ORIGINAL RESEARCH



# Gender Disparities in Critical Care Procedure Training of Internal Medicine Residents

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## ABSTRACT

**Background:** Procedural training is a required competency in internal medicine (IM) residency, yet limited data exist on residents' experience of procedural training.

**Objectives:** We sought to understand how gender impacts access to procedural training among IM residents.

**Methods:** A mixed-methods, explanatory sequential study was performed. Procedure volume for IM residents between 2016 and 2020 was assessed at two large academic residencies (Program A and Program B: 399 residents and 4,020 procedures). Procedural rates and actual versus expected procedure volume by gender were compared, with separate analyses by clinical environment (intensive care unit [ICU] or structured procedural service). Semistructured gender-congruent focus groups were conducted. Topics included identity formation as a proceduralist and the resident procedural learning experience, including perceived gender bias in procedure allocation.

**Results:** Compared with men, women residents performed disproportionately fewer ICU procedures per month at Program A (1.4 vs. 2.7; $P < 0.05$) but not at Program B (0.36 vs. 0.54; $P = 0.23$). At Program A, women performed only 47% of ICU procedures, significantly fewer than the 54% they were expected to perform on the basis of their time on ICU rotations ($P < 0.001$). For equal gender distribution of procedural volume at Program A, 11% of the procedures performed by men would have needed to have been performed by women instead. Gender was not associated with differences in the Program A structured procedural service (53% observed vs. 52% expected; $P = 0.935$), Program B structured procedural service (40% observed vs. 43% expected; $P = 0.174$), or in Program B ICUs (33% observed vs. 34% expected;

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$P = 0.656$). Focus group analysis identified that women from both residencies perceived that assertiveness was required for procedural training in unstructured learning environments. Residents felt that gender influenced access to procedural opportunities, ability to self-advocate for procedural experience, identity formation as a proceduralist, and confidence in acquiring procedural skills.

**Conclusion:** Gender disparities in access to procedural training during ICU rotations were seen at one institution but not another. There were ubiquitous perceptions that assertiveness was important to access procedural opportunities. We hypothesize that structured allocation of procedures would mitigate disparities by allowing all residents to access procedural training regardless of self-advocacy. Residency programs should adopt structured procedural training programs to counteract inequities.

**Keywords:**
gender disparities; procedure training; residency; graduate medical education; critical care

The American Board of Internal Medicine recommends that all residents be provided with the opportunity to achieve procedural competencies as an essential component of training (1). However, few studies have examined the procedural training experiences of internal medicine (IM) residents, and the influence of gender on access to IM procedural training has not been explored. Gender is known to influence procedural training in other specialties, and gender disparities in procedural volume have been described in surgery and ophthalmology residencies (2–4). Authors postulated influence from multiple areas, including bias from teaching faculty and patient perceptions (2). Some of the unconscious bias may relate to preconceived ideas about gender roles, identifying men as hands-on learners and women as having soft skills (5). It remains unknown *1*) if disparities exist in IM procedural training; and *2*) what mechanisms explain potential disparities.

We hypothesized that women would perform disproportionately fewer procedures in IM residency and that disparities would be greatest in unstructured learning environments, particularly in intensive care units (ICUs).

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We further sought to explore how gender influences procedural training in IM residency and what factors promote or mitigate gender-based disparities.

## METHODS

We conducted a mixed-methods observational study of two IM training programs: Program A and Program B. The quantitative data preceded and, therefore, influenced the qualitative data collection in an explanatory sequential design. The institutional review boards at both institutions approved the study protocol. At both programs, IM residents are exposed to procedures via *1*) rotations on a structured procedural service; and *2*) critical care rotations. The structured procedural service provides residents with attending-supervised protected procedural training, and procedural volume is tracked for appropriate allocation. The procedural services at both institutions were similarly structured (6). Briefly, two interns on a mandatory 2-week rotation perform procedures (e.g., lumbar puncture and paracentesis) for admitted patients. Unlike the procedural service, allocation and training for procedures performed in critical care settings are unstructured at both institutions: Opportunities for procedural training occur as the clinical need arises.

