Incidental findings on intensivist bedside ultrasonographic (INBU) examinations: Why should we care?

S. Peter Stawicki, MD1, Adam M. Shiroff, MD1, Geoffrey E. Hayden, MD2, Nova L. Panebianco, MD3, James N. Kirkpatrick, MD4, Annamarie D. Horan, PhD1, Vicente H. Gracias, MD1, Anthony J. Dean, MD1

1 Dept of Surgery, Division of Traumatology and Surgical Critical Care, University of Pennsylvania School of Medicine, Philadelphia, PA, USA
2 Director of Emergency Ultrasonography, Department of Emergency Medicine, Vanderbilt University Medical Center, Nashville, TN, USA
3 Department of Emergency Medicine, University of Pennsylvania School of Medicine, Philadelphia, PA, USA
4 Department of Medicine, Division of Cardiovascular Medicine, University of Pennsylvania School of Medicine, Philadelphia, PA, USA

ABSTRACT

INTRODUCTION: The primary goal of intensivist bedside ultrasonography (INBU) is the assessment of patient hemodynamic and volume status. Inevitably, INBU examinations provide views of various thoracic and abdominal structures. Despite the rapid recent increase in utilization of INBU, there are no published descriptions of incidental findings and/or their significance in this setting.

METHODS: Echocardiographic and vena cava examinations were performed by non-cardiologist intensivists in 124 surgical intensive care unit (SICU) patients using hand-carried ultrasound (HCU). In addition, any findings that were deemed ‘incidental’ were recorded. Information analyzed included patient demographics, time to complete INBU exam, and the nature of each incidental finding. Incidental findings were grouped into cardiac, pulmonary, and abdominal. To determine whether incidental INBU findings may have influenced subsequent diagnostic testing patterns, radiographic and echocardiographic examinations directly relevant to the INBU findings and performed within 48 hours of the INBU examination were reviewed.

RESULTS: Fifty-eight out of 124 (46.8%) patients in the study group had at least one incidental finding. There were 86 incidental findings, with 23 patients having more than one incidental finding. Forty-eight of 86 incidental findings (55.8%) were cardiac-related, 30 (34.9%) were pulmonary-related, and 8 (9.30%) were abdominal. There were significantly more diagnostic tests performed within 48 hours of INBU in the incidental finding group (1.56 per patient) than in the non-incidental group (1.18 per patient, P < 0.04). The most common post-INBU diagnostic tests were chest radiograph (62%), formal trans-thoracic echocardiography (21%), and abdominal aortogram (14%). Computer tomography, formal abdominal ultrasonography, and trans-esophageal echocardiograms were performed less often. Four of 58 patients (6.9%) had a significant change in clinical management associated with the incidental INBU findings. One patient underwent percutaneous drainage of a pleural effusion; three underwent formal echocardiography, with subsequent change in medical management.

CONCLUSIONS: Nearly half of all SICU patients who underwent INBU were found to have at least one incidental finding. The presence of an incidental finding may have influenced the subsequent pattern of clinical diagnostic testing. In addition, incidental findings on INBU were associated with a significant change in clinical management in nearly 7% of patients.

Cite as: Stawicki SP, Shiroff AM, Hayden GE, Panebianco NL, Kirkpatrick JN, Horan AD, Gracias VH, Dean AJ. OPUS 12 Scientist 2008;2(3):11-14.

Correspondence to: S. P. Stawicki, MD. OPUS 12 Foundation, 1011 Rutherglen Drive, Columbus, OH 43235 USA.

Keywords: Intensivist bedside ultrasonography (INBU), Hand-carried ultrasound, Incidental findings, Clinical significance, Clinical audit.

INTRODUCTION

The primary goal of intensivist bedside ultrasonography (INBU) is the assessment of patient hemodynamic and volume status. In addition, the hand-carried ultrasound (HCU) technology also provides visualization of other structures present in the field of view of the ultrasound probe.1,2 It has previously been shown, in more than one setting, that approximately one-third of abnormal findings on abdominal ultrasonographic exams are ‘incidental’ in nature.3,4 Despite the recent rise in the utilization of the INBU examination, there are no published descriptions of incidental findings and/or their significance in the setting of the intensivist-performed ultrasound examination. The purpose of this report is to describe the spectrum and frequency of incidental findings made during INBU exams for the purpose of hemodynamic assessment in the surgical intensive care unit (SICU) at a major academic institution.

