Canadian Medical Education Journal

Original Research

Anticipation or avoidance: internal medicine resident experiences performing invasive bedside procedures

Appréhension ou évitement : l'expérience des résidents en médecine interne par rapport aux procédures invasives au chevet du patient

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Published ahead of issue: Jun 12, 2023; CMEJ 2023 Available at https://doi.org/10.36834/cmej.73122

Abstract

Background: Internal Medicine (IM) residents are required to perform bedside procedures for diagnostic and therapeutic purposes. Residents' experiences with procedures vary widely, for unclear reasons.

Objective: To explore IM residents' experiences with performing bedside procedures and to identify barriers and facilitators to obtaining sufficient experience.

Methods: Using an inductive, thematic approach, we conducted five individual semi-structured interviews and one focus group with seven IM residents (12 residents in total) during the 2017-2018 academic year at a Canadian tertiary care centre. We used iterative, open-ended questions to elicit residents' experiences, and barriers and facilitators, to performing bedside procedures. Transcripts were analyzed for themes using Braun and Clarke's method.

Results: We identified four themes 1) Patient-specific factors such as body habitus and procedure urgency; 2) Systems factors such as time constraints and accessibility of materials; 3) Faculty factors including availability to supervise, comfort level, and referral preferences, and 4) Resident-specific factors including preparation, prior experiences, and confidence. Some residents expressed procedure-related anxiety and avoidance.

Conclusion: Educational interventions aimed to improve procedural efficiency and ensure availability of supervisors may help facilitate residents to perform procedures, yet may not address procedure-related anxiety. Further study is required to understand better how procedure-averse residents can gain confidence to seek out procedures.

Résumé

Contexte : Les résidents en médecine interne (MI) sont amenés à effectuer des procédures au chevet du patient à des fins diagnostiques et thérapeutiques. Les expériences des résidents par rapport à ces procédures varient considérablement, et nous ne savons pas pourquoi.

Objectif : Explorer les expériences des résidents en médecine interne en matière d'interventions au chevet du patient et recenser les facteurs qui entravent ou, au contraire, facilitent l'acquisition d'une expérience suffisante.

Méthodes : En utilisant une approche inductive et thématique, nous avons mené cinq entretiens individuels semi-structurés et un groupe de discussion avec sept résidents IM (12 résidents au total) dans un centre de soins tertiaires canadien au cours de l'année universitaire 2017-2018. Nous avons utilisé des questions ouvertes itératives pour interroger les résidents sur leur expérience d'intervention au chevet des patients, ainsi que sur les obstacles et les facilitateurs de ces interventions. Les transcriptions ont été analysées pour dégager des thèmes selon la méthode de Braun et Clarke.

Résultats : Nous avons relevé quatre thèmes : 1) les facteurs spécifiques aux patients comme l'habitus corporel et l'urgence de l'intervention; 2) les facteurs systémiques comme les contraintes de temps et l'accès au matériel; 3) les facteurs liés aux enseignants, notamment leur disponibilité pour superviser, le fait d'être à l'aise avec eux et leurs préférences en matière de référence; et 4) les facteurs spécifiques aux résidents, à savoir la préparation, les expériences antérieures et la confiance. Certains résidents ont déclaré vivre de l'anxiété face aux procédures et les éviter.

Conclusion : Les initiatives éducatives visant à améliorer l'efficacité des procédures et à assurer la disponibilité de superviseurs peuvent faciliter leur réalisation par les résidents, mais elles ne peuvent pas atténuer l'anxiété que ces interventions suscitent chez ces derniers. Des études supplémentaires sont nécessaires pour trouver des façons d'accroître la confiance des résidents qui sont réticents face aux interventions au chevet du patient.

