Financial Impact of Emergency Department Ultrasound

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Abstract

Objectives: There is limited information on the financial implications of an emergency department ultrasound (ED US) program. The authors sought to perform a fiscal analysis of an integrated ED US program.

Methods: A retrospective review of billing data was performed for fiscal year (FY) 2007 for an urban academic ED with an ED US program. The ED had an annual census of 80,000 visits and 1,101 ED trauma activations. The ED is a core teaching site for a 4-year emergency medicine (EM) residency, has 35 faculty members, and has 24-hour availability of all radiology services including formal US. ED US is utilized as part of evaluation of all trauma activations and for ED procedures. As actual billing charges and reimbursement rates are institution-specific and proprietary information, relative value units (RVUs) and reimbursement based on the Centers for Medicare & Medicaid Services (CMS) 2007 fee schedule (adjusted for fixed diagnosis-related group [DRG] payments and bad debt) was used to determine revenue generated from ED US. To estimate potential volume, assumptions were made on improvement in documentation rate for diagnostic scans (current documentation rates based on billed volume versus diagnostic studies in diagnostic image database), with no improvements assumed for procedural ED US. Expenses consist of three components—capital costs, training costs, and ongoing operational costs—and were determined by institutional experience. Training costs were considered sunken expenses by this institution and were thus not included in the original return on investment (ROI) calculation, although for this article a second ROI calculation was done with training cost estimates included. For the purposes of analysis, certain key assumptions were made. We utilized a collection rate of 45% and hospitalization rates (used to adjust for fixed DRG payments) of 33% for all diagnostic scans, 100% for vascular access, and 10% for needle placement. An optimal documentation rate of 95% was used to estimate potential revenue.

Results: In FY 2007, 486 limited echo exams of abdomen (current procedural terminology [CPT] 76705) and 480 limited echo cardiac exams were performed (CPT 93308) while there were 78 exams for US-guided vascular access (CPT 76937) and 36 US-guided needle placements when performing paracentesis, thoracentesis, or location of abscess for drainage (CPT 76492). Applying the 2007 CMS fee schedule and above assumptions, the revenue generated was 578 RVUs and $35,541 ($12,934 in professional physician fees and $22,607 in facility fees). Assuming optimal documentation rates for diagnostic ED US scans, ED US could have generated 1,487 RVUs and $94,593 ($33,953 in professional physician fees and $60,640 in facility fees). Program expenses include an initial capital expense (estimated at $120,000 for two US machines) and ongoing operational costs ($68,640 per year to cover image quality assurance review, continuing education, and program maintenance). Based on current revenue, there would be an annual operating loss, and thus an ROI cannot be calculated. However, if potential revenue is achieved, the annual operating income will be $22,846 per year with an ROI of 4.9 years to break even with initial investment.

Conclusions: Determining an ROI is a required procedure for any business plan for establishing an ED US program. Our analysis demonstrates that an ED US program that captures charges for trauma and procedural US and achieves the potential billing volume breaks even in less than 5 years, at which point it would generate a positive margin.

Keywords: emergency department ultrasound, financial impact
Several studies have demonstrated that emergency physicians (EPs), with appropriate training, are able to effectively use emergency department ultrasound (ED US) in the management of myriad ED conditions including hemoperitoneum, abdominal aortic aneurysm, deep venous thrombosis, pericardial effusions, and other time-critical conditions to improve both the time to diagnosis and the definitive treatment.\(^1\) Utilization of ED US has also been shown to reduce complication rates for some of the most commonly performed procedures in the ED, such as the insertion of central lines and drainage of fluid collections,\(^5,6\) and it is becoming increasingly standard that US guidance for these procedures is taught in emergency medicine (EM), anesthesia, surgical, and critical care training programs. The current practice of EM increasingly incorporates bedside ED US in the evaluation and management of patients (see Table 1 for definition of terms).

