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Characteristics of procedures performed during an emergency medicine residency in Brazil

Características dos procedimentos realizados durante uma residência de Medicina de Emergência no Brasil

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ABSTRACT

Objective: To assess the type, the frequency, and the success rates of procedures performed by Brazilian emergency medicine residents. **Methods:** This prospective observational study analyzed 1,623 procedures performed by 36 emergency medicine residents at a Brazilian residency program from February to December 2023. Residents recorded procedure type, supervision level, success, and complications using a standardized form. Procedural success, defined as completion without major difficulties, was the primary outcome. Success rates and procedural frequency were compared across residency years. **Results:** Central venous catheterization (28.5%) and orotracheal intubation (27.5%) were the most common procedures, with residents performing a mean of 14 and 13.5 annually, respectively. First-year residents performed most procedures (63.8%), achieving an 87.3% success rate, which improved to 94.6% and 94.0% in the second and third years. Second-year residents had 2.79 times higher odds (95%CI, 1.58-4.94) of successful procedures without difficulty compared to first-years. Rare procedures, including cricothyroidotomy and pericardiocentesis, were performed fewer than 10 times. **Conclusion:** Brazilian emergency medicine residents gain extensive procedural experience with improving success rates across training years. Addressing gaps in training for rare but critical procedures through simulation-based education is crucial. These findings inform curriculum development to ensure comprehensive procedural competence, particularly in low- and middle-income countries and new emergency medicine training programs.

Keywords: Simulation training; Brazil

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RESUMO

Objetivo: Avaliar o tipo, a frequência e as taxas de sucesso dos procedimentos realizados por residentes de medicina de emergência no Brasil. **Métodos:** Estudo observacional prospectivo que analisou 1.623 procedimentos realizados por 36 residentes de medicina de emergência em um programa de residência brasileiro, de fevereiro a dezembro de 2023. Os residentes registraram o tipo de procedimento, nível de supervisão, sucesso e complicações em um formulário padronizado. O desfecho primário foi o sucesso do procedimento, definido como realização sem grandes dificuldades. As taxas de sucesso e a frequência dos procedimentos foram comparadas entre os anos de residência. **Resultados:** A cateterização venosa central (28,5%) e a intubação orotraqueal (27,5%) foram os procedimentos mais comuns, com uma média anual de 14 e 13,5 realizados por residente, respectivamente. Os residentes do primeiro ano realizaram a maioria dos procedimentos (63,8%), obtendo taxa de sucesso de 87,3%, que aumentou para 94,6% e 94,0% no segundo e terceiro anos. Residentes do segundo ano tiveram 2,79 vezes mais chances (IC95%, 1,58-4,94) de realizar procedimentos com sucesso e sem dificuldades em comparação com os do primeiro ano. Procedimentos raros, como cricotireoidostomia e pericardiocentese, foram realizados menos de 10 vezes. **Conclusão:** Residentes de medicina de emergência no Brasil adquirem ampla experiência prática, com melhora progressiva nas taxas de sucesso ao longo da formação. A lacuna no treinamento de procedimentos raros, mas críticos, deve ser suprida por meio da educação baseada em simulação. Esses achados contribuem para o desenvolvimento curricular visando competência abrangente em procedimentos, especialmente em países de baixa e média renda e em programas de residência recentes em medicina de emergência.

Descritores: Treinamento por Simulação; Brasil

INTRODUCTION

In recent years, competence in postgraduate medical education has become increasingly important, serving as the foundation for curricula and assessment of medical residents.[1,2] Procedural competence – defined as the ability to perform specific medical procedures independently and manage potential complications – is particularly emphasized in emergency medicine (EM).[3] This focus stems from heightened attention to patient safety, rigorous accreditation standards for residency programs, and the significant impact that procedural proficiency has on patient morbidity and mortality.[4,5] Emergency medicine residents are required to master a wide array of procedural skills, many of which are critical and time-sensitive.[6] Despite the essential nature of these skills, there is limited data addressing the procedural experiences of EM residents, especially in low-to-middle income countries (LMICs). Most existing literature centers on residents from the United States and Europe, and comprehensive studies examining procedural logs are scarce and outdated.[7,8] In the United States, the Accreditation Council for Graduate Medical Education (ACGME) provides guidelines for procedural experiences, listing 15 critical procedures.[9] However, no such guidelines exist from other countries medical councils, and it remains unclear whether these numbers are sufficient to attain lifelong competence in the Emergency Department (ED).