Introduction

Internal Medicine (IM) residents routinely perform invasive bedside procedures for diagnostic and therapeutic purposes, such as lumbar puncture and paracentesis. In addition to being a necessary part of patient care, performance of invasive bedside procedures is also required by most medical training boards, including the Royal College of Physicians and Surgeons of Canada.[1] In Canada, residents are expected to gain entrustability to independently perform thoracentesis, paracentesis, lumbar puncture, knee arthrocentesis, peripheral arterial catheter insertion, intubation and central venous catheter insertion.[2]

Residents learn to perform these procedures both through structured learning activities like procedural simulation as well as at the bedside while being supervised by a more senior resident or staff physician.[3,4] However, there is growing evidence suggesting poor confidence in the ability to both perform and teach bedside procedural skills amongst trainees and faculty.[5–7] Some researchers have hypothesized that declining procedure volumes and referrals to procedural services may be responsible for lower confidence in residents.[8] It has also been reported that residents with low confidence in their procedural skills are more likely to make a referral to an Interventional Radiology (IR) or subspecialty service, further reducing their overall procedural experience and limiting their ability to gain expertise.[9] This cycle may then be perpetuated. In general, the more procedural experience a resident attains, the more likely they are to report being comfortable performing a specific procedure and the more likely they are to demonstrate competency.[10,11] A recent conceptual review of the alignment between confidence and competence noted that confidence "can change rapidly in response to different modifiers," such as courage on the one hand, or doubt on the other; the level of confidence a learner has "should reflect the dynamics of the specific situation that an individual finds themselves in."[12] It is possible that a resident's confidence can be undermined by doubt, anxiety or past failures, despite adequate training. It is therefore important to understand, from residents' perspective, the factors that influence their own confidence in performing bedside procedures, so that appropriate educational supports can be developed and implemented.

There is considerable variability in the number of procedures completed, both across training programs and within similar training settings.[10] Though factors such as specific procedural skill training and prior experiences with procedures are a predictor of larger procedure volumes amongst junior residents, the reasons for variability amongst residents is not fully understood within IM.[13] The purpose of this study was to understand the experiences of IM residents performing invasive bedside procedures during their core IM years postgraduate year (PGY) 1-3 of residency, and to identify barriers and facilitators to performing bedside procedures. Although residents graduating from PGY3 still require 1-2 years of additional training before they enter independent practice, they are expected to be competent in the core bedside procedures listed. In doing so, we hope to identify areas in which educational interventions may help residents in acquiring these key procedural skills.

Methods

Design

We conducted a qualitative study using an inductive, thematic analytic approach, in order to explore residents' experiences. We conducted semi-structured interviews and a focus group aimed at eliciting residents' experiences and barriers and facilitators to performing the core bedside procedures required of IM residents at a Canadian tertiary care centre.

Participants and setting

After receiving ethics approval from the Research Ethics Board at Mount Sinai Hospital (17-0221-E), we recruited residents enrolled in the University of Toronto General Internal Medicine Program based at Mount Sinai Hospital in Toronto, Canada between July 1, 2017-June 30, 2018 (*n* = 45 residents across PGY1-3 years at this site). This hospital has a large inpatient IM clinical teaching unit comprised of approximately 85 inpatient beds, staffed by approximately 20 attending faculty over the course of the year. Participants were recruited through e-mail, and provided informed consent prior to interviews. At this hospital, IM residents are exposed to bedside procedures early in residency through simulation sessions that are focused on the most common bedside procedures of internal medicine, including: thoracentesis, paracentesis, and bone marrow biopsy. There also exists an IR service that is available during daytime hours from Monday to Friday to perform non-emergent procedures, and several subspecialty services such as respirology, gastroenterology and rheumatology are also present and assist with inpatient procedures.

Data collection

We offered participants the option of either a one-on-one interview or participation in a focus group.[14] We chose to do this because while focus groups allow for sharing of ideas and stories and the opportunity for participants to build on each other's descriptions, we also recognized that some residents may have had adverse experiences with procedures and may prefer a more confidential interview. Between November 2017 and June 2018, the lead author conducted 3 interviews, followed by a focus group and then 2 further interviews. Individual interviews lasted between 16:17 and 27:42 minutes and the focus group lasted 28:40 minutes. Participants included 42% (n=5) PGY1 residents and 58% (n=7) PGY2 residents with an equal number of women and men identifying participants.

The choice to have interviews conducted by the lead author, who was a fellow resident, was deliberate, as we anticipated that participants would be more forthcoming with a peer who shares a nuanced understanding of and experience with procedures beyond what might be expected of a research assistant. All interviews were audio-taped and transcribed verbatim. Any participant information was removed and transcripts were de-identified.