The American College of Emergency Physicians (ACEP), American Institute for Ultrasound in Medicine (AIUM), Emergency Medicine Residents’ Association (EMRA), Residency Review Committee for Emergency Medicine (RRC), and Society for Academic Medicine (SAEM) all recognize the importance of ED US and have included ED US as among the necessary skills an EP should possess.\(^7,8\) This view is supported by the American Medical Association (AMA), which recognizes that use, application, and reimbursement of US is within the scope of practice of the appropriately trained physician.\(^7\)

The ACEP Emergency Ultrasound Guidelines, published in 2001, is a comprehensive consensus document that details the indications for use of ED US, as well as the required training and credentialing process for those EPs who perform ED US.\(^9\) ACEP has also distributed guidance for the coding and reimbursement of ED US, which was most recently updated in 2007.\(^10\) Even though there appears to be relative consensus describing the clinical need for ED US, there has been no guidance on the requirements for initiating an ED US program, nor an analysis of the ongoing fiscal implications.

There are two basic categories of billing codes for diagnostic imaging: limited and comprehensive. For billing purposes, ED US studies are considered “limited” studies in that they address only a single diagnostic problem by answering a specific focused “yes or no” question. There are different reporting guidelines for these studies as opposed to studies billed as comprehensive imaging studies. Similar to other procedural coding, ED US billing codes consist of two components: the professional component indicated by the -26 modifier and the technical component (TC) indicated by a -TC modifier. The professional component is reported by the physician for professional services, while the technical component is usually reported by the hospital to cover cost of equipment, supplies, and technician salaries. Current ACEP-recognized diagnostic and procedural indications and associated current procedural terminology (CPT) codes commonly used for ED US can be found in Table 2.

To date, ED US research has largely focused on demonstrating the accuracy of EP-performed diagnostic US and the impact of ED US on patient outcomes without analysis of fiscal impact, either positive or negative, nor initial capital expenditures required to start a program. The goal of this study is to perform a fiscal analysis, including capital and training costs and potential return on investment (ROI) for an ED US program using current volumes, estimates of current revenue, potential revenue, and costs of implementing an ED US program at one academic ED.

### METHODS

#### Study Design

A retrospective review of billing data was performed for fiscal year (FY) 2007 for an urban academic ED with an ED US program, with an annual census of 80,000 visits and 1,101 ED trauma activations. The institutional review board at the study hospital approved the study protocol.

#### Study Setting and Population

The ED is a core teaching site for a 4-year EM residency, has 35 faculty members, and has 24-hour availability of all radiology services including formal US. ED US is utilized as part of evaluation of all trauma activations and for ED procedures. The formal ED US

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### Table 1

**Definition of Terms**

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bad debt, collection rate</td>
<td>Bad debt is the portion of receivables that cannot be collected. Bad debt = 1–collection rate (%)</td>
</tr>
<tr>
<td>DRG</td>
<td>A system used to classify hospital cases based on resources required to care for cases. Medicare and insurance companies pay a fixed rate to hospitals based on DRG classification. As hospital reimbursement is based on DRG and fixed, additional tests on hospitalized patients such as ED US do not lead to an increase in hospital reimbursement.</td>
</tr>
<tr>
<td>ROI</td>
<td>Ratio of profits gained (or lost) relative to amount invested. Ratio can be expressed in many different ways, e.g., years to break even, internal rate of return, net present value.</td>
</tr>
<tr>
<td>RVU</td>
<td>A measure used by hospitals to permit comparison of the amounts of resources required to perform various services. RVU is usually linked to charges and reimbursement.</td>
</tr>
<tr>
<td>Sunken expense</td>
<td>Expenses that have already been incurred or must be incurred irrespective of the investment decision. For example: CME credits, even though used for US, are mandatory and therefore should not be included in analyzing training expense in ultrasound.</td>
</tr>
<tr>
<td>Years to break even</td>
<td>Years required to recover initial investment. Represents a ROI ratio. Operational profit generated after the years to break even leads to a positive ROI.</td>
</tr>
</tbody>
</table>

CME = continuing medical education; DRG = diagnosis-related group; ROI = return on investment; RVU = relative value unit; US = ultrasound.
program began in 2004 and billing started in FY 2006. Billing in FY 2006 was limited by faculty awareness of both billable indications and required documentation with widespread awareness not occurring until FY 2007. During this period, ED US was limited to the evaluation of trauma patients (CPT-76205 and CPT-93308) and to procedural guidance (CPT-76937 and CPT-76942).

