCR; RNA was assayed for RSV A, human metapneumovirus (hMPV), Influenza A (INF A), and Influenza B (INF B) by reverse transcriptase PCR (either conventional or real-time). Agreement between collection methods was measured with the kappa statistic using Stata 9.2 statistical software.
Results: Ninety-eight patients were enrolled. Agreement between swab and washing for the for RSV-A, hMPV and the detection of any pathogen was substantial at 90.8% (expected 72.0%, κ 0.67, p<0.001) and almost perfect at 99.0% (expected 77.7%, κ 0.95, p<0.001) respectively. The agreement for the presence of any agent was substantial at 88.5% (expected 55.3% κ 0.74, p<0.001). The results of the testing are summarized below:

	hMPV	RSV A	INF A	INF B	B para	B pert
Washings (%)	13 (13.3)	15 (15.3)	2 (2.0)	2 (2.0)	0	0
Swab (%)	12 (12.2)	18 (18.4)	2 (2.0)	6 (6.0)	0	0

Conclusion: We found substantial agreement between anterior nasal washings and swabs for pathogen detection by PCR in this small sample of infants and toddlers taken early in our bronchiolitis season. Flocked swab collection method appears to yield greater detection for INF B and RSV A. However, a larger sample size will be required for a more thorough evaluation of the efficacy of the specimen collection methods.

8 Predicting Complications in Older Adults with Blunt Chest Trauma

S. Kaku, M. Menchine, C. Patel, F. Vaca, C. Anderson M. Lekawa, M. Dolich, S. Lotfipour
University of California, Irvine, Orange, CA

Background: Pulmonary complications increase morbidity and mortality in elderly trauma patients. Little is known about the incidence or variables associated with these adverse events in elderly trauma patients with blunt thoracic injury.
Objective: To determine the prevalence of adverse events in elderly trauma patients with blunt thoracic trauma and to identify variables associated with these adverse events.
Methods: We performed an explicit chart review of 160 trauma patients over age 65 with significant blunt thoracic trauma. Cases were identified from the UCI trauma registry, a prospective data collection instrument. From this registry charts were systematically reviewed using an explicit data extraction tool. We excluded patients with serious injury to other body areas (abbreviated injury score ≥ 3) as this confounds the cause of the adverse events. This left a total of 99 patients for analysis. Data collected included patient historical information, physical examination features, radiologic exam findings, length of hospital stay, and clinical outcomes. Adverse events of interest were the development of ARDS or pneumonia, unanticipated intubation, transfer to the ICU for hypoxemia, or death. Data were analyzed with Stata 9.0.
Results: Sixteen of the 99 patients developed one of the five pre-defined adverse events of interest (16.2% CI 9.5-24.9%) including two deaths. 19.2% of those 65-74 experienced an adverse outcome, 6.1% of those 75-84 experienced an adverse outcome, and 28.6% of those over 85 experienced an adverse outcome. All patients were admitted. The mean LOS was 5.8

days in patients without an adverse outcome and 14.6 days in the group with an adverse outcome. Post hoc data analysis revealed that the presence of any one or more of the following: age≥85, initial systolic blood pressure < 90, hemothorax, pneumothorax, three or more unilateral rib fractures, or pulmonary contusion on chest radiograph identified all 16 cases that developed an adverse outcome (sensitivity 100% CI 79.4100%, specificity 38.6% CI 28.1-49.9%).

Conclusion: Adverse events from isolated thoracic trauma in elderly patients complicate 16% of cases in our sample. A simple set of criteria based on advanced age, vital signs and CXR findings was 100% sensitive and 38.5% specific at predicting the development of these adverse events. Absence of these findings may identify patients at sufficiently low risk for serious adverse outcome that they do not require admission. Further prospective studies will be required to validate these criteria and they should not be used to change routine clinical practice at this time.

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SAEM Western Regional Research Forum and Medical Student Forum
Meeting Announcement and Call for Abstracts
Friday, March 28th - Saturday, March 29th, 2008
University of California, Irvine
Costa Mesa, CA

SAEM is pleased to announce the 10th annual meeting of the Western Regional Research Forum. This meeting is an excellent opportunity for medical students, residents, fellows and junior faculty to present their research. Abstracts from senior faculty are also welcome, of course. All accepted abstracts will be presented as mini-oral presentations.

In addition to presentation of original research and a relevant keynote address, the meeting will include didactic sessions focused on research funding and medical writing.

