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## Impact of bedside right upper quadrant ultrasonography on radiology imaging

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**Abstract** Many Emergency Departments (ED) use emergency ultrasonography of the right upper quadrant (RUQ) to capture images of the gallbladder in patients with suspected gallstones. It is unclear what impact this practice has on additional imaging performed by radiology. Patients were enrolled 24 h a day by ED residents and attending physicians who have completed an educational program in limited RUQ ultrasound. All ultrasounds were videotaped and later reviewed. According to the American College of Emergency Physicians' credentialing standards, 25 ultrasounds were required before using the results clinically. A total of 352 patients were enrolled by 42 physicians over a 1-year period. Two hundred twelve (60.2%) of the ultrasounds were performed clinically, with the rest performed for teaching purposes. One hundred seventy-nine (50.9%) of the ultrasounds were performed by credentialed physicians. One hundred forty-nine (70%) clinical and 29 (20.7%) teaching ultrasounds had additional imaging. The average time to follow up imaging after discharge from the ED was 8.51 days. Most patients receiving emergency ultrasound of their RUQ had follow-up imaging by radiology.

**Keywords** Ultrasound · Emergency ultrasound · Right upper quadrant ultrasound · Gallbladder · Bedside ultrasound

### Introduction

There is a nationwide shortage of ultrasound technicians, and in many institutions an ultrasound technician is not always available. Emergency physicians are increasingly relying on their own ultrasound skills to make clinical

decisions. Emergency ultrasound education is mandated by the emergency medicine residency review committee [1], and Emergency Medicine residencies are now being cited if they do not provide this education (personal communication with Emergency Medicine RRC). Right upper quadrant (RUQ) ultrasound is taught as one of the primary applications for emergency physicians [2]. There is a concern by radiologists that ultrasounds performed at the bedside by emergency physicians will result in a decreased volume of ultrasound imaging in the radiology department.

Right upper quadrant ultrasonography, performed in the radiology suite, is designed to evaluate the gallbladder, liver, right kidney, pancreas, and biliary tree for a wide range of pathological conditions, including gallstones. In contrast, the limited protocols performed by most emergency physicians are designed to identify gallstones and are not designed to diagnose other more complex disorders such as common duct stones, choledochal cysts, obstructing tumors, or hepatic abscesses. The RUQ ultrasound performed at the bedside focuses on the presence or absence of gallstones. Additional information about gallbladder wall thickening, pericholecystic fluid, and other information may be obtained, but are secondary findings. If the findings of the limited bedside ultrasound do not corroborate the history, physical exam, and laboratory findings, then additional imaging or laboratory work should be considered.

Ultrasounds performed by emergency physicians have the potential to increase or decrease imaging by radiologists. A study looking at the impact of emergency ultrasound by emergency physicians indicated that it might raise the volume of imaging by radiologists [3]. Screening ultrasounds in the emergency department (ED) have the potential to identify pathology that are not identified by history or physical exam and trigger additional imaging that would not have normally occurred. Another possibility is that emergency ultrasound results may provide enough clinical information to avoid the need for additional imaging. A third possibility is that emergency ultrasound may allow rescheduling of follow-up imaging from nights and weekends to weekdays. A study

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by Heller et al. looked at right upper quadrant ultrasounds by ED physicians and found that volume decreased initially but returned to normal levels after only a year [4]. A third study found that initially the use of radiology ultrasound increased but dropped after a number of years [5]. In this paper, we examine the effects of emergency-physician performed bedside ultrasound on imaging performed by radiology.

## Materials and methods

This study consisted of a retrospective review of prospectively collected data at a single academic tertiary care emergency department with an active ultrasound educational program for residents, fellows, and attending physicians. Our emergency department is located in an urban setting with an annual census of 75,000. All ultrasounds were performed on a Sonosite Titan (Bothell WA) and recorded on a digital video recorder (Sony, New York, NY).

Any patient with symptoms consistent with cholelithiasis or cholecystitis was eligible for enrollment in the study. ED residents and attending physicians that had completed an educational program on RUQ ultrasound enrolled patients on a sequential basis, 24 h a day. The educational program for emergency ultrasound of the RUQ included a lecture on RUQ ultrasonography and at least 2 h of hands-on skill labs. In addition, the residents and attending physicians participated in lectures on the basics of emergency ultrasound, physics of emergency ultrasound, and videotaped review of ultrasounds performed in the ED. All educational programs were taught by two emergency physicians with extensive experience in emergency ultrasound. Using the American College of Emergency Physicians individual credentialing standards [2], 25 ultrasounds were required before using the ultrasound results clinically. All examinations were videotaped and later reviewed by experienced emergency sonographers. The sole exclusion criterion was the inability to videotape the ultrasound for later review.

Ultrasounds were classified as clinical or teaching depending on the following criteria. A clinical ultrasound was defined as a study that was performed due to a combination of the signs and symptoms of the patient. A teaching ultrasound was defined as a bedside ultrasound performed by an emergency physician to further the education of the physician, without the anticipation that the results would influence the patient management.

