

A Survey of Bedside Ultrasound Use by Emergency Physicians in California

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Objective. The purpose of this study was to investigate the current practice of emergency physician-performed bedside ultrasound examinations in California and to assess differences between academic and community practice. **Methods.** We queried all emergency departments (EDs) in California to determine whether bedside ultrasound was used by emergency physicians. Among EDs that were using bedside ultrasound, we administered a survey to assess use patterns, credentialing criteria, and quality assurance (QA) programs. **Results.** We contacted all eligible EDs ($n = 293$) by telephone and had a 100% response rate for our primary question: 101 EDs (34%) reported use of bedside ultrasound. Of these 101 EDs, 97 (96%) responded to the secondary survey, showing the following: (1) 48% of physicians at each site were credentialed to use ultrasound in at least 1 modality; (2) 70% of EDs used American College of Emergency Physicians (ACEP) criteria for credentialing guidelines; and (3) 33% had an ultrasound QA program. Comparing practice settings, 68% of academic departments used bedside ultrasound compared with 29% of community departments (difference, 39%; 95% confidence interval [CI], 23% to 54%; $P < .0001$). In academic departments, a mean of 60% of physicians were credentialed, compared with 41% in community EDs (difference, 19%; 95% CI, 2.5% to 35%; $P = .036$). **Conclusions.** Most California EDs do not use bedside ultrasound. Although most EDs using ultrasound report that they follow ACEP emergency ultrasound guidelines, most do not have a QA program as recommended by these guidelines. Compared with community EDs, academic EDs are more likely to use bedside ultrasound, have physicians credentialed in ultrasound use, and have QA programs. **Key words:** bedside ultrasound; emergency medicine; emergency physicians.

Abbreviations

ACEP, American College of Emergency Physicians; AIUM, American Institute of Ultrasound in Medicine; AMA, American Medical Association; CI, confidence interval; ED, emergency department; FAST, focused assessment with sonography for trauma; OSHPD, Office of Statewide Health Planning and Development; QA, quality assurance

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The use of bedside ultrasound by emergency physicians has grown substantially over the last 2 decades.¹ With the increased use of this technology, the American College of Emergency Physicians (ACEP), the Society of Academic Emergency Physicians, the American Institute of Ultrasound in Medicine (AIUM), and the American Medical Association (AMA) have developed policy statements outlining the use of and training for bedside ultrasound.²⁻⁵ Sample curricula and guidelines for credentialing and implementation have been widely disseminated.^{6,7} As a result, bedside ultrasound has been extensively incorporated into the academic emergency medicine environment, with more than 95% of residency programs teaching sonography in 2003 and 92% reporting 24-hour availability of bedside ultrasound by academic emergency physicians.^{8,9} In fact, ultrasound training is now a mandate of the Residency Review Committee of the Accreditation Council for Graduate Medical Education for the training of emergency physicians.

Academic settings account for only a small percentage of the total number of emergency departments (EDs) in the country. There are scant data about the diffusion of bedside ultrasound into nonacademic emergency medicine settings.^{9,10} Only 1 study, reported in 2006, attempted to assess the prevalence of emergency physician-performed ultrasound examinations in community EDs in the United States, and its findings suggested that only 19% of such EDs had an ultrasound machine available at all times; the remaining had limited to no availability of bedside ultrasound.¹⁰ That survey, however, was limited by a low response rate (60%) and the attendant broad confidence intervals (CIs) around point estimates for the use of ultrasound. No data were obtained with regard to credentialing policies, the number of physicians performing ultrasound examinations in each ED, or quality assurance (QA) programs in these community EDs.

In this study, we performed a survey of all California EDs to determine the availability and use of bedside ultrasound in both academic and community centers in an attempt to begin to characterize how ultrasound is being used in the current ED environment. We collected descriptive statistics about the prevalence of this technology as well as information about the types of credentialing guidelines used and whether national guidelines were being followed consistently. Finally, we sought to identify and describe differences between academic and community EDs with respect to the overall use of ultrasound, the proportion of physicians credentialed, and the use of QA programs.

