

Decreasing Length of Stay with Emergency Ultrasound Examination of the Gallbladder

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Abstract. **Objective:** To determine whether patients who received emergency screening ultrasound examinations (ESUEs) of the gallbladder by emergency physicians (EPs) have a shorter ED length of stay (LOS) than do those receiving ultrasound studies from radiology. **Methods:** A retrospective chart review from July 1995 to August 1998 identified 1,242 patients who received gallbladder ultrasound examinations. Seven hundred fifty-three patients received ESUEs by EPs of varying levels of ultrasound experience. Four hundred eighty-nine patients received gallbladder ultrasound examinations from radiology, and were not scanned by EPs. The LOSs of the two groups were compared. Significance was evaluated using a two-tailed t-test. **Results:** When patients received an ESUE by an EP, the median LOS was 7% (22 min) less than that for those who received an ultrasound examination by radiology ($p = 0.017$; 95%

CI = 4 min to 41 min). When evaluated by disposition, patients discharged home and scanned by EPs had their median LOSs shortened by 11% or 32 minutes ($p = 0.02$; 95% CI = 5 min to 55 min). When evaluated by time of day, patients who presented after hours (6 PM–6 AM) and were scanned by EPs spent 15% (52 min) less time in the ED ($p = 0.0002$; 95% CI = 26 min to 89 min). Those who were seen after hours and discharged home had their LOSs shortened by 20% (1 hr, 13 min, $p = 0.001$; 95% CI = 28 min to 1 hr, 56 min). **Conclusions:** In a teaching hospital with a residency program, ESUEs decrease ED LOS for these patients. The difference was most apparent for patients presenting after hours. **Key words:** emergency medical services; ultrasonography; gallbladder; length of stay. *ACADEMIC EMERGENCY MEDICINE* 1999; 6:1020–1023

EMERGENCY physicians (EPs) use emergency screening ultrasound examinations (ESUEs) to rapidly diagnose life-threatening conditions such as abdominal aortic aneurysms, ruptured spleens, pericardial tamponade, and ectopic pregnancy.^{1,2} Rapid diagnosis leads to faster treatment and improved outcome.³ Few outcome data exist about the value of ESUEs for common, but non-life-threatening conditions, such as gallbladder disease.

When experienced EPs use ESUEs to diagnosis gallbladder disease, there is a high level of accuracy.^{4,5} ESUEs, looking for gallbladder pathology, are one of the most frequently performed studies in our ED. Both faculty and residents perform gallbladder ESUEs, and ultrasound experience ranges from novice abilities to faculty who have completed more than 1,000 studies. Our department has stockpiled anecdotal cases involving rapid diagno-

sis of cholelithiasis or cholecystitis that led to immediate surgery and/or significant time savings for individual patients. However, concerns have been raised that ESUEs performed in an institution with an emergency medicine (EM) residency may actually increase the overall length of stay (LOS) for these patients.

We wanted to determine whether imaging gallbladders in the ED would increase or decrease ED LOS in an ED with an EM residency program. The study objective was to determine whether gallbladder ESUEs improve flow for these patients in our department when all levels of users were assessed and LOS was used as the main criterion. LOS is a major concern for EDs today, as health care systems are becoming busier and more competitive. Almost all ED administrators are faced with demands to decrease LOS as part of improving quality of service to the individual patient, the community, and the entire health care system. This is especially difficult in teaching programs, where inherent delays may be expected due to the training of physicians.

METHODS

Study Design. This was a retrospective chart review that evaluated LOS for patients receiving

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gallbladder ultrasound examinations in our ED. Two groups were compared for LOS. The first group received gallbladder ultrasound studies from the department of radiology. The other group had their ultrasound studies performed by EPs. Patients who received ultrasound examinations from EPs and then had formal radiology ultrasound examinations performed during their stays were placed into the EP group to avoid a negative effect on LOS for the radiology group.