Interview questions were developed through discussion between all authors, and followed a general open-ended technique with targeted follow-up questions. For example, "Tell me about some successful procedure experiences that you have had. What were some facilitators that made them successful?" or "Tell me about some unsuccessful or negative procedure experiences. What were some barriers?" As data were analyzed, the interview questions were iteratively modified to address evolving themes. For example, in an early interview, one resident described confidence performing procedures being closely linked to early experiences performing the procedure and the procedural success or failure. In later interviews, early procedural experiences were asked about specifically when residents expressed discomfort with procedures. Interviews continued until subsequent interviews did not add new codes, or substantially alter existing codes or themes, at which point we determined that we had reached data sufficiency.[15,16]

Data analysis

All authors contributed to the initial coding framework and review of the themes. As per Braun and Clarke, data analysis and coding began after the first interview.[17] In step 1, the lead author immersed herself in the data by reading and re-reading each consecutive interview, and shared her insights with the team. Reflexivity is a way of being attuned to one's own assumptions and pre-conceptions, which was particularly relevant for this study given the interviewer's shared experiences with the participants as a near-peer.[18] Reflexive discourse was deliberately included during data analysis sessions with the co-investigators, and in the iterative development of our interview questions. This iterative approach allowed us to adapt future questions to more deeply explore themes that were identified early on. In step 2, initial codes were generated by AL and other team members. Step 3 involved all team members in a process to collate codes into themes, going back and forth to the data to ensure representativeness. During this process, all transcripts were considered together as a single dataset. During team meetings we refined, expanded and challenged the codes and themes, going back and forth to the transcripts, until consensus was reached. In steps 4 and 5 the team met to review themes and generate a thematic "map" of the data, and to further refine and name the themes. We used NVivo Software (Version11, QSR International Ptl Ltd., Victoria, Australia) to help organize and facilitate coding.

Results

We identified four main themes that represented both barriers and facilitators to the performance of procedures. These included: a) patient-related factors, b) systems factors, c) faculty -related factors and d) resident-related factors (Table 1).

Patient-related factors

Several patient-specific factors were identified as barriers to performing procedures, including difficult anatomy, perceived difficulty tolerating the procedure, as well as communication and language barriers impeding the ability to obtain consent. Residents also cited potential for complications and concerns regarding patient safety as barriers, and these patients were more likely to be referred to Interventional Radiology (IR): "People will refer to IR because it will be a technically challenging procedure and there are concerns around patient safety." [Interview 4]. Similarly, some residents cited factors such as body habitus "Sometimes if it's a lumbar puncture on a really obese patient…You'll try for half an hour and it's just not happening." [Focus Group (FG)]. Residents also cited some characteristics of individual patients that were helpful to their ability to perform procedures, such as preparation

and familiarity with the procedure. For example, one resident described a positive outcome that was influenced by the patient's prior experience: "The patient knew exactly what the procedure was going to be like…When I walked into the room he even started positioning himself…The whole thing went very smoothly." [Interview 4].

System factors:

Participants described systems-level factors that were typically barriers to performing procedures. Residents universally expressed that time constraint was a major barrier, which was exacerbated on days when there were fewer numbers of trainees on the ward. For example, one resident described,

> *There's a lot of time pressure and recognizing that if we have to discharge 6 or 7 people and there's just one resident on, that procedure is just not going to be done by that one resident in the midst of doing everything else. [Interview 5].*

Residents described that the ability to perform procedures and seek out procedural experiences was hindered by the amount of time it took to gather the materials, perform the procedure, and process the samples, which was perceived as challenging and time-consuming:

> *It's just frustrating because in theory this should take me half an hour to do but in reality it takes me an hour or an hour and fifteen minutes because I have to spend 30 minutes running to the ED, the 10th floor, the 8th floor, finding a kit, trying to find a bottle, all of that stuff. [Interview 4].*

Systems factors that enabled residents to perform procedures included availability and use of preparatory materials such as video tutorials, online procedure guides and availability of a procedure manual. One resident cited that the presence of recent procedural teaching, or observation of a team-member performing a procedure had a positive impact on their confidence and procedural success: "I just went through the videos, and then having gone through the simulation sessions which we have as part of our academic half-days, I went through all the steps and it went very well. Struck gold!" [Interview 3]. Another resident attributed experience gained at a high-volume procedure clinic on a subspecialty gastroenterology rotation to later procedural success, describing the clinic as the "turning point for when I felt comfortable supervising a paracentesis" [Interview 5].