Materials and Methods

Study Design

We conducted a cross-sectional telephone survey of all EDs in California to determine the following: (1) the prevalence of emergency physician-performed bedside ultrasound examinations; and (2) the types of examinations being performed and the credentialing, billing, and QA processes among EDs that reported use of bedside ultrasound. Data were collected from spring 2006 to autumn 2007.

Study Setting and Participants

This study was conducted by the University of California, San Francisco. We generated a list of all California EDs from the Office of Statewide Health Planning and Development (OSHPD) database of licensed acute care hospitals in the state. According to the OSHPD's categorization of EDs, we included basic and comprehensive EDs in our study (ie, those providing 24-hour, in-house physician coverage) but excluded standby EDs (ie, those not requiring a physician to be physically present at all times). We also excluded acute psychiatric facilities, chemical dependency recovery hospitals, and state correctional facilities. For the purposes of this study, we defined academic EDs as those that reported training any emergency medicine residents in the ED. This study was approved as exempt by the University of California, San Francisco, Committee on Human Research.

Survey Method and Instruments

Two trained medical student research assistants contacted each ED and spoke with the physician on duty at each of the eligible EDs to answer the primary survey. The primary survey consisted of 2 questions: (1) are there any emergency physicians who perform bedside ultrasound examinations at your facility for any indication; and (2) do you ever train any emergency medicine residents in your ED?

Emergency departments that reported any use of emergency physician-performed bedside ultrasound examinations were eligible for our secondary survey. For the secondary survey, we developed an 8-item questionnaire that was initially prepared by the investigators and subsequently tested and refined by using the survey on several emergency physicians who direct ultrasound programs at their institutions (Appendix 1). The questionnaire was designed to be an initial brief survey so that we could achieve a high response rate.

For EDs that were eligible for the secondary survey, the research assistant requested the contact information for the ultrasound director. In cases in which there was no formal director of ED ultrasound, the research assistant requested the contact information for the physician most knowledgeable with the ED's use of ultrasound.

If no such person was identified, the research assistant requested contact information for the ED director. By arrangement between the research assistant and the ultrasound director or ED director, the secondary survey was administered by telephone, and responses were typed by the research assistants directly into the research database. The research assistants were trained to ask scripted questions to avoid bias. The 8 survey questions assessed the availability of an ultrasound machine, clinical indications for performing bedside ultrasound examinations, the basis for a credentialing process and percentage of emergency physicians credentialed, assessment of the presence of a QA system, and whether billing for bedside ultrasound was performed. The survey also asked participants to predict whether bedside ultrasound use would increase in their departments in the future.

As noted, we attempted to conduct all surveys by telephone. If this was not possible after 3 attempts, we used fax or e-mail to improve the response rate. The faxed or e-mailed responses were subsequently entered into the database.

Primary Data Analysis

Our a priori hypotheses were that academic EDs would have higher rates of ultrasound use, physician credentialing in ultrasound, and QA programs than community EDs. Other analyses should be considered hypothesis generating.

Both survey responses were recorded onto Excel spreadsheets (Microsoft Corporation, Redmond, WA) by the research assistants. Summary and analytic statistics were done with Stata version 10 software (StataCorp, College Station, TX). Comparisons of proportions were calculated with χ^2 tests, and comparisons of means were calculated with *t* tests for parametric continuous measures and Wilcoxon rank sum tests for nonparametric continuous measures. Differences between groups are reported with 95% CIs. Our a priori definition of α was .05, according to standard conventions.

Results

According to OSHPD 2003 records, there were a total of 323 EDs in California that potentially met our inclusion criteria. On telephone inquiry, 9 of

those hospitals lacked an ED; 10 hospitals had been closed or had their patient services suspended; and 11 of the entries were repeated within the database, creating a survey population of 293 EDs for our primary survey. We surveyed all eligible EDs and had a 100% response rate to the primary survey ($n = 293$).

