Advancing Internal Medicine Training: Experience of a Bedside Procedure Service as A Resident Elective

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Abstract

Background: In 2007, the American Board of Internal Medicine eliminated numeric procedure requirements for licensing. The level of exposure to procedures during residency, and subsequent competence of graduating residents, is variable. In 2015, our institution developed a bedside procedure service (BPS) with the intent to teach ultrasound guidance and procedural training to internal medicine residents with direct supervision of technique by Hospital Medicine faculty to optimize learning, increase confidence, and improve patient safety.

Objective: In this study, we review the number and complication rates of resident procedures on a dedicated internal medicine bedside procedure service (BPS) as a resident elective.

Methods: In this retrospective, observational, single-center study, we reviewed internally collected data from BPS procedures performed from 2015-2019. The BPS offers a variety of procedures done with ultrasound guidance at an adult tertiary care referral center. BPS services are available to all inpatient hospital services. A rotation with the BPS was offered as a stand-alone resident elective for the first time in 2015.

Results: 69 residents performed a total of 2700 ultrasound-guided/assisted procedures and 146 diagnostic ultrasound scans from 2015-2019. Residents performed an average of 40 procedures during their elective month. There were 5 resident performed procedural complications with an overall complication rate of 0.19%.

Conclusions: Our BPS increased procedural opportunities for residents and allowed for real-time feedback by an experienced faculty member in a one-on-one setting. A dedicated rotation allows the time to focus on becoming proficient in invasive procedures with expert supervision.

Introduction

In 2007, the American Board of Internal Medicine (ABIM) eliminated numeric procedure requirements for licensing and instead has put forth that “procedural competence need not be determined solely by a minimum number of successfully completed procedures but may be customized as appropriate through simulation, direct observation, and other criteria determined by the program director and clinical competency committee.” Under “Training and Procedure Requirements,” the ABIM states that “procedures are essential to internal medicine training: to be eligible for certification, all residents must perform procedures during training.” However, this is followed directly by the statement that “not all residents need to perform all procedures,” without any clear guidance as to how many of which procedures are indeed essential to internal medicine training[1]. The level of experience, and subsequent competence of graduating residents is largely unknown and studies report significant variability in the number of procedures performed as well as comfort level in all stages of training[2–6]. Furthermore, it appears that residents are entering a supervisory role before they are comfortable with doing a procedure. In a study by Mourad et al, as many as 42% of residents supervising paracenteses, 26% supervising thoracenteses,

39% supervising lumbar punctures, and 26% supervising central venous catheter (CVC) insertion said that they did so before feeling comfortable with procedure performance[7]. As reported in a qualitative study by Touchie et al on resident procedural skill acquisition, “we learn the procedures from a resident that has been supervised by a senior resident that has been supervised by other senior residents.”[8]. Learning from peers who themselves do not feel comfortable with the procedure they are supervising is a less-than-optimal experience for both the learner and the supervisor. This potentially leads to complications that could have otherwise been avoided. Unfortunately, as shown in a survey of internal medicine program directors by Ricotta et al, it seems that many internal medicine programs rely on credentialed resident to teach peers despite the fact that being credentialed often meant completing a minimum of only 3–5 procedures[5].

Multiple studies have looked at comfort level relative to number of procedures performed. On average, 7–10 procedures are required for a physician to feel comfortable performing that procedure[3, 4, 7]. Lack of procedural volume at institutions and faculty comfort with doing procedures may be limiting the ability of residents to develop comfort with certain procedures, especially if their experience is scattered over three years of residency[9]. For example, in a study by Grover et al, residents in their final year of training reported performing only 3 thoracenteses throughout the course of their residency[2]. The presence of a faculty-staffed procedure service available to offer supervision of resident procedures has been shown to increase the number of procedures performed and significantly increase rates of certification[10]. In a study by Lucas et al, the mean number of procedure attempts in resident medical services with access to a procedure team was 48% higher than in those without such access[11]. This suggests that the ready availability of experienced supervisors is important to residents and empowers them to attempt more procedures. In a study by Tukey et al looking at resident oversight on a medical procedure service, there was attending supervision in almost all (99.7%) of resident procedures done by the procedure team versus only 47% done by the primary medical service. The procedure service in this study had significantly lower rates of unsuccessful procedures and higher use of appropriate ultrasound guidance compared to procedures done by primary services, which may be attributed to more consistent attending-level oversight[12].