Physicians who had not yet performed 25 RUQ ultrasounds were restricted to teaching ultrasounds.

Statistical analysis was performed using a Web-based statistical program (statistics.com). Descriptive statistics were presented as mean value and percentages. Fischer exact test and Students *t* test were used where appropriate.

## Results

A total of 352 patients were enrolled by 42 emergency physicians (35 residents and seven attending physicians) over a 1-year period from 1 June 2004 to 31 July 2005. Two hundred twelve (60.2%) of the ultrasounds were performed clinically with the remainder performed for teaching purposes. The experience level of the sonographers varied greatly with postgraduate years 1, 2, 3, and the attending physicians performed 4, 16, 50, and 27% respectively. All decisions on additional imaging were made by the attending physician regardless of who performed the ultrasound. One hundred sixty (53.4%) of the emergency ultrasounds were performed during nights and weekends.

Of the patients who were imaged by emergency physicians, 178 received additional imaging. One hundred forty-nine (70%) clinical and 29 (20.7%) teaching ultrasounds were followed by a total of 321 additional imaging procedures. Additional imaging included computerized tomography (CT) (52.4%), US (35.5%), hepatoinimodiacetic acid (HIDA) scan (0.9%), and abdominal X-ray (11.2%). Of the patients who required additional imaging, 74.7% received it during their stay in the ED with no clinically significant difference between patients with and without gallstones identified on the emergency ultrasound. Patients who had additional imaging after gallstones were identified on the emergency ultrasound were more likely to have an ultrasound over an abdominal CT scan (61.7 vs 34.0%,  $p=0.0023$ ; see Table 1). The opposite was true of patients who had no identified gallstone on the emergency ultrasound, with 57.9% having a CT and 28.7% having an ultrasound (see Table 1). Information on additional imaging for patients where the initial reading was uncertain is included in Table 1.

Not all of the patients imaged by emergency physicians had additional imaging performed during their visit to the ED. Patients with findings that required additional imaging that was not deemed emergent were discharged with instructions for follow-up imaging as an outpatient. Overall, the average time to follow-up imaging for those

**Table 1** Additional imaging for patients with bedside ultrasound in the emergency department

	Bedside US (+)gallstones	Bedside US (-)gallstones	Bedside US? gallstones	Total
US Imaging	19 (10)	25 (24)	4 (0)	48 (34)
CT Imaging	13 (3)	90 (9)	4 (0)	107 (12)
Both (US, CT)	12 (6)	19 (9)	2 (0)	33 (15)
Total	44 (19)	134 (42)	10 (0)	188 (61)

CT computerized tomography, US ultrasound

patients who did not receive additional imaging during their visit to the ED was 8.51 days with a range of 1–39 days. Follow-up time for CT imaging was significantly shorter than follow-up time for ultrasound imaging (2.2 vs 10.7 days,  $p=0.05$ ).

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## Discussion

The emergency department averaged almost one right upper quadrant ultrasound per day, but 39.8% of these were for teaching purposes. This high percentage of teaching ultrasounds is probably due to the active residency and fellowship educational program and would likely be much lower in a nonacademic setting.

The majority of clinical ultrasounds were performed in two types of patients. In one, the clinical story pointed toward cholelithiasis and the emergency ultrasound was used for confirmation. In this type of patient, finding gallstones may allow the delay of follow-up images for hours or days without risk to the patient. A patient with RUQ pain and gallstones on bedside ultrasound but normal labs whose pain improves in the emergency department would be a candidate to have a more comprehensive ultrasound performed as an outpatient. This delay allows the scheduling of right upper quadrant ultrasounds during normal business hours. The second type of patient has severe but diffuse symptoms with gallstones somewhere in the differential diagnosis. The goal in the first patient is to determine whether any additional imaging is needed now. The goal in the second patient is to decide what type of additional imaging is needed, usually deciding between ultrasound and CT scan.

The majority (70%) of the right upper quadrant ultrasounds performed for clinical purposes were followed by additional imaging: usually abdominal CT or limited US of the right upper quadrant by radiology. Follow-up imaging was more likely to be targeted at the gallbladder (RUQ ultrasound) and was used to confirm the initial findings when the emergency ultrasound imaging identified a gallstone. Follow-up imaging was more likely to address a wider range of possible diagnoses (abdominal CT

imaging) when the emergency ultrasound did not identify a gallstone. This pattern of follow-up imaging demonstrates that one role of the emergency ultrasound was to help rearrange the differential diagnosis in patients with abdominal pain.

The timing of the follow-up imaging was determined by the attending physician. Only 25.3% of follow-up images were performed after the patient's discharge from the emergency department. Patients who were discharged with instructions to have a follow-up ultrasound had to wait an average of 10.7 days. It is unclear if this delay was due to patient effort, scheduling difficulties in radiology, scheduling difficulties with the patient's primary care provider, or difficulties with insurance policies.

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## Conclusion

The majority of patients who received bedside ultrasound in the emergency department received additional imaging in the radiology department. The emergency physician who performed the ultrasound helped to determine the need for further imaging, the timing of additional imaging, and the modality of any further imaging.

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