Differences in ED characteristics by use of bedside ultrasound are shown in Table 1. Overall, 34% (101 of 293) of California EDs reported using any form of bedside ultrasound by emergency physicians. Bedside ultrasound examinations were performed more often at larger hospitals; EDs using bedside ultrasound had an average of an additional 105 hospital beds (95% CI, 63 to 147; $P < .001$). Bedside ultrasound examinations were performed more often in EDs with higher volumes; EDs using bedside ultrasound had an average of an additional 15,195 emergency visits compared with those not using ultrasound. (95% CI, 10,915 to 19,475; $P < .001$). Correspondingly, bedside ultrasound examinations were performed more often in EDs with a larger number of ED beds; EDs using bedside ultrasound had an average of an additional 7.1 beds (95% CI, 5 to 9; $P < .001$).

Of the 101 EDs that reported using bedside ultrasound, 97 (96%) completed our secondary survey (Table 2). Academic EDs made up 27 of the 97 (28%), and the remaining 72% did not train any emergency medicine residents. Of those responding, 92% reported having access to a machine in the ED at all times; 5% shared an ultrasound machine with the radiology department; 2% reported having a hospital-owned ultrasound machine stationed in the ED at most times; and 1% borrowed a machine from the obstetrics and gynecology department (data not shown).

Most EDs with an ultrasound program (70%) reported using ACEP emergency ultrasound guidelines as the basis for their credentialing. For those who did not report the ACEP as the source of their guidelines, 15% reported creating their own guidelines; 3% used criteria from their radiology department; and 7% stated that they only occasionally used bedside ultrasound and thus did not have a formal system for credentialing. The remaining 5% could not identify the source, if any, of their credentialing policy (data not shown).

Table 1. California Hospital and ED Characteristics and Use of Bedside Ultrasound

Parameter	All EDs (n = 293)	Bedside Ultrasound (n = 101 [34%])	No Ultrasound (n = 192 [66%])
Hospital beds ^a			
<50	18	5 (28)	13 (72)
50–149	85	18 (21)	67 (79)
150–249	81	28 (35)	53 (65)
250–349	42	13 (31)	29 (69)
350–450	40	18 (45)	22 (55)
>450	27	19 (70)	8 (30)
ED visits/y ^b (n = 290)			
<10,000	23	1 (4)	22 (96)
10,000–29,999	165	39 (24)	126 (76)
30,000–49,999	79	39 (49)	40 (51)
50,000–69,999	15	13 (87)	2 (13)
>70,000	8	6 (75)	2 (25)
ED beds ^c (n = 290)			
1–10	92	11 (12)	81 (88)
11–20	140	51 (36)	89 (64)
21–30	46	27 (59)	19 (41)
>30	12	9 (75)	3 (25)
Public hospital	41	14 (34)	27 (66)
Private hospital	219	72 (33)	147 (67)

Values in parentheses are percentages of row totals.

^aMean difference in hospital bed number between EDs using bedside ultrasound and those that did not: 105 (95% CI, 63–147; *P* < .001).

^bMean difference in number of visits per year between EDs using bedside ultrasound and those that did not: 15,195, (95% CI, 10,915–19,475; *P* < .001).

^cMean difference in ED beds between EDs using bedside ultrasound and those that did not: 7.1 (95% CI, 5–9; *P* < .001).

On average, 46% of emergency physicians in each ED that maintained an ultrasound program were credentialed to perform ultrasound examinations of any type. A minority (34%) of the credentialed physicians were exposed to ultrasound training during residency. We did not assess the type of training that was received during residency. Quality assurance programs for monitoring

the accuracy of emergency physician interpretations were in effect at 33% of the EDs with an ultrasound program. Twenty-one percent of EDs using ultrasound reported billing for their ultrasound interpretive reports.