There will be an optional hands-on workshop on basic ultrasound techniques, taught by Dr. J. Christian Fox along with UC Irvine Faculty.

A half-day Medical Student Forum will include discussions on how to select a residency program and make one's application as competitive as possible. In addition, students will have ample opportunity to speak informally with residency directors from throughout the Western United States.

The venue of the Wyndham Orange County in Costa Mesa, California, is adjacent to South Coast Plaza, one of the world's premier shopping destinations, as well as the Orange County Performing Arts Center. The conference will run from noon on Friday through Saturday afternoon, leaving time to explore shopping, the adjacent beaches, nearby attractions in the Disneyland Resort, and all that Southern California has to offer.

Please direct any questions to Mark I. Langdorf, MD, MHPE, FACEP, FAAEM, RDMS at milangdo@uci.edu or call (714) 456-5239.

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University of California, Irvine, Department of Emergency Medicine is seeking an HS Clinical Instructor for July, 2008. UC Irvine Medical Center is a Level I Trauma center with 2200 runs/year, 40,000 ED census. The fellowship in Emergency Medical Services and Disaster Medicine, beginning July 1, 2008, combines the traditional emphasis on EMS research with the disciplines of emergency management/disaster medicine and public health. A key focus of the fellowship is health policy and health services systems research including mass casualty management and triage. Completion of American Council of Graduate Medical Education (ACGME) accredited Emergency Medicine Residency required prior to start. The two-year combined program, with an integrated Masters of Public Health, will be jointly administered by Director, EMS and Disaster Medicine. Salary commensurate with level of clinical work. Send CV, statement of interest and three letters of recommendation to:

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Federico Vaca, MD, MPH, FACEP
Department of Emergency Medicine
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101 The City Dr, Route 128-01
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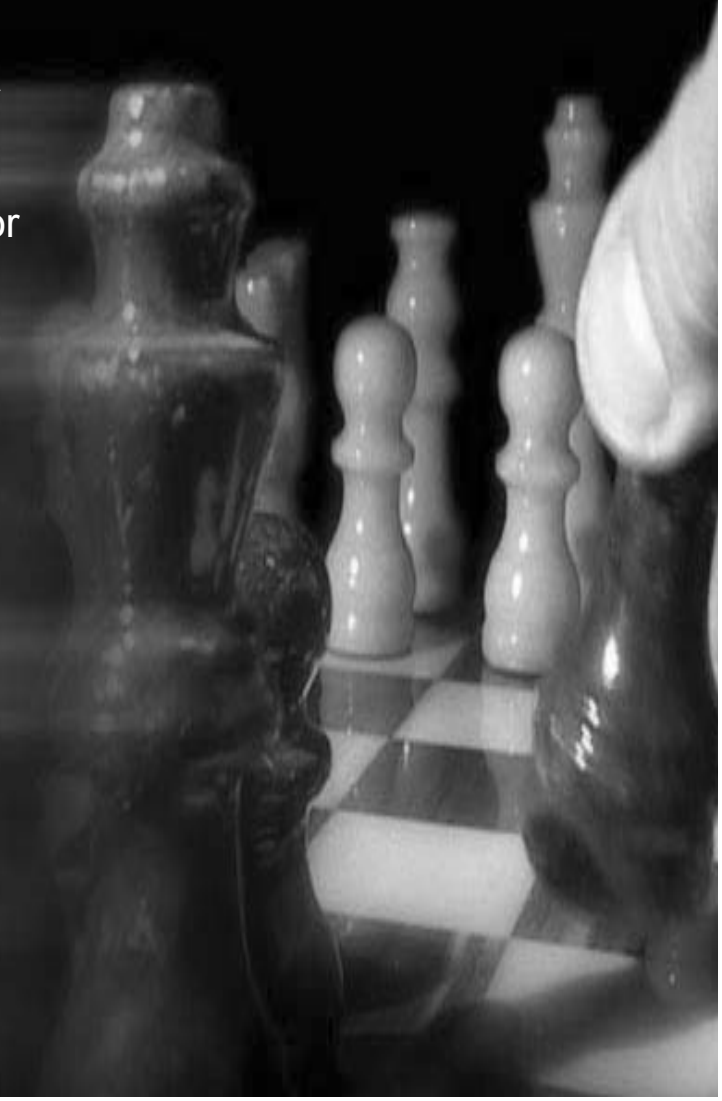

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