Original Article

Bedside sonography by medicine residents in critically Ill patients: A retrospective study from a teaching hospital in India

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Abstract

Context: Ultrasonography has become the frontline diagnostic tool for emergency care because of its non-invasive nature and the feasibility to perform repeated quick assessments in sick patients. The effectiveness of this modality, when used by trainee doctors to take clinically important decisions in patients requiring emergency care, is not much explored. In this pilot study, we analyzed whether use of this technology by Medicine resident doctors can help in better decision making in acutely and critical ill patients. **Setting and Design:** This is a retrospective study conducted in the Department of Medicine, All India Institute of Medical Sciences, New Delhi. **Methods and Materials:** The study was conducted using patient data collected from acutely ill and critical care patients, who underwent bedside ultrasonography from August 2017 to August 2018. In all cases, resident doctor's finding had been assessed by an experienced operator before a treatment decision was made. **Statistical Analysis Used:** Continuous variables with normal distribution were computed using t test. Ordinal variables and variables following non-normal distribution were analyzed using the Wilcoxon rank-sum test. **Results:** Thirty-two patients were recruited. There was agreement on 78% (25/32) ultrasound records between the trainee and the experienced operator. Among patients evaluated for shock, agreement reached 83% (15/18). Among patients who underwent transthoracic echocardiography, agreement was 66.7% (4/6). Among patients who underwent lung ultrasound, agreement was 70% (7/10). In both the patients in whom abdominal ultrasound was done, final inferences were consistent between the residents and experts. **Conclusions:** The results show that in majority of critically ill patients, Medicine residents made sonographic observations correctly and took clinically precise sonography guided decisions on par with expert sonologists even with minimal training and ultrasound exposure.

Keywords: Critical care, medicine residents, ultrasound

Introduction

A major advance in medical field in the 21st century is the extension of sonography to bedside care, also termed point–of-care ultrasonography (POCUS). POCUS is defined as portable ultrasound brought to the patient and performed "real time" by the provider.[1,2] Because of the non-invasive nature of ultrasound and the feasibility to perform repeated quick assessment in sick patients, this modality has become the frontline diagnostic tool for emergency care.[3-6] The clinical importance of sonography in intensive care units has been

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Received: 10-05-2019 **Revised:** 13-05-2019 **Accepted:** 03-06-2019

Access this article online

Quick Response Code:

Website: www.jfmpc.com

DOI: 10.4103/jfmpc.jfmpc_379_19

How to cite this article: Mahendran M, Gupta K, Kumar A, Bhatt M, Khan MA, Vyas S, *et al*. Bedside sonography by medicine residents in critically ill patients: A retrospective study from a teaching hospital in India. J Family Med Prim Care 2019;8:2517-21.

proved beyond doubt, and it is considered the standard of care.[7]

Intensivists and clinicians have now effectively used sonography in bedside patient management, a technique previously considered to be under the radar of trained radiologists alone, especially in India. The efficiency of such sonographic techniques done by newly trained residents and medical students have been analyzed in few studies involving non-critical patients.[8-12] With this background, this study was carried out for evaluating the ability of Medicine residents to perform bedside ultrasonography in various clinical situations in acutely ill and critical care patients. The study is first of its kind in which post graduates in medicine have done bedside sonography for optimization of clinical outcome of patients. This study is a part of preliminary process making this modality useful in Internal Medicine.

Subjects and Methods

Study population

This retrospective study was conducted in the Department of Medicine, All India Institute of Medical Sciences (AIIMS), New Delhi. We used data from the records of patients admitted to the Intensive Care unit of Medicine Department from August 2017 to August 2018. Ethical clearance was taken from the Institute Ethics Committee, AIIMS, New Delhi. Every six monthly, 6–9 postgraduate Medicine residents join the Department of Medicine, AIIMS and duration of the course is 3 years.