Faculty-related factors

There were several faculty-related factors that were perceived as barriers to performing procedures, including a faculty's apparent ability and willingness to supervise. Some residents did not feel supported in doing the procedure themselves, and perceived pressure to refer to IR. One resident described "I've been surprised by how many times I've been told, 'You know what, we're not going to do it. Send to IR.'" [Interview 5]. The reasons for this may be related to discomfort supervising specific procedures that the staff had not performed recently, and perhaps apprehension about the potential for procedural difficulty or complications. One resident, paraphrasing their staff, said, "I had multiple staff that were like, 'I haven't done a lumbar puncture in 10 years, I am absolutely not going to supervise you to do one." [FG]. Interestingly, one of the senior residents brought up their apprehension about approaching the staff to help supervise a junior resident:

> *There are times when I've wanted to ask the staff to go supervise because I have been very short staffed, and I've asked the staff to go and supervise [the procedure], and you feel a bit of tension because they have to go do it, when it should be you as the senior, like it's entirely your responsibility...You have this fear of bringing it up. [FG].*

In contrast, there were other residents that described "there are many staff who are very, very supportive" [FG] and available to help: "The only time I really wanted someone supervising me, I was able to get the supervision from my attending." [Interview 2]. The availability and willingness to supervise is certainly a facilitating factor. The reluctance to ask for additional support was not universal, and may be specific to certain faculty members or residents.

Resident-related factors

We identified several resident-specific factors that heavily influenced their overall experience of performing procedures, including poor confidence and anxiety as barriers. Confidence in performing procedures came partly from previous experiences with procedures including high volumes of prior procedures and early procedural success. Conversely, when residents had a previously negative experience (a procedure that did not go well or resulted in a complication) especially early on in their training experience, they were more likely to develop an aversion to procedures in general:

> *The senior asked me to do a thoracentesis…It just didn't go well…If that had been my first one, I would have definitely been much more ready to refer to IR for every thoracentesis that comes up…It becomes difficult to disentangle the mess of, how much of that was my lack of competence, is this going to happen again? [Interview 5]*

One resident postulated that the early attempts at procedures should be limited to controlled environments with higher likelihood of procedural success: "Was it your first time doing it? Is it ideal? If it's really complicated, maybe that shouldn't be your first one." [Interview 1].

Confidence was also influenced by a resident's perception of themselves through the lens of the patient. In particular, if the resident felt as though the patient might judge them harshly, it reduced their confidence in their ability to perform the procedure. Poor procedural confidence originating from the resident's self-consciousness about their own performance - particularly if they forgot materials or required multiple attempts to obtain a sample –also contributed to a sense of poor confidence: "Fumbling, de-gloving, re-gloving it's like 'man this patient probably doesn't trust me.' If I miss, I'll stop and I suck...I'm tapped out." [Interview 1]. Another resident described that forgetting materials and needing to repeatedly exit the room created "anxiety" for themselves and the patient, leading to eroded confidence [Interview 3]. When junior residents experienced challenges performing a procedure, they were quick to internalize and attribute the challenges to themselves rather than external factors.