**Study Protocol**

Billing data are extracted from paper medical records by coders and represent the current billing volume. Billing charges and reimbursement are institution-specific, considered proprietary information, and thus not publishable. Given this, revenue was estimated by applying FY 2007 billing volume to the Centers for Medicare & Medicaid Services (CMS) national average physician and hospital fee schedule. Medicare reimbursement data is a good proxy for actual reimbursement as it is publicly available information, represents 40% of total health care expenditure, and has been shown to be comparable to average ED reimbursement rates. To adjust for fixed diagnosis-related group (DRG) payments, hospitalization rates based on institutional experience were applied to revenue data. Adjustment for bad debt was done using an assumed collection rate that is consistent with collection rates used in other published financial studies.

Potential revenue from diagnostic ED US was estimated by comparing the volume of diagnostic scans saved in the ED US database to the billed volume for the month of January 2008. The volume of diagnostic scans in the ED US database more closely represents actual utilization and is a conservative estimate of potential diagnostic volume. Although the utilization rates of ED US for procedures (determined by comparing billed volume to procedures where ED US has demonstrated benefit) were lower than our institutional experience, an increase in utilization rate was not included in the potential ROI calculation. However, sensitivity analysis on the impact of an increase in procedural utilization rates on ROI was performed.

Expense assumptions were based on our institutional experience. There are three components of costs: capital costs, ongoing operational costs, and training costs. The capital costs include the US machines and image archiving technology. Operational costs of an ED US program include ongoing quality assurance of images, continuing education of staff, and program administration. Training costs were based on a 2-day continuing medical education (CME) US class and time required to credential physicians. For physicians to be credentialed, they must demonstrate competency for each application according to the 2001 ACEP guidelines. This involves supervised scanning sessions and review of 25–50 scans in each application where the physician-trainee interpretation agrees with a formal confirmatory study. In the institution where the ROI estimate was performed, the training expense was considered a sunken expense and therefore not included in our original ROI estimate; however, this assumption may not be the case for other institutions.

**Data Analysis**

ROI calculation was done based on the number of years to break even. As multiple assumptions were made to estimate revenue and expenses, a comprehensive sensitivity analysis was performed on key assumptions. On the revenue side, sensitivity analysis was performed around different optimal documentation rates and increases in procedural utilization rates. ROI, including the 2-day ED US training session and scanning time required for credentialing, was also calculated. We used Microsoft Excel 2003 for all data analysis.

**RESULTS**

**Billing Volume**

**Actual** In FY 2007, four CPT codes were billed for ED US: ED US diagnostic scans—limited study of abdomen (CPT-76205), limited transthoracic echocardiography (CPT 93308), ED US procedural scans—US guidance for vascular access (CPT-76937), and US guidance for needle placement when performing paracentesis, thoracentesis, suprapubic aspiration, or location of abscess for drainage (CPT-76942). Billing data for ED US-related

<table>
<thead>
<tr>
<th>Indications</th>
<th>Description (CPT Code)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Evaluation of trauma patient</td>
<td>Limited study of abdomen (CPT-76205) and limited transthoracic echocardiography (CPT-93308).</td>
</tr>
<tr>
<td>Evaluation of abdominal aortic aneurysm</td>
<td>Limited study of retroperitoneum (CPT-76775). Limited study of abdomen (CPT-76205) is frequently utilized for this examination.</td>
</tr>
<tr>
<td>Evaluation of biliary tract disease</td>
<td>Limited study of abdomen (CPT-76205).</td>
</tr>
<tr>
<td>Evaluation of confirmed or unconfirmed pregnancy</td>
<td>Limited study of pregnant uterus (CPT-76815) and limited study of pelvis (CPT-76857), respectively.</td>
</tr>
<tr>
<td>Use of US with procedures</td>
<td>US guidance for vascular access (CPT-76937) and US guidance for needle placement when performing paracentesis, thoracentesis, suprapubic aspiration, location of abscess for drainage (CPT-76942).</td>
</tr>
</tbody>
</table>

ACEP = American College of Emergency Physicians; CPT = current procedural terminology; US = ultrasound.
procedures during this period showed 13.2% of central venous catheter (CVC) insertions and 5.7% of abscess drainages were performed using ED US. Billing volume is summarized in Table 3.