Resident training

All postgraduate residents joining the Department of Medicine, AIIMS, New Delhi are trained in sonography by consultants from the Department of Medicine and Department of Radiology. Sonography symposiums are being conducted, followed by observer ship and hands-on training in which residents are made to do focused sonographic assessment of patients and are verified by the expert consultants. Resident doctors are explained regarding rapid ultrasound for shock and hypotension (RUSH) protocol and undifferentiated hypotension protocol (UHP) for management of shock; bedside lung ultrasound in emergency (BLUE) protocol for the evaluation of acute dyspnoea.[13-15] They are also trained for focused echocardiography. After training sessions, the residents are allowed to perform sonography on their own, and the sonographic findings of the residents are discussed with the consultants from Medicine and Radiology in correlation with the clinical status of the patient. Over a period, residents are allowed to do independent bedside sonography in critical care patients. The sonographic findings of the residents are documented in the clinical case records of the patients along with the sonographic findings of the expert consultants and the decisions taken during the bedside clinical rounds.

Tools and materials

Data of intensive care patients, who required critical care or immediate change in management due to acute illnesses within the study period (August 2017 – August 2018), was collected from the Medical Records Department, AIIMS, New Delhi. The study includes acutely ill and critical care patients for whom bedside sonography was done by post-graduate Medicine residents and verified by expert consultants for aiding a clinical decision. Case records, which did not have sufficient data or if not cross checked by experts, were excluded from the study. The patients with abdominal sutures; patients who had undergone a surgical procedure; pregnant females; age less than 14 year; known case of structural lung disease (Interstitial lung disease and Post infectious sequelae); and trauma patients were excluded from the study. After extensive review of the case records, 32 patients who satisfied the above mentioned criteria were selected. Age, sex, and Acute Physiology, Age, Chronic Health Evaluation II (APACHE II) score were documented for every patients. For patients in shock, pre- and post- intervention vitals and APACHE II scores were noted. The indication or clinical scenario for which the sonography had to be done was documented.

Statistical analysis

The means and standard deviations (SD) were calculated for data with normal distribution, whereas medians and ranges were calculated for quantitative variables following non-normal distribution. Continuous variables with normal distribution were computed using t test. Ordinal variables and variables following non-normal distribution were analyzed using the Wilcoxon rank-sum test. Statistical analysis was performed using STATA version 12.0 (STATA Corporation, College Station Road, Houston, Texas, USA).

Results

Thirty-two patients who satisfied the inclusion and exclusion criteria were recruited in the study; of which 18 (56.25%) were males. The median age was 49 years (16, 83). Eighteen patients were in shock and ultrasonography was done in them to look for the etiology of shock and for assessment of fluid-responsiveness. Focused echocardiography was done in six individuals; four of them were hypotensive, and these four patients were also assessed with sonographic techniques used in hypotensive patients. Ten patients were assessed with ultrasonography of lung as a part of evaluation of cause of dyspnea. Two patients were assessed with abdominal ultrasound [Table 1].

The overall agreement of residents' sonographic findings with that of concerned expert consultants was 78.13% (25/32) [Table 2].

Shock

In shock patients, the final inferences of residents were in agreement with expert consultants 83.33% (15/18).

Focused echocardiography

Among six patients in whom echocardiography was done in view of cardio respiratory decompensation, residents' inferences of four patients (66.67%) were in agreement with expert

consultants. Residents correctly diagnosed severe left ventricular systolic dysfunction in three patients; pericardial effusion in one patient (also ruled out cardiac tamponade correctly). However, they failed to recognize large valvular vegetations in two patients. One of these patients had severe aortic regurgitation and required immediate transfer to the department of Cardio Thoracic Vascular Surgery for emergency surgery.

Lung ultrasound

Lung ultrasound per se was done in ten patients for evaluation of respiratory decompensation, and inferences between residents and experts were consistent in seven patients (70%). The residents were able to correctly diagnose pulmonary edema in two patients; lung consolidation in four patients; both pulmonary edema and consolidation in one patient. However, they failed to diagnose empyema thoracis in one patient; pulmonary edema in one patient; and consolidation in one patient.