METHODS

After obtaining Institutional Review Board approval, a prospective evaluation of hemodynamic status was conducted in surgical intensive care unit (SICU) patients. Information regarding the overall patient acuity (APACHE II scores) was obtained from the SICU database.4 Patients were eligible for enrollment if their treating clinicians considered that a focused INBU examination of their cardiac and hemodynamic status was clinically indicated. Examinations were performed using a Micromaxx HCU unit using a PI7 1-5 MHz phased array transducer (Sonosite, Bothell, Washington, USA) with Doppler and Tissue Doppler capabilities in a form of a brief (5-20 minute) bedside examination. Echocardiographic and vena cava examinations were performed by non-cardiologist intensivists with basic bedside ultrasonography skills and three hours of didactics in interpreting and acquiring basic 2D and Doppler images. Each sonologist had performed at least 25 adequate proctored HCU exams.

The views included in the INBU examinations in this study included the parasternal long and short axes, the apical four-chamber and the subxiphoid (both four-chamber and short axes) in the assessment of the heart, and subxiphoid and intercostals windows in the assessment of the inferior vena cava. The choice of windows and views used in any specific patient was left to the discretion of the sonologist, and was frequently determined by patient factors, including incisions, drainage tubes, body habitus an physical positioning. The sonographic evaluation included an assessment of pericardial fluid, gross visual estimation of left ventricular ejection fraction, and, using the apical four-chamber view, assessment of mitral valve inflow velocities and septal wall...
motion using spectral and tissue Doppler, respectively. The inferior vena cava (IVC) was assessed both in the longitudinal and transverse plane 1-3 cm below the inflow of the hepatic veins. Maximum expiratory and minimum inspiratory measurements were made in M-mode to allow for calculation of the inferior vena cava collapsibility index (IVCCI). An in-depth discussion of echocardiographic parameters studied (IVCCI, E and e’ waves) is beyond the scope of this article and the reader is referred to other sources for more information on these topics and descriptions of pertinent sonographic techniques.1,5,6

Any findings seen during an INBU study that were outside of the primary focus and scope of the INBU examination as described above, were deemed ‘incidental’ and recorded as such. Information analyzed included patient demographics, time to complete each INBU exam, and the nature of each incidental finding. Incidental findings were divided into cardiac, pulmonary, and abdominal. The categorization of specific incidental findings was made on a post hoc basis, and is outlined Table 1. Sonologists recorded the time they entered the room to perform the INBU exam, and the time of switching the machine off. This was considered the time required for the study. In order to determine whether incidental observations during INBU examinations may have influenced subsequent diagnostic testing, radiographic and echocardiographic examinations potentially relevant to the INBU findings (e.g., in a patient with gallstones on INBU exam, a subsequent formal abdominal ultrasound or HIDA scan) and performed within 48 hours of the INBU examination, were reviewed and tabulated (Figure 1). The mean number of radiographic and/or echocardiographic tests per patient performed within 48 hours of the INBU examination was compared between the incidental and non-incidental groups in order to determine if the presence of incidental findings was associated with increased utilization of subsequent diagnostic testing. Descriptive statistics, student’s t-test, and chi-square test were used to analyze the data. Statistical significance was set at alpha = 0.05.

### RESULTS

Out of the total 124 patients in the study group, there were 58 patients (46.8%) with at least one incidental finding. The mean age of this group was 61.7 ± 18.9 years, with age range between 16 and 83 years. There were 29 males and 29 females in the ‘incidental’ group, not statistically different from the group without incidental findings (36 males and 30 females). The overall acuity of the study population is reflected by the mean APACHE II score of 16 (range, 11 to 31) for the study period in the SICU.

Eighty-six incidental findings were made in the 58 patients, with 23 patients with more than one incidental finding. Forty-eight of 86 incidental findings (55.8%) were cardiac-related, 30 (34.9%) were pulmonary-related, and 8 (9.30%) were abdominal in nature. The exact nature of the incidental findings, and how they were categorized, is shown in Table 1.