The success of a residency program in establishing procedural competence is difficult to measure directly, as comfort level is a subjective measure and rates of certification are highly institution dependent. While understanding its limitations, we have chosen the number of procedural attempts as our measure of success in procedural education. Each procedural attempt by a resident on our BPS included time discussing the procedure with the patient for the consent, hands-on experience with point-of-care ultrasound used to plan each procedure (with the exception of bone marrow biopsies), and then exposure to the procedure under the direct guidance of an expert faculty member with varying degrees of independence depending on the resident’s skill level. In this retrospective study, we review the number and complication rates of resident attempted procedures as a measure of success of a dedicated internal medicine bedside procedure service (BPS) in providing residents with exposure to a variety of different

ultrasound-guided bedside procedures under the direct supervision of hospital medicine faculty at the Medical College of Wisconsin (MCW).

Methods

Data Gathering

This retrospective, observational, single-center study is a review of internally collected data from BPS procedures performed from 2015–2019. Institutional review board (IRB) approval of this study was granted by the Medical College of Wisconsin/Froedtert Hospital Institutional Review Board #5 on 11/3/2020 (#PRO00039269). All methods were carried out in accordance with relevant institutional guidelines and regulations. Informed consent was waived by the IRB for this study due to its retrospective nature. Data is logged by BPS attendings and reviewed twice monthly by the service director to reconcile data as well as review complications associated with the service. Data is stored on an institution-approved protected drive/server and included the date of the procedure, primary service managing the patient, type of procedure, site(s) selected, number of attempts, success of the procedure, providers by name involved in the procedure (attendings and residents), complications, relevant lab parameters (platelets, hemoglobin, INR, creatinine). A free text column is used to communicate any irregularities related to the procedure or describe any complications that occurred.

BPS Operations

The BPS offers a variety of procedures done with ultrasound guidance at an adult tertiary care referral center for hospitalized patients. BPS services are available to all inpatient hospital services, including surgical services and the observation unit. Procedures offered by BPS include paracentesis, thoracentesis, lumbar puncture, central venous catheter insertion, arterial line insertion, arthrocentesis, bone marrow biopsies, abscess incision and drainage, non-tunneled small bore chest tubes (8.5–14 French), and bedside diagnostic scans of the lung, abdomen, soft tissue, vasculature, and heart. Point-of-care ultrasound is used for all procedures offered except for bone marrow biopsies. A rotation with the BPS was offered as a stand-alone resident elective for the first time in 2015 for one resident per month. This was expanded to two residents per month in 2017 due to resident request and the volume of procedures available. Thus, daily BPS operation currently consists of one attending hospitalist, two internal medicine residents, critical care APP fellows, and third-year medical students. Residents were prioritized over other learners and primarily performed most thoracenteses, paracenteses, and lumbar punctures under the direct supervision of a BPS attending. Depending on skill level, they either performed or assisted in the other procedures.

Results

Since the elective was started in 2015, 69 residents have rotated through it. The BPS performed 5724 procedures and 775 diagnostic scans without subsequent procedure from academic years 2015–2019 (Table 1). Residents performed a total of 2700 procedures and 146 diagnostic scans without subsequent

procedure over the same time period. Residents were involved in a total of 18 arterial lines, 33 arthrocentesis, 35 bone marrow biopsies, 114 central venous catheter placements, 765 lumbar punctures, 1081 paracenteses, 41 chest tubes, and 736 thoracenteses. Residents performed an average of about 40 procedures during their elective month (Table 2).

Over this time period, there were 5 complications among procedures by residents, leading to a complication rate of 0.19%. In comparison, the overall complication rate for the BPS was 0.30% (17 total complications). Both the overall and resident-specific complication rates are well below the standard complication rates cited in literature for the respective procedures (Table 3). Complications by year are detailed in Supplemental File 1.

The success of the elective is further reflected in the abundance of positive feedback it has received from residents (Supplementary File 2). In 2018, it won the Outstanding Rotation award for the internal medicine residency program at our institution. On course evaluations, the average rated quality of the rotation was 4.93 (scale of 1–5 with 5 being “high”), which is higher than the overall average for all electives offered (4.25).

