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BRIEF REPORTS

An Argument for Using Additional Bedside Tools, Such as Bedside Ultrasound, for Volume Status Assessment in Hospitalized Medical Patients: A Needs Assessment Survey

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The frequency at which housestaff need to assess volume status on medical inpatients is unknown. In this brief report, we invited 39 housestaff, over 13 randomly selected dates, to complete a 25-item survey. Participants (n = 31, 79%) logged a total of 455 hours, reporting 197 pages or telephone requests received regarding medical inpatients. Of these, 41 pages (21%) required a volume status assessment. Participants reported their volume status assessment competency to be moderate (median score = 3, interquartile range = 3 to 4, where 1 = not competent to perform independently and 6 = above average competence). In 9 of the 41 assessments (22%), at least 1 barrier was reported in determining volume status. The most commonly reported barriers were conflicting physical examination findings (n = 8, 20%) and suboptimal patient examination (n = 5, 12%). Over 20% of pages regarding admitted medical patients required volume status assessments by medical housestaff. Despite moderate self-reported competence in the ability to assess volume status, barriers such as conflicting physical examination findings and suboptimal patient examinations were present in up to 20% of assessments. Therefore, we urge educators to consider incorporating bedside ultrasound training for volume status into the internal medicine curriculum. *Journal of Hospital Medicine* 2014;9:727–730. © 2014 Society of Hospital Medicine

Clinical estimation of volume status in hospitalized medical patients is an important part of bedside examination, guiding management decisions for many common medical conditions such as heart failure, hyponatremia, and gastrointestinal bleeding. Despite the importance of bedside volume status assessment in clinical care, there are many barriers to its accurate estimation. Specific to the jugular venous pressure (JVP), estimation of its height relies on the transmission of venous pulsations to the overlying skin[1] and has been reported to not be visible in up to 80% of the time in critically ill patients.[2] Additional difficulty in its estimation may be encountered if the central venous pressure is either too high, too low, or obscured by a short or obese neck.[3] Furthermore, in medical patients with respiratory dysfunction, large variations of central venous pressures pose an additional challenge for the bedside examination.[1] Other clinical parameters, such as lung auscultation for crackles and identification of peripheral edema, are likewise equally problematic,[4] and despite training, housestaff may recognize fewer than 50% of respiratory findings at the bedside.[5]

The overall burden of volume status assessment requirements placed on housestaff is unknown. We hypothesize that housestaff are frequently asked to make volume status assessments on admitted medical patients. If this is true, we argue for the need for educating them on the use of additional bedside tools that can assist in volume status determination. An example of such a tool is the use of bedside ultrasound. The objective of this brief report was to conduct a survey to determine the frequency of clinical volume status assessments needed on medical inpatients and secondarily discuss the potential use of bedside ultrasound for volume status determination.

METHOD

Participants

All medical housestaff (medical students and residents) on the inpatient Medical Teaching Unit (MTU) at Foothills Medical Centre in Calgary, Alberta were invited to participate in the study. We randomly selected 13 study dates between February 2012 and January 2013. On study dates, all housestaff designated to be on call were invited to complete the paper-based survey during their call shift. At our center, the majority of medical patients are admitted by family medicine. The more complex medical patients who are suitable for teaching are admitted to 1 of 3 teams on the MTU. Each team's patients (typically 10–13 per team) are covered by its own team's housestaff on call, without cross-coverage. Housestaff included residents in the internal medicine residency program (n = 92), final year medical students (58 out of 163 students rotated through our center that year),

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TABLE 1. Baseline Characteristics of Participants

Baseline Demographics	Participants (N = 31)
Sex	
Male	16 (52%)
Female	15 (48%)
Level of training	
Medical student	12 (39%)
PGY-1	14 (45%)
PGY-2	2 (6%)
PGY-3	3 (10%)
Specialty (excluding medical students)	
Internal medicine	16 (84%)
Off service	3 (16%)
Self-reported competency of volume status assessment	
Borderline competency	4 (13%)
Competent	14 (45%)
Above average	12 (39%)
Well above average	1 (3%)

NOTE: **Abbreviations:** PGY, postgraduate year.

and rotating off-service residents in other residency programs (n = 3–4 per rotation). At the start of each call shift, there was a dedicated time for handover, where information handed over was left to the discretion of the team.

This study was approved by the University of Calgary Conjoint Health Research Ethics Board.