### Study Population and Quantitative Data Acquisition

We quantified procedures performed by male and female IM residents and compared procedural volume and rate while controlling for time on rotations. Gender was determined by demographic data provided by each program, which was collected from self-reports on residency application or on matriculation and available for all residents. During the study period, residency applications provided a binary option for gender. Time spent on procedural service and critical care rotations was determined from individual schedules from the Amion scheduling system (7). Procedure notes authored by IM residents were extracted from the electronic medical records (EMR). Notes between June 2016 and March 2020 were included for Program A residents and between May 2018 and June 2020 for Program B residents. Data before these date ranges were unavailable because of transitions in the EMR and/or changes in the standardized method of procedure documentation. The five most performed procedures for each institution's residents included: paracenteses, thoracenteses, lumbar punctures, and central lines (both programs); arterial lines (Program A); and joint aspirations and/or injections (Program B). Specialty choice was determined by fellowship match reports.

### Quantitative Data Analysis

Two-tailed $t$ tests and chi-square tests were used to compare baseline variables. Two-tailed $t$ tests or Wilcoxon rank sum tests were applied, as appropriate, to compare procedural rates by gender. Expected procedural volume was calculated as the product of the procedural rate within the full cohort and the time spent on rotation, therefore controlling for time on rotation. Gender differences in observed versus expected procedural volume were compared. Data were analyzed by program (A vs. B), as well as by learning environment (structured procedural service vs. ICU rotations). Statistical analysis was performed with STATA 15.1. $P < 0.05$ was considered significant.

### Qualitative Data Acquisition and Analysis

The semistructured focus group (FG) guide was developed by members of Program A on the basis of prior surveys from the surgical training literature that were influenced by gender and identity formation theoretical frameworks (8, 9). The FG guide was pilot tested with five participants and revised accordingly. Questions centered on perceptions of gender disparities in access to procedural training, the influence of gender on interactions with supervisors, the relationship between gender and self-advocacy, and the role of gender in identity formation as a proceduralist (*see* data supplement).

Categorical IM residents enrolled at both institutions were recruited via email by convenience sampling. Participation was voluntary and verbal consent was obtained. FGs included four to seven participants and were led by an individual at each program: J.T.D. and L.S. (A); E.M.O. and D.M.S. (B). FGs were conducted between May and June 2020 at Program A and during October 2020 at Program B. Participant groups were Gender congruent and had a mixture of degrees of training (postgraduate years 1–3). Every participant provided input on open-ended questions. Facilitators prompted further discussion on the basis of nonverbal cues. FG recordings were transcribed verbatim for thematic analysis guided by a grounded theory framework (10, 11). First, three team members (E.M.O., D.M.S., and T.G.D.) familiarized themselves with the data, identifying initial concepts with support from existing literature on procedure acquisition and gender bias. These concepts influenced the coding criteria, which were reviewed and revised by two content experts (L.S. and D,J.K.). By study completion, no new

**Table 1.** Cohort characteristics

| | Program A | | | | Program B | | | |
|---|---|---|---|---|---|---|---|---|
| | Total | Women | Men | *P* Value | Total | Women | Men | *P* Value |
| Residents, *n* (%) | 181 (100) | 95 (52) | 86 (48) | n/a | 218 (100) | 87 (40) | 131 (60) | n/a |
| Matched specialty, *n* (%) | | | | | | | | |
| Cardiology or PCCM | 42 (23) | 19 (20) | 23 (27) | 0.283* | 53 (24) | 15 (17) | 38 (29) | **0.047*** |
| Other or general medicine | 139 (77) | 76 (80) | 63 (73) | | 165 (76) | 72 (83) | 93 (71) | |
| Weeks on rotation, mean (SD) | | | | | | | | |
| Procedure service | 3.61 (0.61) | 3.65 (0.64) | 3.57 (0.57) | 0.430† | 1.06 (1.00) | 1.13 (1.00) | 1.00 (1.00) | 0.392† |
| Critical care | 6.06 (3.07) | 6.24 (3.34) | 5.87 (2.76) | 0.426† | 8.88 (5.12) | 7.52 (4.69) | 9.78 (5.22) | **0.001**† |
| Procedures per months, median (IQR) | | | | | | | | |
| Procedure service | 15.3 (5.92) | 15.5 (7.07) | 15.0 (5.50) | 0.8221‡ | 8.57 (6.43) | 8.57 (6.42) | 10.7 (8.57) | 0.4210‡ |
| Critical care | 2.00 (3.79) | 1.40 (3.37) | 2.65 (3.77) | **0.0262**‡ | 0.54 (1.07) | 0.36 (1.07) | 0.54 (1.07) | 0.2300‡ |