The LOS for levels of users was also evaluated. A level 1 user was defined as an individual who has performed 50 to 99 scans. Level 2 users have performed 100 to 149 scans, and level 3 users have completed 150 scans or more. These levels were based on the model curriculum reported in 1994 by Mateer et al., who state that residents having completed 150 total examinations should be considered trained in EM ultrasonography.⁶ The institutional review board approved this research protocol.

Study Setting and Population. The study included all patients receiving an ultrasound examination of the gallbladder between July 1995 and August 1998. Patients were identified from an ED ultrasound quality assurance database or a computerized patient database.

This study was performed at a high-acuity urban community hospital ED. The department has an EM residency program and has a yearly census of approximately 65,000 patients.

Study Protocol. A total of 1,242 patients were identified. Seven hundred fifty-three patients received ESUEs by EPs. This group was compared with 489 patients receiving gallbladder ultrasound evaluations from the department of radiology, and not scanned by EPs. Only patients who specifically received ultrasonographic examinations of the

gallbladder were included. To further avoid incidentally discovered gallbladder pathology, the chart review specified patients who were being scanned for complaints consistent with gallbladder disease. These included right upper quadrant pain, epigastric pain, and pancreatitis. Not all staff in our ED use ESUE of the gallbladder. When the machine is not available or when physicians who use ESUE are not present, a formal radiology study is ordered. As a result, not all patients in the ED receive a study from the department of radiology, nor are all patients scanned by EPs.

Measurements. Clinical data were obtained from a computerized patient database and from an ED ultrasound quality assurance database. Time seen, the final ED diagnosis, and LOS were used for analysis. LOS was calculated from the time that a patient entered the ED to the time he or she left at discharge or admission.

Data Analysis. All patient information was entered into a Microsoft Excel 5.0 spreadsheet (Redmond, WA). Data were analyzed using SPSS (Chicago, IL) statistical software by professional consultants. Statistical significance for this retrospective case-control study was evaluated using a two-tailed Student's t-test. Significance criteria were set at 0.05. Confidence intervals were performed on all groups. LOS is reported as a median with interquartile ranges (IQRs).

RESULTS

During the study period, EPs using bedside ESUEs evaluated a total of 753 patients for gallbladder disease. The median LOS for this group was 5 hours, 15 minutes (IQR 2 hours, 57 minutes). The 489 patients who received their ul-

TABLE 1. Median Length of Stay (LOS) for Patients Receiving Gallbladder Ultrasound Examinations from Emergency Physicians and the Department of Radiology

	Radiology Performed (n)	ED Performed (n)	Radiology LOS (Hr:Min)	ED LOS (Hr:Min)	Difference	p
Discharges	172	371	4:55 (IQR 2:45)	4:23 (IQR 2:11)	0:32 (11%) 95% CI = 5 to 55 min	0.02
Admissions	317	382	6:15 (IQR 3:14)	6:19 (IQR 3:01)	0:04 (1%) 95% CI = -18 to 30 min	0.63
6 PM-6 AM	212	379	5:47 (IQR 3:57)	4:55 (IQR 2:51)	0:52 (15%) 95% CI = 26 to 89 min	0.0002
Cholelithiasis	130	208	5:57 (IQR 3:36)	5:17 (IQR 3:05)	0:40 (11%) 95% CI = -2 to 103 min	0.065
Cholecystitis	45	79	6:39 (IQR 2:55)	6:00 (IQR 2:23)	0:39 (10%) 95% CI = -5 to 94 min	0.076
6 PM-6 AM discharges	70	204	5:08 (IQR 3:41)	4:05 (IQR 2:33)	1:03 (20%) 95% CI = 28 to 116 min	0.001
Overall	489	753	5:37 (IQR 3:07)	5:15 (IQR 2:57)	0:22 (7%) 95% CI = 4 to 41 min	0.017

TABLE 2. Median Length of Stay (LOS) for Level of Ultrasonography User in the ED and the Department of Radiology