When we compared use of bedside ultrasound at academic and community EDs, we found several notable differences. Ultrasound was used

Table 2. Differences Between California Academic and Community EDs in Use of Ultrasound

Survey Question (n Responding)	Total, % (n)	Academic EDs, % (n)	Community EDs, % (n)	Difference, %	95% CI, %	<i>P</i>
EDs using bedside ultrasound (n = 293)	34 (101/293)	68 (27/40)	29 (74/253)	39	23 to 54	<.0001
EDs that had their own ultrasound machine (n = 97)	92 (89/97)	100 (27/27)	89 (62/70)	11	4 to 19	.07
EDs that used ACEP guidelines for credentialing (n = 86)	70 (60/86)	69 (18/26)	70 (42/60)	1	–20 to 22	.94
Average ED physicians credentialed (n = 92)	46 ± 35 (SD)	60 ± 37 (SD)	41 ± 33 (SD)	19	2.5 to 35	.036
Average physicians ultrasound trained in residency (n = 89)	34 ± 27 (SD)	28 ± 25 (SD)	35 ± 28 (SD)	7	–5.6 to 20	.26
EDs with quality assurance programs	33 (31/93)	48 (13/27)	27 (18/66)	21	–0.8 to 43	.053
EDs that billed for ultrasound	21 (20/96)	35 (9/26)	16 (11/70)	19	1.2 to 39	.04

more often in academic settings than in community EDs (68% versus 29%; difference, 39%; 95% CI, 23% to 54%; $P < .0001$). Academic EDs reported that $60\% \pm 37\%$ (SD) of physicians were credentialed on average, compared with $41\% \pm 33\%$ in the community setting. The mean difference was 19% (95% CI, 2.5% to 35%; $P = .036$). Figure 1 depicts this difference, showing the higher prevalence of credentialed physicians at academic centers compared with community settings.

With regard to QA programs, 48% of academic EDs reported implementation of such a program, whereas only 27% reported this in community EDs (difference, 21%; 95% CI, -0.8 to 43; $P = .053$). In addition, 35% of academic EDs billed for their ultrasound examinations, whereas only 16% did so in the community setting (difference, 19%; 95% CI, 1.2 to 39; $P = .04$). There were no notable differences between academic and community EDs with regard to the percentages that had constant access to a machine and used ACEP emergency ultrasound guidelines or the percentages of physicians credentialed during residency.

Table 3 shows the use of ultrasound in California by indication. Focused assessment with sonography for trauma (FAST) was the most frequently cited indication across the state, with 97% of EDs with an ultrasound program reporting its use. There were no significant differences between academic and community EDs in the use of ultrasound for FAST, cardiac, biliary, and pelvic ultrasound. However, academic EDs were more likely to perform examinations in each of the following categories than were community EDs: aortic examinations (96% versus 80%), renal examinations (74% versus 46%), basic procedures (93% versus 73%), and advanced procedures (52% versus 14%). (See Appendix 1, question 5, for descriptions of basic versus advanced procedures.)

Discussion

Overall, our 100% response to the primary survey and 96% response to the secondary survey provide great certainty with respect to current practice regarding the use of bedside ultrasound technology in California EDs, and our results revealed significant variations in its use. We found that a minority (34%) of all EDs in California used bedside ultrasound in any form.

On average, 46% of the physicians were credentialed to perform ultrasound examinations of any type in California EDs. This estimate may inflate the true number of physicians credentialed to use bedside ultrasound for all of its indications because we only asked for the percentage of physicians credentialed in any modality; there are likely to be physicians who are only credentialed in 1 area of ultrasound (such as FAST or procedural ultrasound). Furthermore, the proportion of credentialed physicians across the state was skewed toward academic EDs (Figure 1). For example, more than half of academic EDs reported that 80% or more of their physicians were credentialed in the use of ultrasound, whereas only 20% of community EDs reported this level of credentialing.

Most EDs used the guidelines set forth by their own specialty college (ACEP) when establishing ultrasound programs, as recommended by the AMA.⁴ It is important to note that other formal ultrasound training guidelines are in common use, such as those of the AIUM.⁵ Although ACEP guidelines call for a minimum of 16 hours of initial ultrasound didactic training followed by at least 25 studies in each of 6 primary categories (for a total of 150 studies), the AIUM guidelines call for 100 hours of AMA Physicians Recognition Award credit plus at least 300 ultrasound studies.^{5,7} These two organizations have recently collaborated to create joint guidelines for the performance of FAST examinations in trauma.¹¹

Despite citing the ACEP training guidelines as the foundation of most of the ED ultrasound programs, we found a relatively low adherence to

Figure 1. Comparison of the proportion of emergency physicians credentialed for bedside ultrasound at community versus academic EDs.