Potential Review of the database of diagnostic images for January 2008 showed that 35% of scans had the appropriate documentation needed for billing. Assuming an optimal documentation rate of 95%, the potential volume of emergency department ultrasound (EDU) diagnostics would have been 1,270 and 1,302 for CPT-76705 and CPT-93308, respectively (see Table 3).

Our institutional experience shows high rates of utilization of ED US for insertion of CVC (in line with the Department of Health and Human Services recommendations for reduction in central line complications\(^1\)) and abscess drainage. Although these utilization rates are higher than the billing data, we did not assume an increase in utilization of ED US with procedures in estimating potential revenue due to the lack of utilization data.

### Table 3
**ED US and Related CPT Codes: Actual and Potential**

<table>
<thead>
<tr>
<th>CPT Codes</th>
<th>2007 Billing Volume</th>
<th>2007 Billing Volume Potential*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ED US</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>76705–Echo exam of abdomen</td>
<td>468</td>
<td>1270</td>
</tr>
<tr>
<td>93308–Echo exam of heart</td>
<td>480</td>
<td>1302</td>
</tr>
<tr>
<td>76937–US guide, vascular access</td>
<td>78</td>
<td>78</td>
</tr>
<tr>
<td>76942–US guide, needle placement</td>
<td>36</td>
<td>36</td>
</tr>
<tr>
<td><strong>Other related procedures</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>36556–Insert nontunnel CVC</td>
<td>592</td>
<td></td>
</tr>
<tr>
<td>10060–Drainage of skin abscess (simple)</td>
<td>320</td>
<td></td>
</tr>
<tr>
<td>10061–Drainage of skin abscess (complex)</td>
<td>257</td>
<td></td>
</tr>
<tr>
<td>49080–Puncture, peritoneal cavity</td>
<td>39</td>
<td></td>
</tr>
<tr>
<td>32000–Drainage of chest</td>
<td>12</td>
<td></td>
</tr>
</tbody>
</table>

CPT = current procedural terminology; CVC = central venous catheter; US = ultrasound.

*Assumes improvement in documentation rate for diagnostic scans only.

### Revenue Estimate
Assuming a hospitalization rate of 33% for patients receiving trauma ED US, 100% for patients receiving ED US-guided vascular access, and 10% for patients receiving ED US-guided needle placement, and a 45% collection rate for all patients, the CMS national averages for physician and facility fees were adjusted to account for fixed DRG payments as well as bad debt expense (see Table 4). Hospitalization rates were based on institutional experience while the 45% collection rate was based on other published financial analysis papers and is in the commonly accepted range.\(^14,15\)

Applying adjusted CMS reimbursement rates to actual volumes, the estimated relative value units (RVUs) and revenue generated by the ED US program in FY 2007 was 1,487 RVUs and $94,593 ($33,953 in professional physician fees, $60,640 in facility fees). If optimal documentation rate for diagnostic scans were achieved, 1,487 RVUs and $94,593 ($33,953 in professional physician fees, $60,640 in facility fees) would have been generated (see Table 5).

### Expense Estimate
Expense consists of three components—capital costs, training costs, and ongoing operational costs. Capital required to achieve potential volume are two US machines as well as the equipment required for archiving images. Using an estimated cost of $60,000 per US machine (includes $10,000 maintenance agreement for the life span of the machine) and $15,000 for the archiving equipment, the total capital expenditure required is estimated at $135,000. This capital expenditure is projected to have a life span of 5–7 years.

The ongoing operational costs consist of the time required by appropriately trained US faculty to maintain the program. The faculty is expected to do quality assurance of images (5 hours per week based on current volume of scans being documented and billed), continuing education of faculty (3 hours per week), and program administration (3 hours per week). Applying a faculty salary rate of $120 per hour, the ongoing operational expense is $68,600 per year.