Abdomen ultrasound

In both the patients in whom abdominal ultrasound was done, final inferences were consistent between the residents and experts. The resident correctly diagnosed post renal obstruction in a catheterized patient while evaluating for new onset anuria. In another patient presenting with severe acute onset abdominal pain, the resident was able to diagnose perinephric abscess.

Acute Physiology, Age, Chronic Health Evaluation II score

Median APACHE II score before and after intervention were 18 (8, 35) and 12 (3, 32), respectively. After interventions, APACHE II score improved in 29 patients and worsened in three patients.

Shock patients- subgroup analysis

A subgroup analysis was done in shock patients [Table 3]. Although the inferences in 3 out of 18 patients were inconsistent, the final decision of taking a call on whether the patient is fluid responsive or not was consistent among residents and experts, in all 18 hypotensive patients. The mean heart rate before and after intervention were 127.61 and 98.33, respectively. Mean arterial pressure (MAP) before and after sonography guided intervention were 59.11 and 80.28, respectively. The median APACHE II scores before and after sonography guided intervention were 19 (10, 35) and 11 (4, 31), respectively, and the change was statistically significant. The inotrope requirement was also significantly reduced following the sonography-guided intervention. The median noradrenaline requirements before and after interventions were 0.3 mcg/min (0.1, 0.7) and 0.05 mcg/min (0, 1), respectively.

Discussion

This is the first retrospective study involving newly trained post graduate Medicine residents to show the efficiency of sonography in aiding clinical decisions in acutely ill and critical care patients.

Table 1: Baseline data

Total no. of patients	32
Median age	49 (16, 83)
Males	18 (56.25%)
Median APACHE II score	18 (8, 35)
USG procedure	
USG done for shock evaluation	18
Focused echocardiography	6
USG lung for acute dyspnea	10
USG abdomen	2

USG - Ultrasonography

Table 2: Final inferences

	n	Consistent	Inconsistent
USG for shock evaluation	18*	15/18 (83.33%)	3/18 (16.67%)
2D echocardiography	6*	4/6 (66.67%)	2/6 (33.33%)
USG lung	10	7/10 (70%)	3/10 (30%)
USG abdomen	2	2/2 (100%)	0/2 (0%)
Total	32	25/32 (78.13%)	7/32 (21.88%)

*In four patients, both sonography for evaluation of shock and 2D echocardiography were done separately; USG - Ultrasonography

Table 3: Subgroup analysis - Shock patients

	Before intervention	After intervention
Mean heart rate (per minute)*	127.61±25.38	98.83±21.44
Mean SBP (in mmHg)*	78.67±14.32	104.83±17.7
Mean DBP (in mmHg)*	49.33±12.58	68±12.88
Mean MAP*	59.11±11.54	80.28±13.18
Median APACHE II score*	19 (10, 35)	11 (4, 31)
Median dose of Nor-Adrenaline (mcg/min)	0.3 (0.1, 0.7)	0.05 (0, 1)

**P*-value<0.05; SBP - Systolic Blood Pressure; DBP - Diastolic Blood Pressure; MAP - Mean Arterial Pressure; APACHE II - Acute Physiology, Age, Chronic Health Evaluation II

We found that the final inferences from the sonographic assessment done by residents and experts were consistent in 78.13% (25/32).

Sonography is traditionally considered an area of expertise for radiologists. The popular belief that clinicians will require extensive training sessions to gain expertise in the field and to use the skill to perfection is no more true. Several studies, although small, have tried to utilize sonographic advantage in bedside and intensive care management by short-term basic training of resident physicians. Internal Medicine residents desire ultrasound training, but self-reported competence is low.[8] Studies have shown that after brief training, residents can become reasonably competent in performing and interpreting basic ultrasound examinations.[9-12] Hellmann DB, *et al.* showed that medical residents, after 15–30 min of didactic instruction and hands-on training by a certified echocardiographic technician, learned important aspects of hand-carried cardiac ultrasonography scanning and interpretation at a reasonably rapid rate.[12] Panoulas *et al.* did a study to assess the role of pocket-size hand-held echocardiographic (PHHE) devices as an adjunct to clinical examination when done by medical students and junior doctors. A total of 122 PHHE were performed of