Some residents eagerly sought out procedures in order to gain experience, such as one who noted that "in every situation where it's like 'should we send them to IR just for the convenience of it?', and I've been on service, I've stepped in and said 'I would like to do the procedure'". [Interview 4] However, several residents also expressed anxiety related to procedures, describing "feeling nervous" about procedures, particularly those requiring repeated attempts to obtain samples [Interview 3]. Another resident described performance anxiety: "It makes you think that the patient is thinking, like, oh man this guy is terrible!" [Interview 1]. One resident expressed significant anxiety they felt related to their limited procedural experience as a barrier to seeking out further procedure experiences:

> *It's a catch-22 because it's nerve wracking to do a procedure where I haven't had much experience, but I need to do the procedure to get the experience. And as I move forward, the fact that I haven't had as much experience as I would have liked to becomes the large elephant in the room. At the beginning of PGY1 I would have been very happy to do the procedure, but now it's nerve wracking. [Interview 5].*

This resident described feeling "relieved" when there was a contraindication to a bedside procedure that would prevent them from being required to perform it overnight. They also described the relative ease of procedure avoidance, and the feeling that they could "slide under the radar" if they chose to avoid procedures. Similarly, they described a "vicious cycle" of referring patients to the IR service, and the resulting inexperience leading to less confidence performing procedures [Interview 5].

A main facilitator for procedural performance was future-planning and the knowledge that the residents would be required to independently perform procedures urgently, overnight and unsupervised, in the future. One resident described,

> *I want to get as many procedures under my belt as possible…In the very near future I will have to be supervising someone do this…for every procedure that we do in Internal Medicine, there is a circumstance or situation that can't wait until the morning… I want to get my hands on as many as I can so I'm ready for when I need to be doing them emergently. [Interview 4].*

Discussion

We studied residents' experiences of performing invasive bedside procedures during their core IM training program and have captured insights into the complex barriers that residents face when attempting to obtain procedural skills. Within the greater context of IM residency programs in which rotations are structured in order to achieve specific learning outcomes, procedural skill development is largely self-directed.[19]

In contrast to non-procedural competencies which are rigorously assessed by standardized examination by the Royal College of Canada, procedural skills training and assessment falls to individual residency programs. As a result of this framework, it is crucial for residency programs to understand and address barriers to the acquisition of procedural skills, and to bolster the facilitating factors that enable residents to seek out these procedure experiences. We identified both barriers and facilitators to procedure performance at the patient-level, system-level, faculty-

level and at the level of the individual resident. While many of the barriers that we identified are non-modifiable, for example patient anatomy and the amount of time residents have in their already busy days, we were able to identify several key areas for educational interventions aimed at improving procedural experiences.

We were struck by the variability in residents' comfort levels around procedures. Although Kay et al identified similar themes of time, supervision, experience, patient factors, logistical challenges and resident referral tendencies, their participants did not discuss anxiety as a substantial barrier to resident performance of invasive bedside procedures.[20] The majority of residents interviewed individually expressed some degree of anxiety or discomfort performing procedures, whereas those participating in the focus group did not volunteer this information, perhaps due to discomfort disclosing this in front of their peers. In our series, one particularly anxious resident had a substantial aversion to procedures, and experienced distress associated with both performing procedures and feeling incompetent to perform them. Though discomfort has been previously reported when performing procedures emergently, or during the first procedural experience particularly for PGY1 residents, subsequent and ongoing procedural aversion has not been reported in this context.[10,21] In the psychology literature, avoidance learning is the process through which individuals learn a response to avoid anxiety-provoking situations.[22] Our findings suggest that procedural aversion may develop in residents with a negative early procedural experience such as development of a complication, or difficulty obtaining a diagnostic sample. We hypothesize that early procedure experiences in a controlled environment and avoidance of challenging first experiences should be attempted to build confidence. To our knowledge, this has not been specifically studied before in the context of acquiring procedural skills.

The vicious cycle described by residents of low procedure volumes resulting in poor confidence and procedural avoidance is also important to identify as early intervention may reduce avoidance in the future. It has been shown previously that residents with low procedural confidence were more likely to refer to subspecialty services.[9] In particular, anxious residents could be encouraged to self-identify in order to allow program directors and clinical supervisors to create an individualized plan to build confidence, address personal psychological barriers and to disrupt avoidant behaviours. In our study, one procedure-averse resident gained confidence in paracentesis after performance of several paracenteses in a lower-stress environment of a subspecialty clinic. Perhaps residents with low procedural experience or high procedure-related anxiety should be specifically identified and receive encouragement to attend specialized procedure clinics if available, though this strategy has not been formally evaluated. The optimal identification of these residents is unclear and could be the subject of future study.