### Training Expense
The training and credentialing costs assumed in this model are taken from the 2001 ACEP guidelines. Training consists of a 16-hour CME class on US. This class...
usually takes 2 days at a cost, based on current class offerings, of $700 per individual. There is also an associated scanning requirement needed for credentialing. This requirement is estimated to take 5 hours per application. Assuming a faculty hourly rate of $120 per hour, two applications per faculty, and 35 staff EPs, the one-time training cost is $66,500.

ROI Estimate
Using estimated actual revenue there is an annual loss of $33,099 (Table 6) and therefore an ROI cannot be calculated. However, if estimated maximum potential revenue can be achieved, the estimated income per year of ED US will be $22,846 (Table 6), and time to break even is estimated at 4.9 years (Figure 1). If training costs are not considered “sunken” costs and thus included, the time to break even will be 6.8 years.

Sensitivity analysis using different optimal documentation rates (90%–100%) still leads to time to break even of 3.4 to 5.3 years. Sensitivity analysis also demonstrates that if billing rates for procedure-related ED US are doubled (26.4% of central lines placed and 11.5% abscess drained with ED US), the time to break even will be 3.7 years (Figure 1).

Table 5
RVU and Revenue Estimate: Actual and Potential, U.S. dollars

<table>
<thead>
<tr>
<th>CPT Codes</th>
<th>Actual RVU</th>
<th>Actual Physician Fee</th>
<th>Actual Facility Fee</th>
<th>Actual Total</th>
<th>Potential RVU</th>
<th>Potential Physician Fee</th>
<th>Potential Facility Fee</th>
<th>Potential Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>76705–Echo exam of abdomen</td>
<td>276</td>
<td>5,985</td>
<td>8,877</td>
<td>14,862</td>
<td>749</td>
<td>16,242</td>
<td>24,089</td>
<td>40,331</td>
</tr>
<tr>
<td>93308–Echo exam of heart</td>
<td>254</td>
<td>5,895</td>
<td>11,902</td>
<td>17,796</td>
<td>690</td>
<td>15,899</td>
<td>32,284</td>
<td>48,273</td>
</tr>
<tr>
<td>76837–US guide, vascular access</td>
<td>23</td>
<td>532</td>
<td>0.00</td>
<td>532</td>
<td>23</td>
<td>532</td>
<td>0.00</td>
<td>532</td>
</tr>
<tr>
<td>76942–US guide, needle placement</td>
<td>24</td>
<td>522</td>
<td>1,829</td>
<td>2,351</td>
<td>24</td>
<td>522</td>
<td>1,829</td>
<td>2,351</td>
</tr>
<tr>
<td>Total</td>
<td>578</td>
<td>12,934</td>
<td>22,607</td>
<td>35,541</td>
<td>1,487</td>
<td>33,285</td>
<td>58,201</td>
<td>91,486</td>
</tr>
</tbody>
</table>

CPT = current procedural terminology; RVU = relative value unit; US = ultrasound.

DISCUSSION
Today, ED US is a critical tool in the practice of EM. Research has demonstrated the benefits of using ED US in evaluation of patients with multiple time-critical diagnoses. As such, the 24-hour availability of ED US and EPs who are capable of using ED US in clinical decision-making are becoming the standard of care in EDs across the country.

Although guidelines are available on the training and credentialing of EPs, there is limited information on the appropriate setup and financial implications of instituting a formal ED US program. Our objectives were to describe the investment required and estimate the financial impact of ED US in an academic center to initiate the discussion of the costs associated with this change in practice.