*Definition of abbreviations*: IQR = interquartile range; PCCM = pulmonary and critical care medicine; SD = standard deviation.
Bold values denotes statistically significant with $P < 0.05$.
*Chi-square test of independence.
†Two-tailed *t* test.
‡Wilcoxon rank sum test.

themes were identified, indicating thematic saturation. Themes between Program A and Program B were compared.

## RESULTS

### Quantitative Analysis

At Program A, 181 residents (52% women) completed 3,094 procedures (2,448 on procedural service and 646 ICU). Women in Program A performed a median of 1.40 ICU procedures per month, compared with 2.65 for men ($P < 0.05$) (Table 1). On the basis of their time spent in ICU rotations, Program A women were expected to perform 54% of the 646 ICU procedures. In actuality, women performed significantly fewer procedures than expected for their time in critical care rotations, completing only 47% ($n = 304$) of the ICU procedures ($P < 0.001$) (Figure 1A). For equitable gender distribution, 38 of 342 (11%) of the intensivist procedures performed by men would have needed to be performed by women instead. At Program A, performing at least five of a particular procedure indicates clinical competency (signed-off). Only 27% ($n = 26$) of women had performed five or more ICU procedures during the study period, compared with 38% ($n = 33$) of men. No gender disparities existed in procedural volume for procedures performed on the structured procedural service at Program A ($n = 2,448$ on procedural service; $P = 0.935$) (Figure 1A).

At Program B, 218 residents (40% women) completed 926 procedures (565 on procedural service and 361 ICU) (Table 1). Women in Program B performed a median of 0.36 ICU procedures per month, compared with 0.54 for men ($P = 0.23$) (Table 1). No gender disparities in procedural volume existed for procedures performed either in the ICU setting ($n = 361$; $P = 0.656$) or on the structured procedural service ($n = 565$; $P = 0.174$) (Figure 1B).

### Qualitative Analysis

Program A held four gender-congruent FGs with 22 participants (11 men and 11 women). Program B held two gender-congruent FGs with eight participants (four men and four women). FGs averaged 43 minutes for men and 58 minutes for women.

We identified three themes related to gender and access to procedural training in residency: *1*) procedural self-identity; *2*) procedural self-advocacy; and *3*) team

