Two-Year Experience of 14 French Pigtail Catheters Placed by Procedure-Focused Hospitalists

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BACKGROUND: Recent studies show small-bore chest tubes, commonly 14 French pigtail catheters (PCs), are noninferior to large-bore chest tubes for treating various conditions, and they are associated with better patient comfort. The Medical College of Wisconsin implemented a bedside procedure service (BPS) that has been trained in the placement of PCs as an adjunct to its interventional radiology department.

METHODS: The data regarding consults for PC placement was collected by the BPS over a 2-year period. Primary outcomes reviewed were insertion-related complications (IRCs), unsuccessful attempts (UAs), and adverse outcomes (AOs) because the authors believe these represent the safety and effectiveness of the group. It was determined which services consulted the BPS for PC placement, the indications for consults, and a brief review of declined PC consults.

RESULTS: Of the 124 accepted consults, the service had 3 IRCs (2.4%), 2 UAs (1.6%), and 3 AOs (2.4%). A total of 18 consults were declined. The BPS was consulted by 12 services with 8 primary reasons for PC placement.

CONCLUSIONS: At high-volume, tertiary care centers, and with the support of cardiothoracic surgical and interventional radiology services, procedure-focused hospitalists can safely serve as an adjunct service for PC placement in selected hospitalized patients. *Journal of Hospital Medicine* 2020;15:526-530. © 2020 Society of Hospital Medicine

Over the last 15 years, studies have demonstrated the efficacy of small-bore chest tubes (SBCTs), or pigtail catheters (PCs, most commonly ≤14 French), in treating pneumothorax (PTX),[1-5] traumatic hemothorax (THTX), hemopneumothorax (HPTX),[6,7] parapneumonic effusions (PPEs),[8,9] pleural infections,[10] and symptomatic malignant pleural effusions.[11] A randomized, controlled trial also showed that PC placement resulted in better pain scores, compared with large-bore chest tubes (LBCTs), for traumatic PTX.[5] The British Thoracic Society does state that LBCTs may be needed for PTXs with very large air leaks, especially postoperatively. Further, LBCTs may be indicated if small-bore drainage fails, but otherwise they recommend PCs as first-line therapy for PTX, free-flowing pleural effusions, and pleural infections.[12]

BEDSIDE PROCEDURE SERVICE DEVELOPMENT

The Medical College of Wisconsin (MCW) provides hospitalist services to Froedtert Hospital, a large, tertiary care, teaching hospital in Milwaukee, Wisconsin. A subset of hospitalists started the bedside procedure service (BPS) in 2013. The BPS initially performed procedures within the traditional scope of internal medicine–trained physicians (eg, thoracentesis, paracentesis, lumbar puncture, and arthrocentesis). Because of hospital need, the BPS began to include procedures not traditionally performed by hospitalists, including bone marrow biopsies and nontunneled central access venous catheters. With the service's low complication rate and high volume of procedures, it was sought by cardiothoracic (CT) surgery services to assist in PC placement as an alternative to interventional radiology (IR).

BPS Pigtail Catheter Training

CT surgery initially trained the BPS director in PC placement using the Seldinger technique in 2015. The director's training period with CT surgery included direct observation by CT surgery providers for 5 PC placements. Prior to placing PCs, the director had performed approximately 400 ultrasound-guided thoracenteses. The BPS director then independently trained the remaining BPS and has placed or supervised over half of the service's 124 PCs. Initial credentialing for each BPS physician requires 5 PC placements and 20 thoracenteses under direct supervision of credentialed BPS members. Credentialing is maintained by BPS physicians completing 3 PCs and 15 thoracenteses per year.

Newly credentialed providers are capable of independently placing most PCs. However, the requirements for credentialing are minimal and newly credentialed physicians still encounter PC placements with challenging factors not addressed in their training, such as anterior approach, small effusions, atypical effusion location, mild to moderate coagulopathy, recent therapeutic anticoagulation, and large body habitus. To address

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TABLE 1. **BPS PC Placement Standards**