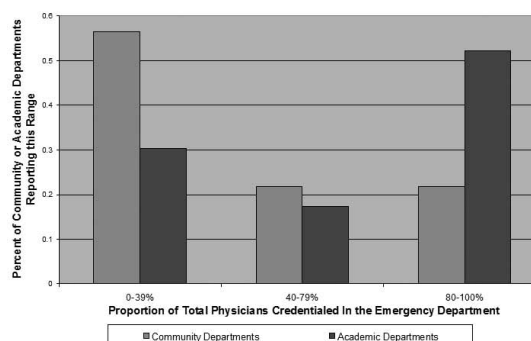


Table 3. Differences in Indications for Ultrasound Between California Academic and Community EDs

Ultrasound Type	All EDs, % (n = 97)	Academic EDs, % (n = 27)	Community EDs, % (n = 70)	Difference, %	95% CI, %	P
FAST	97	96	97	1	-9 to 7.3	.83
Biliary	73	85	69	16	-0.6 to 33.9	.1
Cardiac	78	89	74	15	-1.1 to 30.3	.12
Aorta	85	96	80	16	4.53 to 28.1	.05
Renal	54	74	46	28	8.1 to 48.6	.01
Pelvic	85	89	83	6	-8.7 to 20.8	.46
Basic procedures	78	93	73	20	5.4 to 34.1	.03
Advanced procedures	25	52	14	38	17 to 58.1	<.001

the QA recommendations. The 2001 ACEP ultrasound guidelines recommend that EDs using ultrasound have a QA program to further education and provide feedback as well as to monitor ongoing performance.⁷ These guidelines recommend that 100% of scans be reviewed during the credentialing/training phase, and then a percentage of overall scans be reviewed once credentialing/training has been completed. Although most of the EDs reported following the ACEP guidelines as the foundation for their use of ultrasound (70%), only one-third reported having a QA program. We did not assess what percentage of EDs reporting QA programs were able to achieve 100% review during the credentialing period. There was a greater use of QA programs at academic EDs (48%) compared with community departments (27%). This was of borderline statistical significance ($P = .053$); however, it may suggest a trend. One prior report revealed that few academic programs complied with established guidelines when implementing ultrasound programs; thus, it is not surprising to see this trend in the larger practice of community emergency medicine as well.¹²

Our study found that only a small minority of EDs (21%) billed for the additional time and effort spent performing bedside ultrasound scans of any type. This is another area in which large differences emerged between academic and community EDs. Because the EDs that billed for their services were also those with a greater number of credentialed physicians and a higher percentage of QA programs, it is possible that these factors caused the ED to feel justified in billing for bedside ultrasound examinations. We did not survey EDs about the barriers they experienced in billing for bedside ultrasound.

In this cross-sectional study, we had no ability to determine whether ultrasound use is increasing in California EDs. However, both academic EDs (78%) and community EDs (82%) predicted increased use of ultrasound in the future. We would expect that use will increase as more EDs are staffed by physicians who have been trained in ultrasound during their residencies.

There were several limitations worth considering. Although our response rate was excellent, we collected data over an 18-month period. It is unlikely that there were any significant changes during this period; however, some differential is possible. In addition, because all of our data were collected in California, it is unclear whether our findings are generalizable to the entire United States. However, with more than 10% of all emergency medicine residency training programs in the country and well more than 10% of the population of the United States, California is an important gauge of the status of this technology. Finally, as with all survey-based research, our study was limited by the accuracy of the responses we obtained. We sought to survey only the physicians most knowledgeable of their ED's use of ultrasound. We are unaware of any reason to suspect a systematic bias in the collection of our data. Because of the brief nature of the survey, we were unable to assess all of our areas of interest in detail but leave such questions for future research.