which 64 (53%) by final-year medical students and 58 (47%) by junior doctors. The mean ± SD for diagnostic accuracy after history, physical examination, and ECG interpretation was 0.49 ± 0.22 (maximum = 1), whereas the addition of PHHE increased its value to 0.75 ± 0.28 ($Z = -7.761$, $P < 0.001$).[10]

In all these studies, it is seen that residents or junior doctors were trained for a brief period, and their competency were assessed in clinically stable patients in whom expert physicians already did the sonographic examination. However, the ability of residents to take sonography guided clinically important decisions in acutely ill patients is not studied till now. In our study, residents were trained by symposiums and hands-on training conducted by faculties of Medicine and Radiology. They were also briefed about various sonographic protocols and approaches to be used in critical care management.

With this background, the residents approached the critically ill patients and took clinically important decisions, which were in agreement with the experts in 78.13% patients. The percentage of agreement was higher when sonographic evaluation of shock and acute abdomen was done (83.33% and 100%, respectively). Out of 18 shock patients, although the observations were inconsistent in three patients, the residents correctly decided the fluid-responsiveness in all 18 patients. The clinical outcome as measured by heart rate, mean arterial pressure, and APACHE II score improved in all of these 18 patients following sonography guided decisions and interventions.

The results show that in majority of critically ill patients in intensive care unit, Medicine post-graduate residents made sonographic observations correctly and took clinically precise sonography guided decisions on par with expert sonologists even with minimal training and ultrasound exposure [Figure 1]. These observations should prompt pro-active sonographic training of post-graduate residents of medicine, emergency medicine, critical care, and other clinical departments who encounter critically ill and intensive care unit patients on a regular basis. The outcomes of this study will encourage more such studies

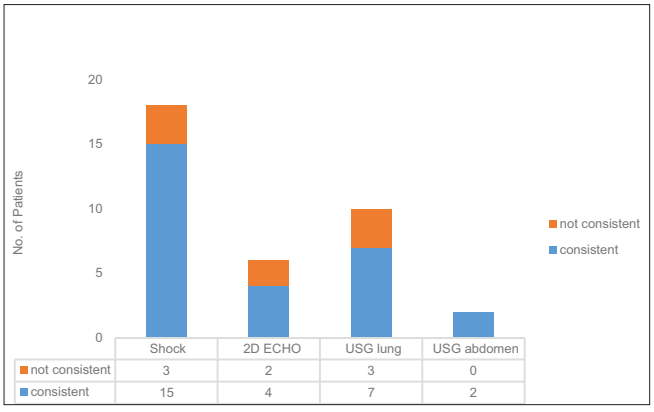

Figure 1: Graph depicting number of patients in whom ultra-sonographic assessments done by medicine postgraduate residents and experts separately showed consistent inferences. USG - Ultrasonography

involving role of residents in clinically important sonography. Many authors have quoted bedside sonography as modern day "stethoscope" in clinical practice.[16,17] In few decades, sonography will be an essential component of primary care. Hence, it is necessary to train the budding clinicians with these techniques irrespective of the branch of medical science, they are related to. Recently, recommendations are being framed to include ultrasonography training in medical curriculum.[18] However, it is well acknowledged that point of care sonography is different from the sonographic imaging performed in the Radiology department by technologists and radiologists. It is not meant to alter the established indications for (or replace the use of) comprehensive diagnostic imaging studies performed by certified radiologists or sonologists. Being a retrospective study is one of the major limitations. The other limitations of this study are its small sample size, possible inter-observer variations, and the assumption that the expert physician made the right diagnosis. We will need a prospective study with higher sample size, to counteract these issues.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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