Ultrasound Requirements	
Prior to Pleural Space Access: Visualization of the cephalad rib border superficial to an adequate depth of pleural effusion or PTX.	
After Pleural Space Access: Video of guidewire entry into pleural space.	
Pleural Effusion	**Pneumothorax**
Depth ≥1.5 cm	Evidence of PTX (absence of lung sliding confirmed with M-mode). Optional: Lung point (intermittent appearance of lung sliding marking the edge of PTX nearest the lung).
Location Recommendations	
Pleural Effusion	**Pneumothorax**
Location of deepest effusion pocket, typically the posterior axillary line in the 6th-8th ICS.	3rd-5th ICS along the mid-axillary line (approximately the "triangle of safety") or 2nd ICS anteriorly along the midclavicular line (rarely).
Coagulation Criteria for PC Placement	
Platelets: ≥50	
International Normalized Ratio: ≤2.0 (including patients on warfarin)	
Heparin Drip: Stop at least 2 hours prior to placement; restart no earlier than 2 hours after placement.	
Therapeutic Enoxaparin: Give last dose (1 mg/kg or 1.5 mg/kg) 24 hours prior to placement; restart no earlier than 2 hours after placement.	
Direct Oral Anticoagulants: Give last dose (1 mg/kg or 1.5 mg/kg) 24 hours prior to placement; restart no earlier than 2 hours after placement.	
Safety Criteria	
Patient must be able to tolerate procedure per the judgement of the procedural attending.	
If unable to tolerate procedure, usually patient is too weak or sedation is required, then procedure is declined. If patient requires procedural sedation, we recommend interventional radiology.	

Abbreviations: BPS, bedside procedure service; ICS, intercostal space; PC, pigtail catheter; PTX, pneumothorax.

these challenges, the BPS has instituted an "on call" system. This system is typically staffed by the BPS director or associate director, already attending on a separate medical service. When needed, the "on call" physician will supervise the newer BPS members to ensure safety while the less experienced physician places the PC. Although rare, if an "on call" member is not available, then it is the practice of the BPS to recommend IR for PC placement.

BPS Operation

Daily BPS operation consists of one attending hospitalist, two internal medicine residents, and a third-year medical student. PCs are placed primarily (95%) by the attending on service under ultrasound guidance using the Seldinger technique with lidocaine for anesthetic. For all PC consults, the attending BPS physician reviews the indication prior to placement. If not a direct consult from surgical services, most PC consults are appropriate referrals to the service after the primary medicine service has consulted CT-surgery or pulmonary consult teams. After review, the primary role of the BPS is assessing safety of PC placement, including whether the patient can tolerate PC placement without procedural sedation. The BPS's additional standards for safe PC placement are listed in Table 1.

Additionally, it is not routine practice of the BPS to recommend PC placement when consulted for a thoracentesis. The exception to this rule is patients whose PPE sonographic imaging demonstrates loculation or septations. This is consistent with the latest review on pleural disease.[13] In addition, the institution's CT surgery services prefer to initially treat septated PPEs with PCs and fibrinolytic therapy rather than immediate video-assisted thoracoscopic surgery (VATS).

The BPS operates a partnership with CT surgery in which, after successful PC placement, CT surgery manages the PC immediately and until removal including the negative pressure applied and need for fibrinolytic therapy. CT surgery also determines if secondary therapy, commonly second PC or VATS, is required. After PC placement, a portable chest x-ray (CXR) is taken and then BPS follows the patient in person the following day to note any insertion-related complications (IRCs).

In this paper, data on the consults to the BPS for PC placement over a 2-year period are presented. Primary outcomes included numbers of and indications for PCs consulted—attempted or not attempted—consulting services, IRCs, unsuccessful attempts (UAs), and adverse outcomes (AOs). PC duration, fluid drainage, need for fibrinolytic therapy, or need for secondary therapy were not measured because these decisions were managed by the CT surgery service.

PATIENTS AND METHODS

Institutional review board approval of this retrospective study was granted by MCW/Froedtert Hospital Institutional Review Board #5 on January 14, 2019 (MCW IRB #PRO00033496). Adult patients hospitalized at Froedtert Hospital whose primary team determined they would clinically benefit from a PC and

TABLE 2. **Insertion-Related Complications**

Complication	Sequela	Adverse Outcome
1. Hemothorax (Mammary Artery Laceration)	Required CT surgery intervention.	Patient exsanguinated and died.
2. PC tip coiled in RLL of Lung	IR placed CT-guided 2nd PC same day. CT surgery removed incorrectly placed PC following day.	Respiratory failure; required ventilatory support for 3 days.
3. PC tip coiled in RLL of Lung	Fluoroscopy guided 12FR PC placed by IR. Old PC removed by IR.	None.

Abbreviations: CT, cardiothoracic; IR, interventional radiology; PC, pigtail catheter; RLL, right lower lobe.

TABLE 3. **Unsuccessful Attempts**

Reason	Unsuccessful on Review	Sequela
1. Unable to place: Patient uncooperative	Yes	PC placed by IR with conscious sedation.
2. Unable to Pass PC: Wire kinked	Yes	PC removed at bedside; PC placed by IR.
3. Loculated apical pneumothorax: partial response	No	Secondary apical PC placed same day by CT surgery.

Abbreviations: CT, cardiothoracic; IR, interventional radiology; PC, pigtail catheter.

consulted the BPS service for placement were included. There were no exclusion criteria.