Survey Development

After a review of key articles in the literature,[1,6–9] an initial 46-item survey was generated by 1 investigator (D.L.), with additional input from a second investigator (I.W.Y.M.). The survey covered items on (1) impression and self-reported certainty of impression of the patient's volume status assessment, (2) clinical parameters used to decide on volume status, and (3) self-reported ability to perform volume status assessments. In addition to demographic information, consenting housestaff were asked to record the number of total pages or telephone requests received on patients that required a volume status assessment and the total number of pages or telephone requests received during the call shift. This survey was first piloted on 6 trainees (1 medical student, 2 postgraduate year [PGY]-1 residents, 2 PGY-2 residents, and 1 PGY-3 resident), and feedback on completeness, flow, redundancy, and clarity of items was sought. Revision based on pilot data resulted in a final 25-item survey. The final 25-item survey was then administered to consenting participants on the selected study dates (see Supporting Information in the online version of this article for an example of the survey). Housestaff were instructed to include only pages regarding admitted inpatients. Pages regarding newly admitted patients were excluded, because all new patients require a comprehensive assessment, rather than targeted volume status assessments. Completed surveys were then returned anonymously in a designated collection folder.

Statistical Analysis

Correlations between continuous variables are reported using Pearson correlation coefficients. Data that are normally distributed are reported using mean $\pm$ standard deviation, whereas data that are not normally distributed are reported using median and interquartile range (IQR). All reported *P* values are 2-sided. Analyses were conducted using the SAS version 9.3 (SAS Institute Inc., Cary, NC).

RESULTS

The 13 randomly selected study dates included 10 weekdays and 3 weekend days. Of the 39 eligible housestaff who were on call during those study dates, 31 (79%) unique individuals consented to and completed the survey. The baseline characteristics of the study participants are reported in Table 1.

A total of 455 on-call hours were logged, with a total of 197 pages received during the study period. Median shift duration was 12 hours (IQR = 12–24 hours, range = 7–24 hours) with a median of 5 pages received per shift (IQR = 3–10). Of the 197 total pages received, 41 of these (21%) were felt by the participants to warrant a volume status assessment.

Of the 14 volume status assessment parameters considered, housestaff used a mean of 7 ± 3 parameters per assessment. The most frequently used parameters in volume status assessment were the patient's history (90%), respiratory examination (76%), JVP (73%), blood pressure (71%), and heart rate (71%) (Figure 1). In 35 of these 41 assessments (85%), housestaff indicated examining the patient for JVP, respiratory examination, edema, heart sound, or abdominal jugular reflux. Of those who examined the patient, an average of 3 ± 1 physical examination findings were sought. Of the 6 patients who were not examined,

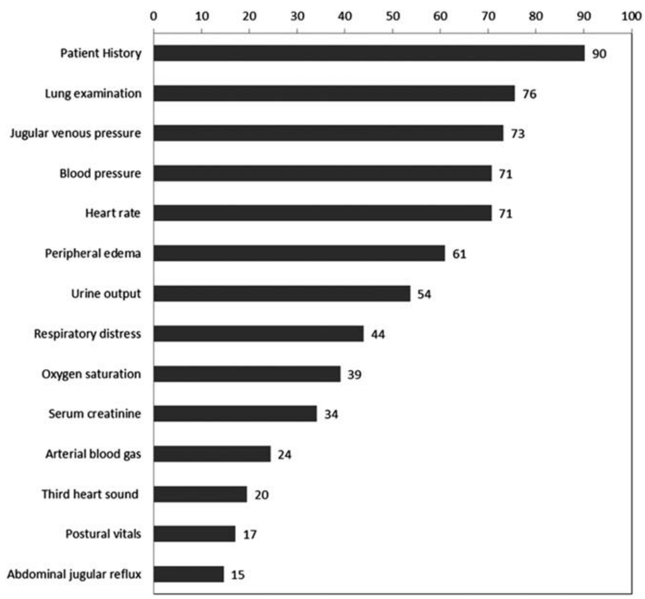

FIG. 1. Percentage of volume status assessments using 14 clinical parameters in 41 patient assessments.

TABLE 2. Reasons Cited for Having Difficulty With Volume Status Assessments and Self-Reported Confidence in Overall Assessment

	Volume Status Assessments (N = 41)
Difficulty with volume status assessment	
Conflicting history	0 (0%)
Conflicting examination findings	8 (20%)
Conflicting laboratory findings	1 (2%)
Unsure of own examination skills	3 (7%)
Suboptimal patient examination	5 (12%)
Required help to confirm volume status assessment	9 (22%)
Confidence in assessment*	3.5 (± 1.4)

NOTE: *1 = very uncertain, 5 = very certain.

housestaff reported being very certain of the patients' volume status using nonphysical examination parameters.

In 24 cases (59%) the intravenous was changed (ie, type of intravenous fluid used, rate change, starting or stopping of fluids). In 9 cases (22%) a diuretic was given, and in 15 cases (37%) a chest radiograph was ordered.

Confidence in Volume Status Assessment

Overall self-reported competency in performing volume status assessments was moderate (median score = 3, IQR = 3–4, range = 2–5; where 1 = not competent to perform independently, 3 = competent to perform independently, 6 = above average competence to perform independently). Overall certainty regarding the accuracy of volume status assessments on each patient during the call shift was moderate (mean score = 3.5 ±1.4, range = 1–5; where 1 = very uncertain; 5 = very certain (Table 2).