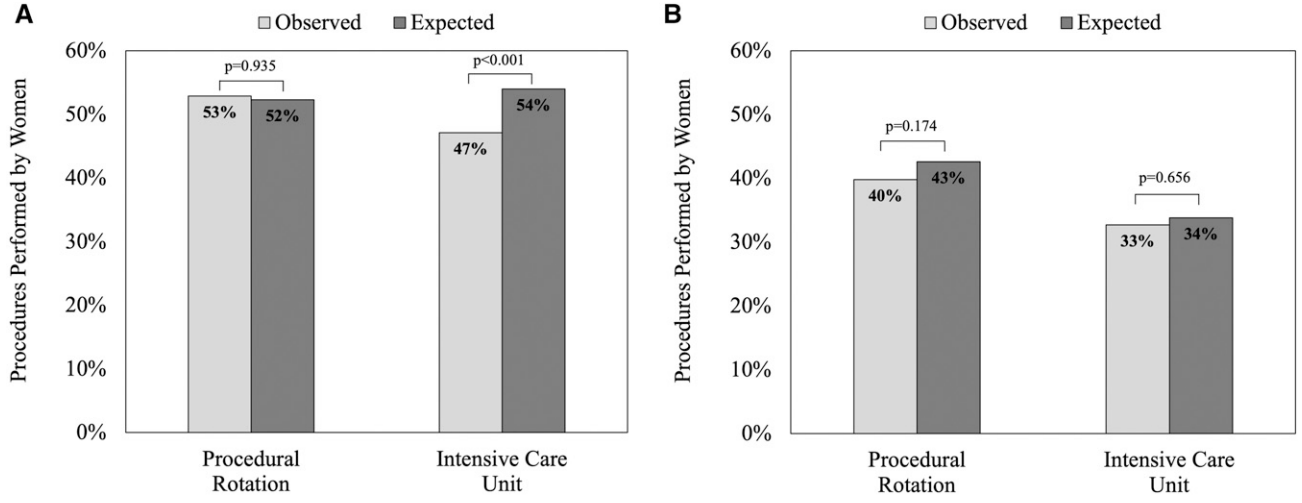


**Figure 1.** Observed versus expected number of procedures performed by women. (*A*) Program A. (*B*) Program B.

**Table 2.** Representative quotes from focus group analysis

| Themes | Representative Quotes |
|---|---|
| Self-identity | |
| Subspecialty interest | "There was a time when I really wanted to do cardiology, and probably the biggest deterrent was the procedural aspect of it. For some reason, and I do feel that [gender] is part of this, I don't see myself doing it." A, Female, PGY2 |
| | "I do feel that when I think of a proceduralist, I don't necessarily think of a woman." A, Female, PGY2 |
| Self-doubt | "Your job shouldn't be to convince the fellow or the [attending] that you're smart enough or good enough or read-up enough to do [a procedure]. It should be, how do we get our interns more procedures, and maybe, it's the senior's job to go to bat on your behalf." B, Female, PGY3 |
| Deferring procedures | "The fellow would do all of our lines, and I didn't even realize it was an option that [the fellow] would be able to teach me … because we were so overloaded." A, Female, PGY2 |
| Self-advocacy | |
| Comfort level | "Men don't question themselves as much, whereas women do. That might be an unfair stereotype, but I would never be like: 'Oh, there's a central line; I'm going to do it'. I would be like: 'Do I actually feel comfortable? Do I need to go watch a video?'" B, Female, PGY1 |
| | "There's probably bending of the rules … I probably would attempt a femoral line on my own without supervision, so there's probably some disparity in terms of the confidence and the comfort in doing those, even if you technically crossed [the sign-off] threshold." A, Male, PGY3 |
| Gender dynamics | "There is a difference in comfort level between men and women, even though we're trained the same … I've noticed my coresidents who are men tend to be much more likely to say, 'Yeah! I'm up for that!' or 'I'll definitely do that!' even early on compared with my female coresidents, including myself." B, Female, PGY2 |
| Suggestions for improvement | "I like the idea about … not having to forcibly advocate for yourself or feel like you're taking away from anyone else's experience." A, Female, PGY3 |
| Team dynamics | |
| Chain of supervision | "I don't feel like my male gender has stopped me from getting procedures in the ICU. I feel like it's more a decision of allocation. It depends on the [supervisor] and whether they push more for the resident to kind of step up and take the procedure or if they're more in the background." B, Male, PGY3 |
| Depends on higher-level trainee needs | "I did not let interns do lines because I needed the lines myself. It's a bit more on me to be proactive and ask, especially if I'm not signed off. Otherwise [another service] will do it if the fellow doesn't want to come in [to supervise]." A, Female, PGY3 |
| Supervisor impact | "There's definitely a bro culture being a procedures person, and that sort of general environment in terms of who we see and what's modeled. They were overwhelmingly men who were going into procedural fields, and I think that creates an environment where there's a disparity." A, Male, PGY3 |
| Patient impact | "[On the procedure service], I do not think gender plays that much of a role because once you get into the room, patients do not have that much of a chance to discriminate or allocate on the basis of gender." B, Male, PGY1 |
| | "I have to overcompensate with confidence to try to make the patient believe that I deserved to be there doing that procedure." A, Female, PGY1 |