The authors conducted a retrospective review of two secure BPS databases. The first database is a record of all procedure consults, while the second database contains information about all attempted PCs. Initial review of the BPS's consult database found 142 PC consults. Consults were classified as "declined" or "attempted." In addition to the database comparison, the authors performed a manual chart review on patients with documented complications (n = 6) to clarify sequela, those with unclear PC indication (n = 2), and to resolve the discrepancies between our two databases (n = 3). Finally, a brief chart review was performed to review procedures in the subsequent 48 hours after a declined PC consult (n = 18).

Complications fell into two categories, IRCs and UAs. IRCs were defined as unintentional PC placement into a location other than the pleural space or PC placement that resulted in an AO according to the judgement of the attending BPS physician. A UA was defined as an unsuccessfully attempted PC placement, with the BPS unable to pass a PC in the pleural space for any reason. An AO was defined as any escalation of care that could be related to the procedure within 24 hours of attempt/placement found in our databases and/or manual chart review (eg, emergent intubation, surgery, death).

RESULTS

Over a 2-year period, the BPS was consulted to place 142 PCs. After resolution of the 3 discrepancies, total consults remained 142, PC attempts totaled 124 (87.3%), and declined consults totaled 18 (12.7%).

The 18 declined consults were not performed for reasons relating to procedural safety. These included 15 (83.3%) for insufficient fluid depth, 1 (5.6%) poor window for PTX, and 1 (5.6%) patient unstable per BPS attending judgement. One (5.6%) final consult had a previous drain in same hemithorax that resumed functioning.

The manual chart review of procedures performed 48 hours after declined PC consults found only 3 of 17 (17.6%) patients received a PC within the subsequent 48 hours. The 18th patient was unable to be followed in our electronic medical record because his medical record number was recorded incorrectly.

The remaining 124 consults were deemed safe for PC placement. Indications for PC placement varied; the most common indications were complicated effusion (36.3%), large or recurrent effusions (21.8%), PTX (17%), and hemothorax (HTX; 17%). The most common teams who consulted the BPS for PC were medicine/hospitalists (42.7%) and CT surgery (40.3%).

There were 3 IRCs (Table 2) out of 124 attempted consults (2.4%). Of these cases, 2 patients had AOs. IRC patient No. 1 required a PC for PTX and developed a hemothorax from a right-sided mammary artery laceration. Emergent operative measures were taken, but unfortunately the patient died. IRC patient No. 2 was septic from pneumonia when a PC was placed for a complicated PPE. Unfortunately, the patient went into respiratory failure and required intubation. The postintubation computed tomography scan did note that the PC placed by the BPS likely terminated in the lower lobe of the right lung but without PTX. After a new PC was placed by IR, the patient received antibiotics, 3 days of ventilator support, and was discharged home. The authors believe that sepsis from pneumonia was the more probable cause of the respiratory failure in IRC patient No. 2 instead of the PC placement.

Three UAs were charted in the database, but on review it was determined that only 2 (1.6%) qualified as UAs (Table 3). A PC was attempted with the UA patient No. 3 for a loculated apical PTX. It is clear in the procedure note that the

pleural space was accessed, air was appropriately drained, and a PC was advanced safely into the pleural space; however, the PC then stopped draining air. CXR interpretation also noted "pneumothorax described on prior exam is less evident." Because the pleural space was accessed safely and had a partially therapeutic response, we do not count this PC placement as a UA. The PC may count as "failed," but determination of a "failure rate" is not the intent of this paper. This point is further discussed in the Discussion section.

In addition, chart review demonstrated that UA patient No. 3 required intubation within the 24-hour period after our PC attempt, which is an AO. Approximately 10 hours after our PC was placed and removed, CT surgery placed a second PC, and 3 hours after their PC placement, the patient was intubated with subsequent bronchoscopy. The patient was extubated after only 17 hours. This sequence of events suggests mucus plugging as a more likely cause for respiratory failure than our PC attempt, but we have included it as an AO given the time frame.

Overall, the AO rate was low. Out of 124 attempted PC placements only 3 (2.4%) had an AO, and as noted above, it is believed that 2 of these patients had an AO caused by other medical problems rather than by PC placement.

DISCUSSION

To our knowledge, this is the first report of the experience of procedure-focused hospitalists with PC placement in a partnership with CT surgery. We believe that, at high volume, tertiary care centers similar to Froedtert Hospital, internal medicine–trained, procedure-focused hospitalists can serve as adjuncts to surgery, pulmonary, and IR services in the placement of PCs in hospitalized patients who do not require procedural sedation.