	ED LOS (Hr:Min)	Radiology LOS (Hr:Min)	Difference	p (95% CI)
Level 1 users (n = 274)	5:54 (IQR 2:39)	5:37 (IQR 3:07)	-0:17 min (-5%)	0.3 (95% CI = -18 to 27 min)
Level 2 users (n = 188)	4:37 (IQR 1:58)	5:37 (IQR 3:07)	60 min (19%)	0.0001 (95% CI = 28 to 82 min)
Level 3 users (n = 291)	5:06 (IQR 3:12)	5:37 (IQR 3:07)	31 min (9%)	0.027 (95% CI = 15 to 60 min)

trasound studies from the department of radiology, but were not scanned by an EP, had a median LOS of 5 hours, 37 minutes (IQR 3 hours, 7 minutes) (Table 1). This 22-minute (6%) difference was significant ($p = 0.017$; 95% CI = 4 minutes to 41 minutes). Those patients who were scanned by an EP and were discharged home had a median LOS of 4 hours, 23 minutes (IQR 2 hours, 11 minutes) as compared with those scanned by radiology and sent home, who had a median LOS of 4 hours, 55 minutes (IQR 2 hours, 45 minutes). The 10% (32-minutes) difference was significant ($p = 0.02$; 95% CI = 5 minutes to 55 minutes).

Patients who presented to the ED after hours (from 6 PM to 6 AM) had a median LOS of 4 hours, 55 minutes (IQR 2 hours, 51 minutes) when scanned by an EP, but those who were scanned by radiology had a median LOS of 5 hours, 47 minutes (IQR 3 hours, 57 minutes). The 15% (52-minutes) difference was significant ($p = 0.0002$; 95% CI = 26 minutes to 89 minutes). Patients who presented after hours, were scanned by EPs, and were discharged had a median LOS of 4 hours, 5 minutes (IQR 2 hours, 33 minutes), and the comparable radiology group had a median LOS of 5 hours, 8 minutes (IQR 3 hours, 41 minutes). The 21% (1-hour, 3-minute) difference was also significant ($p = 0.001$; 95% CI = 28 minutes to 1 hour, 56 minutes).

The EP-scanned group contained 258 patients who were scanned in the ED and then received a study from the department of radiology during their stays. The median time for this group was 5 hours, 18 minutes (IQR 3 hours, 1 minute). The 19-minute difference from the radiology median LOS was significant ($p = 0.018$; 95% CI = 5 minutes to 40 minutes).

Patients scanned by level 1 users had a median LOS of 5 hours, 54 minutes (IQR 2 hours, 39 minutes) (Table 2). This did not differ significantly from the median radiology LOS of 5 hours, 37 minutes ($p = 0.3$; 95% CI = 18 minutes to 27 minutes). Those scanned by level 2 users had a median LOS of 4 hours, 37 minutes (IQR 1 hour, 58 minutes). This was significantly different from that for radiology (5 hours, 37 minutes) ($p = 0.0001$; 95% CI = 28 minutes to 1 hour, 22

minutes). Those scanned by level 3 users had a median LOS of 5 hours, 6 minutes (IQR 3 hours, 12 minutes). This also differed significantly from that for radiology ($p = 0.001$; 95% CI = 15 minutes to 60 minutes).

The difference in LOS for patients diagnosed as having cholelithiasis or cholecystitis was not statistically significant (Table 1). Cholelithiasis patients scanned by EPs had a median LOS 30 minutes shorter (8%). Patients diagnosed as having cholecystitis had a median LOS 44 minutes shorter (10%).

DISCUSSION

Emergency physicians have demonstrated the ability to learn and accurately perform focused diagnostic imaging with ultrasound.^{2,3} Courses are now available around the country, and can be frequently found at national EM meetings. Many training programs have established ultrasonography curriculums and are teaching residents how to apply bedside ultrasound. Although cases have been published describing time saved in individual situations, to our knowledge no one has looked at large numbers of patients evaluated by EPs of all levels in a residency program.³ Burgher et al. did find a more rapid ED transit time when transvaginal ultrasonography was performed at the bedside by EPs. Their total numbers of patients scanned by EPs and by obstetrical consultants were 46 and 38, respectively.⁷

We hypothesized that the ability to quickly evaluate, at the bedside, patients with suspected gallbladder pathology would decrease the LOS for these patients in our ED. It was our anecdotal experience that we could shorten diagnostic delays due to laboratory analysis and radiologic evaluation. When an EP can diagnose cholelithiasis or cholecystitis in minutes, further testing can be minimized, thus saving time (Table 1). If the patient's diagnosis warrants, surgical consultation can be made immediately. When no gallbladder pathology can be identified, the differential diagnosis can be refocused on other possibilities, again saving time.