*Definition of abbreviations*: A = Program A; B = Program B; ICU = intensive care unit; PGY1 = postgraduate year 1; PGY2 = postgraduate year 2; PGY3 = postgraduate year 3.

dynamics around procedural training (Table 2). Procedural self-identity includes perceptions about intrinsic procedural skillsets. Procedural self-advocacy captures the requirement for the learner to be proactive in accessing procedural opportunities and be selected by supervisors for procedures. Team dynamics around procedural training describe the interactions with the learning environment leading to procedure acquisition.

### Procedural Self-identity

Male residents were more likely to describe themselves as proceduralists or procedure-oriented. Male residents reported that their greater interest in procedural specialties may lead to increased procedural volume relative to women. Women residents noted that pursuing procedural subspecialties was often a gender-incongruent aspiration. Even female residents with reported interest in receiving procedural training did not identify as inherently procedure-oriented. Females in FGs at both institutions identified a perceived priority to complete other tasks over procedures, including putting in orders, updating families, teaching, etc., which they noted as possibly more aligned with traditional gender stereotypes.

> *"I feel like growing up [ … ] there's more of a perception of men as tinkerers who fix things. I see myself more as someone who thinks about things to fix them rather than someone who actually gets my hands on to fix things that way" (Program A, female, postgraduate year 3).*

Reluctance to perform a procedure often resulted in fellows performing the procedures instead of residents. Together with potentially having different self-identified priorities compared with their male colleagues, female residents acknowledged their own inherent gender bias. Even if the female resident was interested in procedures, they assumed their male colleagues fit the prototype of a proceduralist more than they did.

### Procedural Self-advocacy

Residents of both genders acknowledged a need for self-advocacy to acquire procedural training, particularly in the ICU. Increased allocation of procedures to residents who self-advocate was perceived as being primarily influenced by confidence rather than overt gender discrimination. Residents discussed justifying to supervisors that they were confident completing the procedure, especially if they had less experience. Participants at both institutions perceived that rotating non-IM residents (e.g., emergency medicine and anesthesia) were approached for procedures more frequently, attributing this to their alleged increased experience. Both genders pointed out that men may be more active in seeking procedures and more willing to self-advocate for these opportunities, possibly because of increased expressed interest in procedural subspecialties. Confidence is built from experience, so residents who effectively self-advocate early in training continue to receive more opportunities later. Women frequently identified that self-advocacy was adversely influenced by negative reinforcement from supervisors who asked them to be team players or share procedural opportunities. Women also displayed a heightened focus on adequate self-preparation to ensure a safe procedure as a barrier to volunteering for procedures.

### Team Dynamics around Procedural Training

Although the allocation of the procedure service was perceived to be equitable and fair by residents of both genders, there was a sense that the allocation of

procedures in the ICU was dependent on a hierarchy with gender influencing interactions with supervising fellows/faculty, coresidents, nursing staff, and even patients. Program B residents relied on their existing team structure and adherence to a strict hierarchy influencing ICU procedure allocation. In comparison, Program A residents observed a less well-defined hierarchy in which certain residents may be afforded earlier opportunities on the basis of subjective factors (e.g., confidence over competence). Male residents may develop more rapport with male fellows or nurses and thus may be preferentially selected. Female FGs at both institutions emphasized the importance of having female critical care faculty as role models, which counteracts the influences of a bro culture referenced in both male and female FGs. A key difference between institutions was that Program A residents commented on nurses or fellows actively seeking out residents who were perceived as procedure-focused.