In 9 of the 41 assessments (22%), there was at least 1 barrier identified in terms of conflicting history, examination findings, laboratory findings, or suboptimal patient examination. The most commonly reported barrier was conflicting physical examination findings (8 assessments, 20%). Five of the assessments (12%) were reported to be suboptimal in terms of patient examination.

In general, although none of the associations were significant, the more elements housetaff reported using, the less certainty was reported regarding the accuracy of volume status assessment ($r = -0.11$, $P = 0.49$); the more pages received by the housestaff during the work shift, the less the reported certainty ($r = -0.22$, $P = 0.33$). Finally, the higher the level of training, the higher the reported certainty ($r = 0.36$, $P = 0.11$).

DISCUSSION

In this brief report, we identified that over 20% of pages over a call shift regarding admitted medical patients required volume status assessments by medical housestaff. Despite moderate self-reported competence in the ability to assess volume status, barriers to volume status determination, such as conflicting physical examination findings and suboptimal patient examinations, were present in up to 20% of the assessments.

Other studies have similarly shown trainees with difficulty regarding clinical examinations for volume status. In these studies, difficulty with findings ranged between 16% to well over 50%.[1–3,5] To our knowledge, this is the first report on the estimated burden of volume status assessments borne by medical housestaff. Together, our results on the burden of volume status assessments and the uncertainty regarding volume status assessments argue for the need for either better education of examination skills, or alternatively, additional tools for volume status assessments.

Although future studies evaluating the effects of improving education on examination skills and accuracy would be helpful, it has been previously reported that even attending physicians' examination skills were poor.[3] Suboptimal educator's skills, coupled with less-than-ideal patient characteristics in some settings, such as obesity and anatomical variations, suggest that education of bedside examination skills alone is unlikely to optimally assist clinicians with volume status assessments. Therefore, we believe our results argue for the need for additional tools for determining volume status in patients.

Bedside ultrasound is a promising tool that may be of use in this setting. It can assist in volume status assessments in a number of ways. First, for example, the height of the JVP can be located on ultrasound, using a linear transducer, as the site of where the vein tapers, using either a longitudinal or transverse view.[10] This measurement can be readily obtained even in obese patients.[10] Second, pulmonary findings, such as pleural effusions and the appearance of bilateral B lines would be suggestive of volume overload.[11,12] The presence of unilateral B lines and consolidation/hepatization, on the other hand, would be suggestive of an infective or atelectatic process.[11–13] Last, a small inferior vena cava (IVC) diameter (<2 cm) or collapsibility of >50%, although more controversial, may be able to help identify patients who may benefit from intravascular fluid loading.[13,14] Response of IVC diameter to passive leg raise may also be assessed.[13] Feasibility wise, many of these bedside skills require minimal training, even for novices. As little as 3 to 4 hours of training may suffice.[12,15]

Although the use of bedside ultrasound holds promise, a number of important questions should be addressed. First, can trainees be taught to use ultrasound accurately and reliably? If so, can ultrasound be incorporated into clinical care or would the time required to perform these additional examinations be prohibitive? Second, how will its use impact on volume status estimation accuracy and clinical outcomes?

Third, what may be some unintended consequences of introducing this tool into the existing educational curriculum? Future studies addressing these questions are needed to better assist educators in optimizing an educational curriculum that would best benefit learners and patients.

Some limitations in our study include the fact that first, this is a single-centered study. However, as previously stated, our results regarding difficulty with clinical examination findings are in keeping with findings from other centers.[1–3,5] Second, our results are based on what housestaff felt necessitated volume status assessments, rather than what calls truly needed volume status assessments. In addition, the number of pages received was by self-report. However, housestaff are more likely to under-report by forgetting to log their pages, rather than to over-report. Thus, our results are likely a conservative estimate of the burden of volume status assessments faced by medical housestaff. Third, some parameters were not included in our survey. For example, ordering of B-type natriuretic peptide required a cardiology consultation at our center, and thus this investigation is not readily available to us. Daily weights, urea to creatinine ratio, and fractional excretion of sodium were not included based on feedback from our pilot survey suggesting that these parameters were not commonly used or available for admitted patients. Thus, overall confidence in volume status assessments may differ should these parameters be routinely employed. Fourth, our participants were predominantly junior learners. Therefore, our results may not generalize to centers where patients are managed primarily by more senior learners. Last, our results pertain only to patients admitted to internal medicine. For patients in the intensive care unit or coronary care unit, the burden of volume status assessments is likely even higher.

These limitations notwithstanding, our results do raise a potential concern regarding the current practice by which patients' volume statuses are assessed. We urge educators to consider incorporating bedside ultrasound training for volume status into the internal medicine curriculum and to address the need for future studies on its utility for volume status assessments.

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