The study results support our hypothesis.

There was a 22-minute shorter LOS among all patients who were evaluated with right upper quadrant ultrasonography by EPs (Table 1). The difference was more obvious for patients who were sent home, with a 32-minute or 11% decrease in LOS for those patients scanned by EPs. This difference further increased for the patients seen and scanned after hours. During this time, ultrasound technologists are often called in from home by the radiology department, and this can frequently add one to two hours to the evaluation. Those patients scanned by EPs stayed 52 minutes, or 15%, less in the ED prior to being admitted or discharged home. Most significant was when they were discharged home; patients stayed one hour and three minutes, or 20%, less.

When separated by level of user, the EPs who were levels 2 and 3 had significantly shorter LOSs when compared with radiology. Level 1 patients did not have significantly different LOSs. This may be explained by the decreased likelihood that less-experienced ultrasonographers would act based on their findings and streamline their workups of patients. The time differences for patients diagnosed as having cholelithiasis or cholecystitis were not significant. For the groups that did not differ significantly, the power was low and ranged from 0.1 to 0.4. This suggests that we would be unlikely to detect the type II error of accepting the null hypothesis, which states that there is no difference between the EP group LOS and the radiology LOS.

LIMITATIONS AND FUTURE QUESTIONS

The limitations of our study include its retrospective, nonrandomized design. With a prospective, randomized design, eligible patients assigned to "no ultrasound" may have a shorter LOS compared with any ultrasound group. Some may argue that other outcomes beside ED LOS should be evaluated (patient satisfaction, cost, etc.). Finally, we did not try to re-prove the accuracy debate with our study. Although all examinations were recorded on videotape for quality assurance review,

not all patients had criterion standard follow-up studies available. Some with cholecystitis/cholelithiasis were taken directly to the operating room.

Many patients with benign, resolving biliary colic and cholelithiasis received formal outpatient ultrasound examinations, but no follow-up was performed on these patients. This could affect overall patient satisfaction, since the patient still faces a test after discharge. Any future prospective studies may need to address this issue.

CONCLUSIONS

This study shows that patient LOS does not suffer during evaluation of suspected gallbladder disease at an institution with an EM residency program that teaches ultrasound applications. This is reassuring to residency programs that are considering introducing ultrasound education programs but are concerned that this new modality would slow patient transit time through their departments. Further, we hope that the decrease in LOS may encourage a broader use of ultrasonography by EPs.

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References

1. Blaivas M, Quinn J. Diagnosis of splenic hemorrhage with ultrasonography in the emergency department. *Ann Emerg Med.* 1998; 32:627-30.
2. Mateer RJ, Aiman EJ, Brown MH, Olson DW. Ultrasonographic examination by emergency physicians of patients at risk for ectopic pregnancy. *Acad Emerg Med.* 1995; 2:867-73.
3. Durham B. Emergency medicine physicians saving time with ultrasound. *Am J Emerg Med.* 1996; 14:309-13.
4. Schlager D, Lazzareschi G, Whitten D, Sanders A. A prospective study of ultrasonography in the ED by emergency physicians. *Am J Emerg Med.* 1994; 12:185-9.
5. Jehle D, Davis E, Evans T, et al. Emergency department sonography by emergency physicians. *Am J Emerg Med.* 1989; 7:605-11.
6. Mateer J, Plummer D, Heller M, et al. Model curriculum for physicians training in emergency ultrasonography. *Ann Emerg Med.* 1994; 23:95-102.
7. Burgher SW, Tandy TK, Dawdy MR. Transvaginal ultrasonography by emergency physicians decreases patient time in the emergency department. *Acad Emerg Med.* 1998; 5:802-7.