Given the development of this service and the nature of its shared operations with CT surgery, we do not believe that the BPS has an appropriate comparison in the literature; however, the IRCs are similar to previous papers describing PC placement.[5-7,14] Notably, the IRC and AO rates were low, both 2.4%, which indicates safe placement of PCs. Kulvatunyou et al and Bauman et al reported on PC placement from a surgical perspective and reported IRC rates of 4%-10%.[5-7,14] These higher IRC rates likely have a few reasons. First, Kulvatunyou et al and Bauman et al did not use ultrasound guidance. Use of ultrasound guidance may have significantly lowered their IRC rate. Second, the definition of IRC used by Kulvatunyou et al and Bauman et al included dislodgements, but we do not believe this to be an IRC. Dislodgements can happen for several reasons, frequently a result of patient movement or forgetfulness, not because of improper placement. Third, the PCs with this BPS are placed primarily by attending physicians. Resident roles on our BPS in PC placement are primarily as assistants, whereas Kulvatunyou et al and Bauman et al note that both attendings and residents, under attending supervision, placed PCs; however, it is not clear what percentage of PCs were placed by attendings or residents in their studies. Finally, this BPS's IRCs are self-reported, so they could be perceived as falsely low, but given the small number of physicians involved in the group and its standardized follow-up, we do not suspect this is truly contributing to the low rates.

Other complication rates regarding the use of wire-guided SBCTs and PCs range from 0% to 42%[15-20]; however, several differences including tube size, physician training, and PC indication make these studies imperfect comparisons. The most notable difference in our opinion is the variable definition, or lack of definition, of a complication. One study did not define their complications,[19] while other studies list subjective measures like pain,[16,20] cough,[16] bleeding,[16,20] and hematomas[4,15] as complications. We believe that the lack of consensus definition for PC complication or IRC contributes to the large range of complication rates in the literature. This problem is likely not unique to PC placement, but is instead true across all bedside procedures. In a shared-practice model between hospitalists and CT surgeons, we believe the definition of IRC in this paper is adequate in capturing most complications. The only complication we are currently unable to track well is infection. We consider other items discussed previously, such as pain, cough (often from lung re-expansion), minor bleeding, and even small hematomas, to be a part of the procedure and not a complication.

Finally, regarding the IRCs and associated death, this was a tragic event. Complications for all of the BPS's procedures are infrequent (0.35% over the same time period) and reviewed between the BPS director and the attending who performed the procedure; in addition, given this mortality, the case was reviewed immediately in detail with our CT surgery colleagues. On review, it was easy to determine that the operator had found a clear lung tip and sonographic signs of PTX; however, CXR review did demonstrate a medial placement of the PC. This was judged to be a poor placement location (even with imaging demonstrating PTX in that area) given the well-known "triangle of safety" defined by the British Thoracic Society.[12]

After review, the primary emphasis for PC placement was safe location. The BPS now strives to place PCs for PTX only in the "triangle of safety." The BPS believe that most PTXs can be addressed with this placement. In the rare case of a PTX requiring an anterior approach, only the BPS director currently places apical PCs for PTX while on service or "on call." He discusses the placement with pulmonary and CT surgery directly to determine that the PC is of absolute necessity.

Given the focus on appropriate location, no formal changes were made to the procedural imaging practice described in Table 1. We realize that vascular imaging would seem necessary after this patient's mammary artery laceration; however, safe location, in addition to the BPS's current image requirements, is believed to minimize this risk. We feel the imaging criteria align with recommendation No. 5 of the Society of Hospital Medicine's Position Statement for Ultrasound Guidance for Adult Thoracentesis.[21] Some BPS members use vascular ultrasound imaging to confirm absence of vascularity, but it is not required and occasionally not possible, such as in the occasional case of PTX with subcutaneous emphysema.

The UA rate is low without a natural comparator in the literature. It is important to clarify the difference between the UAs and the frequently mentioned "failure rate" (FR) in Kulvatun-

you et al and Bauman et al.[6,7,14] We classify UAs as the inability, for any reason, to access the pleural space and insert a PC. At this stage, these UAs appear to reflect the service's new experience with PC placement and inability to provide procedural sedation. Kulvatunyou et al and Bauman et al's FR is defined as an initial PC successfully placed into the pleural space that then required a second PC or intervention (frequently VATS) to resolve the PTX or retained HTX.

We believe calculating the failure rate will be helpful in demonstrating the value of our BPS and our shared-practice model. We look forward to publishing this and other future research, including determination of the cost and time saved by the BPS for PCs and other procedures.

Limitations of this study include its retrospective nature, results from a single center's experience, and lack of a comparison group.

Our institution feels that there is great benefit in having a BPS operated by procedure-focused hospitalists. It would also be important to determine if our model can be replicated by another institution.

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