The use of procedural services such as IR was viewed as a double-edged sword in that residents were relieved to have more free time, but this detracted from their procedural learning volumes and experience. Aside from the impact on resident education, heavy use of procedure services has been reported to be associated with procedure delay, and an increased cost and length of stay in hospital.[23] Referral to IR may however be appropriate for certain procedures, particularly those anticipated to be technically challenging or higher-risk, and balancing the educational needs of residents with patient safety is of utmost importance.[24]

The residents we interviewed were more comfortable and felt more proficient when there was recent procedure training which, in our institution, includes a simulation day timed at the beginning of PGY1. The literature indicates that there is significant skill decay after three to six months post simulation activity when there has not been interim application or practice, supporting the importance of placing simulation training close to the clinical activity, such as just-in-time simulation strategies, or at multiple time-points during the academic year.[25,26]

Several educational interventions were cited by our residents as being helpful in facilitating performance of procedures, including the formation of "procedure carts" to reduce the time necessary to gather materials.[27] In addition, they suggested simplifying the complexity of sample labeling and processing by creating site-specific instructions.

Based on our findings, we suggest that the model of apprenticeship learning of procedures, which is highly variable and dependent on the abilities and skills of the clinical teacher, be supplemented by additional opportunities.[28] One possibility is a procedures service rotation, which offers high volumes and opportunity for skilled supervision.[21] If this is not feasible given resource constraints, our results suggest that participation in a dedicated procedures clinic may offer similar benefits to

allow residents to learn techniques from skilled operators and to gain experience with more procedures.

Limitations

There are some limitations of our study that may impact the transferability of our findings. This was a single-centre study at a large academic centre with resources that may not be universally available. Also, although we reached data sufficiency, we can make no claims regarding representativeness of our sample. Our participants may have been drawn to participate because of extremely positive or negative experiences that they wished to share. Our data set included only PGY1 and PGY2 residents and no PGY3s volunteered to participate. While we cannot be certain why, we suspect that scheduling limitations, interest, and availability were factors. Our results may therefore be more reflective of early procedural learning experiences. Our decision to offer either individual interviews or a focus group allowed participants who were uncomfortable in a group setting to participate more confidentially. This was borne out in our results, as we only saw evidence of anxiety and avoidance in the individual interviews. However, by doing so we may have missed out on capturing discussion between the more procedurally averse residents, which may limit interpretation. Combining interviews and FGs is not uncommon in qualitative research and allows for the triangulation and integration of findings from each method into a more robust understanding of a phenomenon.[14] However, caution should be taken when assessing transferability of these findings to other settings or studies that may have used other methods of data collection.

Additionally, at the time of our study the residency program had not yet fully transitioned to competency-based medical education (CBME), and it is unclear what effect this might have on the issues we identified.[29] For example, it is not known whether procedural requirements under CBME will provide an impetus to perform more bedside procedures, or if residents will gravitate towards more predictable simulated settings in order to achieve the required assessments.

Conclusions

Internal Medicine residents perceive several barriers to their acquisition of competence in procedural skills. Though there are health systems and education systems-level issues that can be addressed to facilitate performance of procedures by residents, procedure-averse residents may be less likely to benefit unless their procedure-related anxiety and avoidance is specifically addressed. Further research is warranted to enable identification of residents who develop aversion to procedures, and to develop effective strategies to help them succeed.

Conflicts of Interest: No conflicts of interest or funding
Authorship: All listed authors contributed equally to study design, data analysis and manuscript preparation. All listed authors declare that they have no competing interests.

Table 1. Thematic analysis and coding.