> *From my experience, lines beget more lines, procedures beget more procedures, and you become kind of known as the procedural person. So, the nurses or fellows will seek you out because they want something done quickly (Program A, male, postgraduate year 3).*

Perceptions of gender inequity were more obvious when there was less supervision, such as overnight. Several male residents at Program A felt comfortable doing central lines unsupervised at night, even if they hadn't been formally signed off. They described limited resources at night, including the need to call in a fellow for supervision as a primary reason for doing the procedure unsupervised. Comparatively, Program A female residents spoke of avoiding doing procedures overnight because of feeling guilty for calling in a fellow overnight. Lack of supervision was perceived as a barrier to performing the procedure themselves. These residents may delay the procedure until morning or enlist others (e.g., emergency or anesthesia providers and more experienced/confident coresidents) to help.

## DISCUSSION

In both programs, there were no gender differences in procedural volume for procedures performed during structured procedural rotations. However, there was a notable disparity in ICU procedural volumes for women residents at Program A but not at Program B. Residents from both institutions reported that self-advocacy and confidence were important characteristics for obtaining opportunities to perform procedures in the unstructured critical care setting. Men attributed gender differences in procedural volume to gender differences in interest in procedural-based specialties. Women expressed evidence of stereotype threat with regard to identifying as proceduralists. We summarized our interpretation of the qualitative analysis into a practical quality–improvement–informed framework to highlight causes, mitigating factors, and potential consequences for gender disparities in procedural volume (Figure 2).

Our FGs uncovered several resident-level factors that might explain why ICU procedural training is particularly vulnerable to gender disparities (Figure 2). Women, unfortunately, are known to rate themselves as less confident in their clinical competencies compared with men (12, 13). They tend to underestimate their abilities (14–16) even when they outperform men (17, 18), which is often attributed to stereotype threat, or "the anxiety faced when confronted with situations in which one may be evaluated using a negative stereotype" (19, 20). Even when there is numerically equitable procedure