Discussion

Our BPS demonstrates the success of a bedside procedure team teaching model in providing residents with a high volume of a variety of procedures with a low complication rate of 0.19%. On average, residents were able to perform almost 40 procedures per month during their rotation. For the most basic internal medicine procedures of lumbar puncture, paracentesis, and thoracentesis, the numbers were well above the average numbers cited by residents in other studies and the number of 7–10 procedures that multiple studies have suggested is necessary for a physician to feel “comfortable” doing a procedure [3, 4, 7, 13]. In addition to the techniques learned in doing the procedures themselves, the residents spent a lot of time using point-of-care ultrasound to evaluate lung, abdomen, vasculature, and soft tissues as part of decision-making process before any procedure (with the exception of bone marrow biopsies). As we often emphasize on the rotation, understanding when NOT to do a procedure is as important as knowing the technical skill of how to do it. The volume of encounters during the rotation provide them with ultrasound and procedural skills that will serve them well regardless of their ultimate practice environment. For this study, we have focused on procedural attempts by the residents as our proxy for measuring educational success in our program. As mentioned earlier, success is difficult to measure as it possesses a very subjective component, resident comfort, but we believe that number of procedures can be a simple measure of this success given previous studies.

A study by Huang et al evaluating resident comfort with common inpatient medical procedures including lumbar puncture, thoracentesis, paracentesis, and CVC placement found that more than half of resident physicians were uncomfortable with at least one of these procedures with thoracentesis having the lowest comfort status. Rotation on a medical procedure service doubled the odds that a resident was comfortable with the procedure suggesting that a dedicated experience with one-on-one supervision was

helpful in improving competency[4]. A similar study by Lenhard et al evaluating resident comfort levels in invasive procedures found that there was a statistically significant increase in the number of residents who felt comfortable performing thoracentesis, CVC placement, and lumbar puncture after rotating on a procedure service. Rates of comfort for these procedures were in the 80–90% range for those who did the rotation even though the residents performed a mean of only 8.3 procedures during their time on that procedure service, suggesting there is a very high educational yield for relatively few experiences[13]. Our study adds to this body of evidence by providing an accurate assessment of exact numbers of procedures done by residents, approximately 40 procedures per resident. The complication rate is also acceptably low and showed a clear decline as our service matured, further supporting the role of a group of experts who supervise/train residents.

The development of a simulation-based standardized curriculum, which has been proposed by Lenchus as a way to improve invasive beside procedural instruction, is a growing area of interest and certainly an important and effective method of ensuring competency[14]. However, we believe that the hands-on experience afforded by a dedicated procedure service (in addition to simulation education) allows residents the repetition and real-life experience necessary to be truly comfortable with doing procedures. Additionally, point-of-care ultrasound has become the standard of care for procedures in hospital and critical care medicine with multiple position statements regarding the use of ultrasound with procedures as well as for diagnostic purposes [15–20]. As well as becoming increasingly mandatory for hospitalists and intensivists, ultrasound has many applications in other subspecialties, making it important to have a strong ultrasound curriculum so that internal medicine residency graduates will have a good foundation in these skills.

There were several limitations to this study. The level of independence during the procedure was dependent on previous experience and the level of confidence of the learner. Therefore, if the resident was an early learner then the attending physician likely assisted significantly during the procedure, whereas by the end of the rotation the resident would likely be doing the procedure independently with only verbal feedback from the attending physician. There was an attending physician present and involved with each procedure, thus ensuring patient safety and direct learner feedback. This was a single-center study at a tertiary care academic medical center and may not be generalizable to other programs.

Conclusion

The development of dedicated procedure services allows increased procedural opportunities and the direct resident supervision by an experienced faculty member in a one-on-one setting, therefore addressing some of deficits in current procedural training. A stand-alone rotation allows residents the time to focus on becoming proficient in invasive procedures with expert supervision to teach troubleshooting and minimize complications, which will prepare them for procedures as an attending physician. The Medical College of Wisconsin BPS counts our resident elective as successful given the high-procedural volume and positive reviews from our residents.

Declarations

Ethic Approval and Consent to Participate: Institutional review board (IRB) approval of this study was granted by the Medical College of Wisconsin/Froedtert Hospital Institutional Review Board #5 on 11/3/2020 (#PRO00039269). All methods were carried out in accordance with relevant institutional guidelines and regulations. Informed consent was waived by the IRB for this study due to its retrospective nature.

Consent for Publication: Not applicable

Availability of Data and Materials: The datasets generated and/or analyzed during this study are not publicly available due to the inability to fully de-identify the data such that protection of patient information can be assured. It is a requirement of the institution that this data be kept only on a secure server within the internal system of the institution. Aspects of the dataset could be made available from the corresponding author on reasonable request if adequate de-identification is possible.