Patient-Related Factors	Anatomy	"Sometimes if it's a lumbar puncture on a really obese patient…You'll try for half an hour and it's just not happening." FG
	Tolerance of procedure	"This was a psych patient who just wouldn't tolerate that well. It just didn't work, she wasn't sedated enough and there were contraindications to sedation." Interview 1
	Communication barriers	"it took a long time to get consent for this non-English speaking patient." FG
	Patient preparation	"The patient knew exactly what the procedure was going to be like…When I walked into the room he even started positioning himself…The whole thing went very smoothly." Interview 4
	Urgency of procedure	"For every procedure that we do in internal medicine, there is a circumstance or situation that can't wait until the morning." Interview 4
	Patient safety concerns	"I'm inclined to not poke and prod again and again just to prevent harm to the patient obviously, for fear of causing harm or infection, you know, I just gave up" Interview 3
	Contraindication to procedures	"I know their INR is 3, they make me a bit more jittery, and those I would defer" Interview 4
	Potential for complications	"Because of the pleural involvement we didn't want to go through tumour and cause bleeding, and the effusion was loculated as well, so we deferred to thoracic surgery." Interview 3
Systems Factors	Accessibility of materials and equipment	"It's just frustrating because in theory this should take me half an hour to do but in reality it takes me an hour or an hour and fifteen minutes because I have to spend 30 minutes running to the ED, the 10th floor, the 8th floor, finding a kit, trying to find a bottle, all of that stuff." Interview 4
	Physical space limitations	"For example if a patient has a knee to be tapped in the middle of the hallway that's sort of suboptimal." Interview 5
	Challenging sample processing	"After procedures there's always a mad-dash scramble when you're like, what do I do with these 3 or 4 tubes and what labels to put where and how to not get this lost, because that's another huge thing." Interview 5
	Availability of IR	"They're referred to IR because of having the convenience of just having someone else do the procedure for you" FG
	Culture of referral	"It was like its okay we won't get this other stuff done but this procedure is a priority. Whereas at [this hospital] I felt like everything was sent to IR." FG
	Time constraints	"There's a lot of time pressure and recognizing that if we have to discharge 6 or 7 people and there's just one resident on, that procedure is just not going to be done by that one resident in the midst of doing everything else." Interview 5
	Short-staffing	"So if you're busy and you're short staffed in terms of your juniors, it just won't get done." FG
	Time of day	"It was like 4 or 5 and then the senior who was on call got busy and was like, no I don't have time to supervise this right now lets just do it tomorrow morning" Interview 4
	Procedure volumes	"Well I don't know if the [hospital] volumes are less than elsewhere in the city, it might be a component of that or that as we do less procedures or IR does more, we get less comfortable and familiar and less confident in our skills and it is a bit of a vicious cycle." Interview 5
Faculty-Related Factors	Ability to supervise	"I had multiple staff that were like, 'I haven't done a lumbar puncture in 10 years, I am absolutely not going to supervise you to do one." FG
	Pressure to refer	"I've been surprised by how many times I've been told, 'You know what, we're not going to do it. Send to IR'" Interview 5
Resident-Related Factors	Motivation	"if I was really procedure averse, it would have been possible for me to totally slide under the radar." Interview 5
	Confidence	"Fumbling, de-gloving, re-gloving it's like 'man this patient probably doesn't trust me.' If I miss, I'll stop and I suck...I'm tapped out." Interview 1
	Experience/volume	"I just don't have enough experience" FG
	Early experiences	"The senior asked me to do a thoracentesis…It just didn't go well…If that had been my first one, I would have definitely been much more ready to refer to IR for every thoracentesis that comes up…It becomes difficult to disentangle the mess of, how much of that was my lack of competence, is this going to happen again?" Interview 5
	Troubleshooting ability	"I haven't done enough that I feel comfortable troubleshooting the procedure. Because if I'm like, not in the right space, I wouldn't know how to fix that." Interview 4
	Comfort with equipment	"Sometimes for malignant patients with a thick pleura, using the catheter that comes with the kit you don't always have great control of the introducer." Interview 2
	Preparation	"I just went through the videos, and then having gone through the simulation sessions which we have as part of our academic half-days, I went through all the steps and it went very well. Struck gold!" Interview 3
	Anxiety and Distress	"It's a catch-22 because it's nerve wracking to do a procedure where I haven't had much experience, but I need to do the procedure to get the experience. And as I move forward, the fact that I haven't had as much experience as I would have liked to becomes the large elephant in the room. At the beginning of PGY1 I would have been very happy to do the procedure, but now it's nerve wracking." Interview 5

Acronyms: Interventional Radiology (IR), Focus group (FG)

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