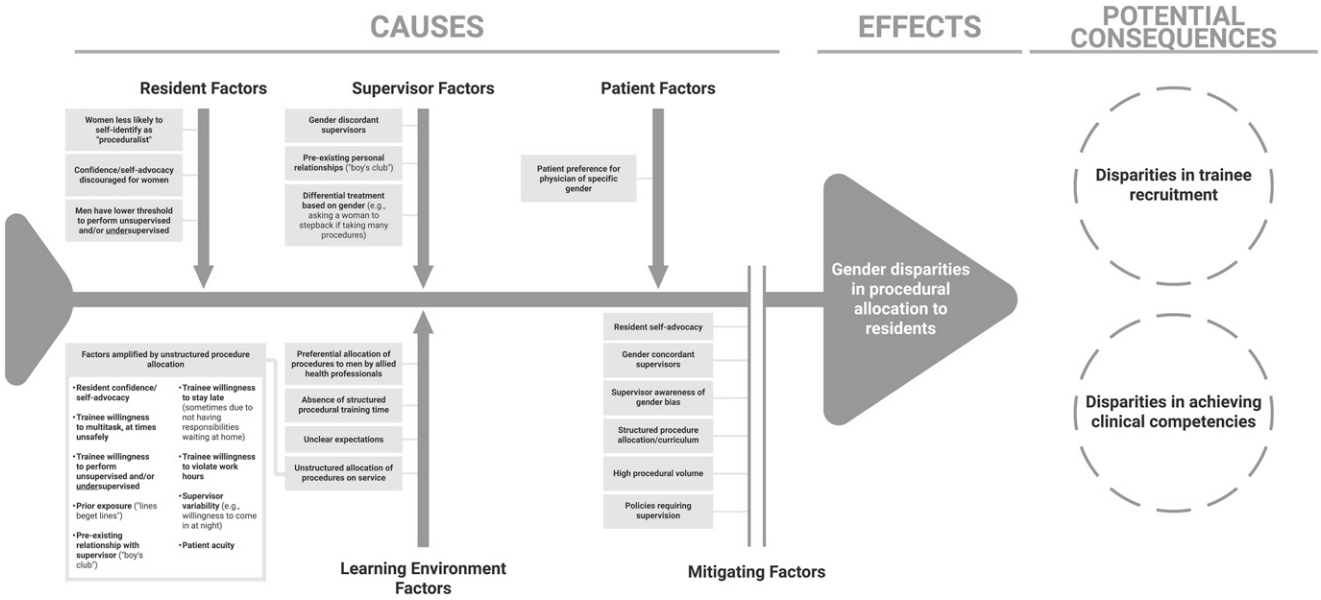


**Figure 2.** Thematic analysis identified overlapping themes influencing gender disparities in resident procedural allocation. Our analysis revealed four causative themes contributing to gender disparities in procedural allocation (resident factors, supervisor factors, patient factors, and learning environment factors), in addition to mitigating factors that protected against disparities. Factors amplifying the unstructured procedure allocation highlighted in parentheses are paraphrased from longer direct resident quotes. Resident, supervisor, and patient factors (all of which represent individual or interpersonal factors) are likely under the influence of larger sociocultural forces.

allocation, stereotype threat still exists, as seen in our FGs. The described need for exaggerated self-confidence while advocating for a procedure may reflect implicit biases associated with these procedural subspecialties, described in the FGs as bro culture. Male residents may prioritize procedural exposure over patient safety as a result of their confidence, or they may enjoy performing additional procedures over nonprocedural skills. Alternatively, female residents may be satisfied with the lower volume and choose to focus on nonprocedural aspects of the ICU experience, especially if procedures are not perceived as important to their future careers. Nevertheless, confidence and self-identity are highly dependent on sociocultural factors impacting a resident's decision to self-advocate for a procedure.

External factors, including the supervisor and the learning environment, can also undermine procedural confidence and volume (Figure 2). Residents at both institutions performed relatively few ICU procedures, particularly at Program B, in which arterial lines are primarily performed by respiratory therapists. Limited access to procedural volume may affect equitable allocation. In ICU settings, unlike the procedural service, the distribution of procedural rates was uneven, with a small number of residents performing many procedures while the majority of residents performed few. In settings in which procedural training is a scarce resource and allocation is unstructured, more aggressive and outspoken individuals will have more educational opportunities.

There are many reasons why men may disproportionately benefit in these types of learning environments relative to women. The presence of stereotype threat and stigmatization negatively influence procedural performance, as seen in recent surgical literature (9). There is a common misconception that men perform better in

procedural environments compared with women (4, 8, 21). Feedback on the basis of gender likely contributes, with men more frequently receiving positive feedback on competency-related behaviors compared with women (22). In our FGs, women were less likely to self-identify as proceduralists and reported prioritizing more traditionally gender-congruent tasks over procedures. Self-perception depends, in part, on the supervisor, who is controlling the learning environment, recognizing that a female–female dyad improves a female resident's procedural confidence (23). Unfortunately, there are existing gender differences in how IM faculty score residents on core competencies, with male residents outscoring female residents by training completion and benefiting more from gender-congruent pairings (i.e., male faculty scoring male residents) (24). Female ICU faculty often receive negative feedback on the lack of autonomy and excessive supervision (25). Ongoing efforts to mitigate inequitable learning experiences must not only address allocation but also how gender influences the learning environment for both the resident and supervising faculty (Table 2).

Although Program A had a greater proportion of women residents and more women matching into cardiology and pulmonary and critical care medicine, it was surprisingly Program A, and not Program B, that displayed gender disparities in ICU procedural volume. This suggests that representation itself is not sufficient to counteract disparities, and programs must proactively evaluate for gender disparities. We have several hypotheses for the observed institutional differences. FG analyses suggested that Program A residents had less supervision and structure relative to residents in Program B, which possibly led to more subjective procedural allocation in Program A and was influenced by factors such as confidence or self-advocacy. For example, all intensivist procedures at Program B required faculty supervision, whereas intensivist procedures at Program A could be performed independently by residents who had reached clinical competency and felt comfortable with the procedure. The requirement of direct supervision in Program B may have emphasized that all residents require ongoing training to hone procedure skills. It may signal to less confident residents, who could be predominantly female, that it is fine to ask for help even as third-year residents. Comparatively, upper-year residents at Program A who had yet to be signed off may be embarrassed, influencing their confidence and, thus, motivation to complete additional procedures regardless of interest.