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Sheila Swartz, Adrian Umpierrez De Reguero, Ricardo Franco Sadud: Conceptualized and designed the study, collected data, drafted the manuscript, agree to be accountable for all aspects of the work, and approved of the final manuscript as submitted.

Joseph Ronald Puetz, Lara Voigt, Nikola Cuzovic, and Matthew Bielecki: Contributed to design of the study and data collection instrument, participated in data collection, revised the manuscript, agree to be accountable for all aspects of the work, and approved of the final manuscript as submitted.

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Tables

Table 1: Overall BPS Procedures by Year

Procedure	2015-2016	2016-2017	2017-2018	2018-2019
Total Evaluations	1203	1702	1833	1761
Total Performed Procedures[1]	1100	1517 (89.1%)	1610 (87.8%)	1485 (84.3%)
Arterial line[2]	77/75	10/10	3/3	6/6
Arthrocentesis	10/10	15/14	20/18	27/19
Bone Marrow Bx	0/0	25/25	122/122	115/113
CVC (including non-tunneled dialysis catheters)	139/138	104/100	96/89	69/60
Lumbar puncture with and w/o IT chemo	239/237	387/382	452/449	360/356
Paracentesis	478/423	696/611	557/467	542/427
Pulmonary drain	3/2	60/55	72/61	81/67
Thoracentesis	246/207	389/310	499/397	557/436
Other[3]	11/8	16/10	12/4	4/1
Complications	8 (0.74%)	2 (0.18%)	5 (0.31%)	2 (0.13%)

[1] Procedure attempted with at least one needle pass.

[2]Numbers indicate total evaluated/total performed.

[3] Includes procedures performed with low frequency: peripheral intravenous lines, point-of-care cardiac scans, central line removals, line suturing, I&D, lymph node biopsy, abdominal drain placement

Table 2: Resident Procedures by Year (% of total performed)

Procedure	2015-2016	2016-2017	2017-2018	2018-2019	Total	Average per Resident
Total Evaluations	454 (37.7%)	687 (40.4%)	860 (46.9%)	845 (48.0%)	2846	41.2
Performed	420 (38.1%)	645 (42.5%)	831 (51.6%)	802 (54.0%)	2698	39.1
Arterial line	14 (18.2%)	1 (10%)	0	3 (50.0%)	18	0.26
Arthrocentesis	4 (40.0%)	7 (46.7%)	10 (50%)	12 (44.4%)	33	0.48
Bone Marrow Bx	0	1 (4.0%)	21 (17.2%)	13 (11.3%)	35	0.51
CVC (including non-tunneled dialysis catheters)	28 (20.1%)	24 (23.1%)	36 (37.5%)	26 (37.7%)	114	1.7
Lumbar puncture	104 (43.5%)	182 (47.0%)	268 (59.3%)	215 (59.4%)	768	11.1
Paracentesis	208 (43.5%)	305 (43.8%)	284 (51.0%)	288 (53.0%)	1084	15.7
Pulmonary drain	2 (66.7%)	6 (10.0%)	9 (12.5%)	24 (29.6%)	41	0.59
Thoracentesis	89 (36.2%)	158 (40.6%)	229 (45.9%)	264 (47.2%)	739	10.7
Other[1]	5 (50.0%)	3 (18.8%)	3 (25.0%)	0	11	0.16
Total Residents	10	12	23	24	69	
Complications	4 (0.36%)	0	1 (0.05%)	0	5	

[1] Includes procedures performed with low frequency: peripheral intravenous lines, point-of-care cardiac scans, central line removals, line suturing, I&D, lymph node biopsy, abdominal drain placement

Table 3: Complication Rates of BPS Procedures from 2015-2019[a]

Procedure	Overall	Resident	Standard
CVC/Dialysis catheter	3/405 (0.7%)	1/114 (0.9%)	1.2%[21]
Paracentesis	1/2269 (0.04%)	0	1.4%[22]
Pulmonary drain	2/213(0.9%)	0	2%[23]
Thoracentesis	11/1690 (0.7%)	4/736 (0.5%)	2.5%[24]

a. There were no complications associated with arterial line placement, bone marrow biopsy, I&D, arthrocentesis, or lumbar puncture.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- suppfile1.docx
- supplfile2.docx