INBU exams in patients with incidental finding(s) required significantly more time than those without (16.7 ± 5.74 minutes, n = 58 vs. 13.8 ± 5.53 minutes, n = 65, respectively, p < 0.006). The median number of INBU exams per examiner was 26 (range, 7 to 65 exams). In terms of operator experience and INBU exam learning curve, time to exam completion was significantly longer for the first three INBU clinical sessions (13.8 ± 5.75 minutes) when compared to the last two INBU clinical sessions (11.3 ± 3.48 minutes, p = 0.04) for the average INBU-participating ultrasonographer. There was no difference in study time duration when comparing examinations utilizing tissue Doppler to those not utilizing the tissue Doppler (15.2 versus 15.1 minutes, p = NS).

The most common diagnostic tests performed within 48 hours of INBU included chest radiogram (62%), formal trans-thoracic echocardiography (21%), and abdominal roentgenogram (14%). Computed tomography, formal abdominal ultrasonography, and trans-esophageal echocardiograms were performed less often (Figure 1). There were 1.56 diagnostic imaging studies that were anatomically related to the incidental finding(s) performed per patient within 48 hours of INBU. In patients in whom no incidental findings were made, only 1.18 diagnostic imaging studies were performed, during the same time period (P<0.04). The group with incidental findings also had more formal echocardiograms (32%) performed within 48 hours of INBU than the group without incidental findings (15%, P<0.04). Similarly, a significantly higher proportion of patients without incidental findings received no diagnostic imaging or echocardiographic studies after their INBU (30% vs. 3% in the incidental findings group, P<0.001).

Four out of 58 patients (6.9%) in the incidental group had a significant change in clinical management associated with the incidental finding(s) on INBU. One patient underwent percutaneous drainage of a pleural effusion; two patients underwent formal echocardiography, which led to subsequent change in medical management; and one patient underwent trans-esophageal echocardiography that confirmed the presence of infectious endocarditis.

### DISCUSSION

Among critical care specialists there has been burgeoning recent interest in bedside ultrasonography, wherein ultrasound images are obtained as often as needed at the bedside by the treating physician as an integral component of the ongoing clinical
evaluation. This is in contrast to the traditional arrangement in ultrasonography where specially trained technicians, usually with limited availability, obtain images that are subsequently transmitted to and reviewed by an imaging specialist (typically an echocardiologist or radiologist). The advantages of bedside ultrasonography are its rapid deployability, its lower resource utilization, and its availability at all hours (assuming the presence of a treating physician). Its limitations, compared to traditional ultrasound evaluation, include the relatively limited expertise and time of the providers who are performing it. For all these reasons, bedside ultrasonography is likely to be most useful in time-sensitive or time-critical patient scenarios, directed to answering one or more focused clinical issues. In the intensive care unit, the most common of these applications is in the assessment of hemodynamic status. Here, the intensivist bedside ultrasonography (INBU) can be extremely useful for the non-invasive and rapid assessment of intravascular volume and cardiac function. To our knowledge, there are no previous reports describing the occurrence, frequency, and clinical relevance of incidental findings discovered during INBU examinations.

The majority of incidental findings (55.8%) were cardiac or pulmonary in nature. Abdominal findings comprised only 9.3% of incidental findings. This is not surprising, given that most of the INBU exam is directed to evaluation of thoracic structures. Conversely, the fact that less than 10% of all incidental findings were in the abdomen in this relatively high acuity study group (where a high prevalence of such conditions as ascites and gallbladder disease might be expected) is probably due to the INBU exam only rarely including abdominal views when the sonologist needed to use intercostal windows for the assessment of the IVC. It is also possible that the presence of drainage catheters, tubes, incisions, wounds, and dressings impeded visualization of incidental abdominal findings. This study suggests that incidental findings on INBU exams may be associated with changes in diagnostic test ordering patterns. Patients with incidental findings underwent significantly more diagnostic testing in the 48 hours subsequent to their INBU study. In addition, they were significantly more likely to undergo formal echocardiography, whether transthoracic or trans-esophageal. Only 3% of patients in the incidental group did not undergo any further testing, compared to 30% in the non-incidental group.