Our data suggest that structured procedural training may promote equity in procedural volume and could provide a template that could be applied to other settings, such as ICUs. Prior research on Program A's structured procedural service has found it improves resident experience, confidence, and knowledge with performing bedside procedures while achieving low complication rates and high patient satisfaction (6, 26). The differences in structure between Program A and B invite examination of whether structured procedural allocation and supervision could reduce or eliminate gender disparities in procedural volume (Figure 2). The structure could come in many forms, including a dedicated ICU procedure team, a systematic allocation system between residents, or identifying a consistent, unbiased individual to monitor procedure numbers. Supervision requirements could indirectly mitigate the underlying confidence issues female trainees experience when both seeking out and performing procedures.

Interventions should be multifaceted and ensure longitudinal equity regardless of the institution or proportion of female residents. Procedure workshops increase resident self-confidence (27), an essential aspect of professional development (12). Focused training sessions for female residents could further address stereotype threat (28). As a result of these data, Program A implemented a policy for intensivist procedure allocation by posting a list in a common location for equitable tracking, similar to the general ward procedure teams. Identifying a designated ICU procedure resident daily may mitigate the perception of fewer procedures being offered to females.

### Strengths and Limitations

This is the first study to investigate the role of gender in procedural training during IM residency. The mixed methodology used in this study allowed for both numeric quantification of the magnitude of gender disparities as well as further description of underlying contributing factors. The institutional differences in our findings invite further questions. Using a large cohort is a strength; however, by only comparing two sites, our analysis is limited, given the inherent differences in institutional practices. It is unclear how the inclusion of data from the coronavirus disease (COVID-19) pandemic (March–June 2020) might have influenced procedural volume. Similarly, residents on ICU rotations from July to September may have had limited access to procedures because of the presence of new fellows. However, we were unable to capture the total ICU procedures performed each month to account for this possible difference.

In using binary self-identified gender, we regret that transgender or nonbinary individuals may not have been captured appropriately. Directly extracting procedures from the EMR is a strength compared with prior surgical studies relying on self-reported procedures, particularly among IM residents who are not universally required to track these procedures. Residents involved in procedures but not the primary author of the note would not have been included. Thus, our analysis may be an underrepresentation of total resident procedures. We did not analyze the proportion of men/women or ICU team size, which may influence access.

FGs were developed after quantitative analysis was completed to develop explanatory models for the observed findings. It is possible that FGs designed in this way may have implied the presence of gender disparities among participants. However, we found it interesting that male and female residents at both institutions consistently denied any perception of gender disparities in structured procedural services, suggesting that reported perceptions of disparities were more likely to stem from differences in the clinical environment rather than being predetermined by the interview guide. The FG results are impacted by nonresponder bias. In missing residents not interested in procedure acquisition, our results may be biased to the negative impacts of gender on procedure training.

### Future Directions

Further studies are needed to determine if gender disparities in IM residency procedural volume are a widespread issue and whether these might constitute a measurable upstream disparity that impacts the gender disparities in procedural subspecialties. Interestingly, we only found evidence of gender disparities for procedures in critical care settings, in which women are underrepresented, comprising 21% of cardiology and 33% of pulmonary and critical care medicine fellows (29).

Educational experience often drives specialty choice (21, 29, 30). Further research is needed to determine if increased exposure to and experience with procedures may build clinical confidence and encourage women to pursue procedural subspecialties in which they are underrepresented.

### Conclusions

Our findings suggest that residency programs should assess for disparities in procedural volume and adopt structured training to combat inequities. Even if women residents have equitable distribution of ICU procedures, women experience stereotype threat, influencing their learning environment and possibly limiting interest in procedural subspecialties in which they are underrepresented. Further multiinstitutional studies are needed to determine the national impact of these disparities and enable us to understand how implicit biases and organizational cultures may be driving disparities (31).

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