In conclusion, EDs using ultrasound systems in California are currently in the minority. Ultrasound programs in this state have a considerable effort ahead of them to comply with the QA guidelines set forth by the ACEP to maintain the highest quality medical care. As evidenced by this survey, the diffusion of bedside ultrasound into the daily practice of emergency medicine is still in its early stages in California.

Appendix 1. Survey Questions

1. Does your ED have its own ultrasound machine?
 Yes No
2. Do you follow ACEP guidelines as the basis for your credentialing process?
 Yes No
3. What percentage of your emergency physicians are credentialed to use bedside ultrasound (for any indication)?
Number _____
4. Concerning training, can you estimate the percentage of your credentialed staff that were originally trained in ultrasound during residency?
Number _____
5. Does your department perform FAST examinations?
 Yes No

Does your department perform biliary tract examinations?
 Yes No

Does your department perform cardiac examinations?
 Yes No

Does your department perform abdominal aorta examinations?
 Yes No

Does your department perform renal examinations?
 Yes No

Does your department perform pregnancy examinations?
 Yes No

Does your department perform any basic procedural ultrasound examinations? (this includes any or all of the following: vascular access, pericardiocentesis, paracentesis, thoracentesis, foreign body localization, and abscess drainage/localization)
 Yes No

Does your department perform advanced ultrasound? (this includes any or all of the following: deep venous thrombosis evaluation, ocular evaluation, testicular examination, pneumothorax evaluation, Doppler use, and suprapubic aspiration)
 Yes No
6. Do you have a formal ultrasound QA process?
 Yes No
7. Do you bill for ultrasound examinations performed by ED staff?
 Yes No
8. In the future, do you anticipate:
 Increased, decreased, or the same amount of ultrasound use in your department?

References

1. Cardenas E. Emergency medicine ultrasound policies and reimbursement guidelines. *Emerg Med Clin North Am* 2004; 22:829–838, x–xi.
2. American College of Emergency Physicians. Use of ultrasound by emergency physicians. *Ann Emerg Med* 2001; 38:469–470.
3. Society for Academic Emergency Medicine: Ultrasound Position Statement. Lansing, MI: Society for Academic Emergency Medicine; 2004.
4. American Medical Association. Privileging for Ultrasound Imaging. Chicago, IL: American Medical Association; 2001. Policy H-230.960.
5. American Institute of Ultrasound in Medicine. Training Guidelines for Physicians Who Evaluate and Interpret Diagnostic Ultrasound Examinations. Laurel, MD: American Institute of Ultrasound in Medicine; 2008. <http://www.aium.org/publications/statements.aspx>.
6. Mateer J, Plummer D, Heller M, et al. Model curriculum for physician training in emergency ultrasonography. *Ann Emerg Med* 1994; 23:95–102.
7. American College of Emergency Physicians. ACEP emergency ultrasound guidelines—2001. *Ann Emerg Med* 2001; 38:470–481.
8. Counselman FL, Sanders A, Slovis CM, Danzl D, Binder LS, Perina DG. The status of bedside ultrasonography training in emergency medicine residency programs. *Acad Emerg Med* 2003; 10:37–42.
9. Moore CL, Gregg S, Lambert M. Performance, training, quality assurance, and reimbursement of emergency physician-performed ultrasonography at academic medical centers. *J Ultrasound Med* 2004; 23:459–466.
10. Moore CL, Molina AA, Lin H. Ultrasonography in community emergency departments in the United States: access to ultrasonography performed by consultants and status of emergency physician-performed ultrasonography. *Ann Emerg Med* 2006; 47:147–153.
11. American Institute of Ultrasound in Medicine. AIUM practice guideline for the performance of the focused assessment with sonography for trauma (FAST) examination. *J Ultrasound Med* 2008; 27:313–318.
12. Witting MD, Euerle BD, Butler KH. A comparison of emergency medicine ultrasound training with guidelines of the Society for Academic Emergency Medicine. *Ann Emerg Med* 1999; 34:604–609.