The identification of incidental findings in imaging studies is a well-known phenomenon. Such findings can sometimes direct attention to an unnoticed acute problem, but may also be irrelevant to the patient’s immediate health, or indeed to his or her long-term well-being. Faced with incidental findings, the treating physician must strike a balance between appropriately addressing the additional information they provide, and the risk of initiating an unnecessary cascade of potentially harmful, resource intensive, and time-consuming tests.1,3,7-11

A previous study of 1,000 abdominal and pelvic ultrasounds found that among the 25% of patients who had a significant abnormality, almost one-third were considered ‘incidental’.2 With the wide range of described indications for INBU which include (in addition to those of the current study) intraperitoneal fluid collections, lung water assessment, evaluation for proximal lower extremity DVT, biliary tract disease, abdominal aortic aneurysm, and numerous procedural applications, the potential spectrum of incidental findings and their implications are very broad and may be beyond the scope of the bedside sonologist, resulting in a plethora of secondary diagnostic testing to clarify the bedside exam.1,3 Conversely, imaging specialists frequently raise the concern that bedside sonologists may overlook incidental findings resulting in the risk of delayed or missed diagnosis.2 While the current study suggests that incidental findings are associated with an increased rate of subsequent diagnostic imaging, it is unclear whether this resulted in improved outcomes. It is also possible, but uncertain from the data of the current investigation, that incidental findings are a reflection of higher morbidity, which might suggest an appropriately higher utilization of diagnostic testing in this group. For a relatively rapid, inexpensive, and non-invasive test, the 6.9% rate of altered management based on incidental findings does not appear to be a gross misallocation of resources. Further study is warranted on this topic.

**Figure 1.** The frequency of diagnostic tests performed in the incidental INBU group (shaded bars) and non-incidental INBU group (white bars). Note the higher proportion of echocardiograms performed in the incidental group and the higher proportion of patients without any subsequent follow-up studies performed in the non-incidental group.

INBU is an integral part of the care of the critically ill patient. As such, it is informed by, and it serves to inform the ongoing clinical evaluation. Several studies have demonstrated that HCU is more accurate than clinical examination alone.13-16 However, bedside ultrasonography has been shown to be less accurate when not applied within the context of the clinical exam.7 Performance of INBU strictly within the patient’s clinical context may decrease the likelihood clinically irrelevant findings, especially if the sonologist recognizes that the exam is focused in interest and limited in scope. Prior studies have suggested that while the negative predictive value for a bedside cardiac evaluation is quite
high (90% to 97%), the positive predictive value is significantly lower (32%).\textsuperscript{13, 17} Of note, incidental findings were most common in those aged >65 years and omissions were more likely when the protocol for the limited study included only one view.\textsuperscript{12, 18}

When using the HCU as an ultrasonic stethoscope, comparisons against the clinical examination are more relevant than comparisons against studies performed on a standard ultrasound machine. The ability to detect pathologic findings outside of the intended scope of the original examination has fueled significant debate. Issues arise regarding the requirements for interpretation and reporting of these findings, follow-up tests that arise from them, and the costs and risks of these additional procedures, some of which may be unnecessary.\textsuperscript{8-11} This problem arises in all imaging modalities, whether performed by specialists or bedside sonologists. The potential implications of incidental findings are therefore of great importance to the patient and the provider alike. Limitations of this clinical investigation include its relatively small sample size, inability to determine cause-and-effect relationships, and biases inherent to a single-institution study. Its strengths include the prospective nature of the collected information, the investigation of a clinical phenomenon that was not previously described, as well as the data regarding INBU sonographer-related characteristics.

CONCLUSIONS

Nearly half of all surgical ICU patients who underwent INBU were found to have at least one incidental finding. The presence of an incidental finding may have influenced the subsequent pattern of clinical diagnostic testing. In addition, incidental findings on INBU were associated with a significant change in the clinical examination of patients in 7% of patients. Further study is needed to determine the cost and benefit of incidental findings recognized on INBU examinations, and their effect on outcome.

REFERENCES


Copyright 2007-2008 OPUS 12 Foundation, Inc.