Based on our estimates, the annual revenue generated from current billing volumes does not cover ongoing annual operational expenses leading to operating losses. However, the current billing volume at our institution is not consistent with the current utilization of ED US. Our estimate of potential revenue based on current utilization patterns and other conservative assumptions lead to a break even of 4.9 years. These findings are consistent with a previously published abstract that derived ROI using a different methodology from our approach.14 As the time to break even is lower than the life expectancy of the initial investments, an ED US program achieving the potential billable volume can be considered a positive financial investment. Of note, current capital and ongoing expenses are based on current utilization patterns and not billing volume. Because the potential billing volume is more consistent with the current utilization patterns and other conservative assumptions lead to a break even of 4.9 years. These findings are consistent with a previously published abstract that derived ROI using a different methodology from our approach.14 As the time to break even is lower than the life expectancy of the initial investments, an ED US program achieving the potential billable volume can be considered a positive financial investment. Of note, current capital and ongoing expenses are based on current utilization patterns and not billing volume. Because the potential billing volume is more consistent with the current utilization patterns, achieving this volume will not require additional investments beyond those that are currently in place. This assumption may not be the case if ED US indications are significantly expanded (e.g., abdominal aortic aneurysm or first-trimester pregnancy scanning). Although the same machines can be used to perform a variety of scans, there are many other factors to consider when choosing the ED US applications for which an emergency practice bills. Although the training, credentialing, and ongoing quality assurance costs will potentially increase with more indications, the revenue generation of more billable scans will more than offset those costs. One of the key factors considered in choosing the current ED US applications in this
instance was the 24-hour availability of formal US studies and relationship with the radiology department that provides this service. While studies have shown that ED US programs do not impact the total number of formal studies done, and indeed may even increase follow-up referrals,\(^17\) political considerations, formal US availability from the radiology department, and interdepartmental relationships may impact the choice of applications on which a program should focus.

In our analysis, factors such as growth in volume and improvement in operating efficiencies were not factored into the ROI. As the ED US program that we describe is relatively new, the operating costs may be significantly higher and can be expected to reduce over time, thus improving the income generated from the ED US program.

It is also important to note that the financial implications described in this article are the direct impact of ED US. Studies have demonstrated that EPs using ED US are more efficient and generate more relative value units per hour.\(^18\) This is a significant implication, although it is difficult to measure and quantify efficiency improvements. Other indirect financial benefits, such as the impact on reducing patient length of stay or reducing costs to care for patients, especially given fixed DRG payments, are not captured in our analysis. Finally, our ROI cost estimate was calculated with the cost of training ED faculty only. Clearly, there is a significant cost for training residents and in an academic program resident training costs are ongoing and do not have the same benefit of decreasing over time. We hoped to make this analysis as generalizable as possible to community practices and so did not include teaching residents in the cost estimate.

A key driver to realizing the potential billing volume is optimal documentation rates. Our data demonstrate that although the utilization rates are high, documentation rates were much lower. The paper documentation system appears to play a role in low documentation rates, and interventions such as computer charting systems and automated report generation may help improve documentation on ED US and other procedures performed in the ED. Research looking at increased revenue capture as this system adopts computer charting protocols is ongoing. Another area for achieving potential volume is increasing the billing rate of ED US for procedures. Although our institutional experience suggests that utilization rates are higher than billing rates for ED US use with procedures, a combination of improving documentation and increasing utilization will be needed to achieve the maximum potential.

**LIMITATIONS**

Several estimates are used to determine current revenue, potential revenue, and program expense, and thus the ROI calculation is an estimate. Sensitivity analysis was done to demonstrate the possible range in potential ROI. In addition, this is a single center study in an academic trauma center. The assumptions and practice setting must be considered carefully before applying these estimates to any specific institution. For example, collection rates and reimbursement rates relative to CMS data may be significantly different based on the patient population mix served by the ED. Also, the reimbursement environment in the future may change, leading to changes in revenue and ROI.

**CONCLUSIONS**

Our analysis shows that initiating an ED ultrasound program that bills for trauma and procedural
ultrasounds and achieves its potential billing volume breaks even in 4–5 years, which is less than the life span of initial investment, and thus is a positive investment.

References


18. Sierzenski PJ, Geria R, O’Connor RE. Emergency physicians who use emergency ultrasound demonstrate higher patient charges, patients seen, and relative value units per hour when compared with colleagues who are rare or non-users of emergency ultrasound [abstract]. Acad Emerg Med. 2006; 13(s5):193.