Given the importance of procedural competence and the paucity of data on EM procedural training, there is a need to understand EM residents' procedural skills in countries like Brazil, where EM is a relatively new specialty.[10] Technological advancements and evolving diagnostic and management practices necessitate a reassessment of procedural training during residency. Additionally, the minimum procedural experience required to achieve competence has yet to be established. This study aimed to assess the type, the frequency, and the success rates of procedures performed by Brazilian EM residents.

METHODS

Study design, setting, and participants

This manuscript adheres to the guidelines outlined in the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement for reporting observational studies.[11] This prospective observational study was conducted from February to December 2023, and the study received approval from the institutional review board at Hospital de Clínicas de Porto Alegre (HCPA) (CAAE number 68304823.8.0000.5327). Participants included EM residents from a combined residency program in Porto Alegre, Southern Brazil, which incorporates Hospital de Pronto Socorro de Porto Alegre (HPS-POA) and HCPA. HPS-POA has the oldest EM residency program in Brazil. The combined program has a total of

36 residents (12 per year), all of whom were eligible and provided informed consent to participate.

Data extraction and variables

During the study period, residents were required to document each procedure performed during their clinical rotations using a structured data extraction form. For each procedure, residents recorded the type of procedure performed and whether the procedure was supervised, noting the level of supervision (second-year, third-year, attending, or no supervision). They also indicated the success of the procedure, categorized as successful with no self-reported difficulties, successful with some self-reported difficulties, successful with significant self-reported difficulties, or unsuccessful. Additionally, residents documented any complications that occurred, selecting from a predefined list of common periprocedural complications specific to each procedure type.

The procedures included in the data extraction form were central venous access, orotracheal intubation, arterial line placement, lumbar puncture, peripheral venous access, peripheral nerve blocks, paracentesis, chest tube insertion, thoracentesis, transcutaneous and intravenous pacing, leading cardiac arrest codes, electrical cardioversion, tracheostomy cannula change, laryngeal mask airway placement, vaginal delivery, cricothyrotomy, pericardiocentesis, abscess incision and drainage, urinary catheterization, arthrocentesis, intraosseous access, bone reductions, and foreign body removal.

Data analysis

All analyses were carried out using R. Descriptive analyses were performed considering two different units of analysis. At first, the procedures performed by residents were considered as the unit of analysis and their success rates were described using absolute and relative frequencies. Success rates were described using the original operationalization of the outcome (successful with no self-reported difficulties, successful with some self-reported difficulties, successful with significant self-reported difficulties, or unsuccessful), and following a dichotomous operationalization that did not consider the level of difficulty (successful, or unsuccessful). Mean number of procedures and its 95% confidence interval (CI) were calculated.

In the second step, the unit of analysis was the residents, and their year of residency was described using absolute and relative frequencies. In order to describe and compare the prevalence of success of procedures performed by residents according to their year of residency, a two-level (level 1: procedures; level 2: residents) multilevel Poisson regression model was fitted to account for the hierarchical nature of the dataset and for the different number of procedures performed by each of the residents. Odds ratios with 95%CI were calculated.

RESULTS

Type and number of procedures performed

A total of 1,623 medical procedures were analyzed, being almost two-thirds (63.8%) performed by first-year residents. 36% of all residents were in their first year of residency, 36% in the second year, and 27% in the third year. Overall, the most prevalent procedures reported were central venous catheter (28.5%) and orotracheal intubation (27.5%). Arterial line was the third most commonly performed procedure, representing 13% of all medical procedures performed in the residency program (**Table 1**)

The top two medical procedures performed by residents were the central venous catheter and the orotracheal intubation, with a mean number of 14.0 and 13.5 procedures performed per year, respectively (**Table 2**). For both procedures, the mean number performed by first-year residents was higher compared to second and third years. On average, 25 central venous catheter and orotracheal intubation procedures were performed by first years, while less than 10 procedures were performed by second years, and less than six by residents in third year.

Table 1. Medical procedures performed according to the year of residency

	Total	Year of residency		
		First	Second	Third
	1,623 (100.0)	1,036 (63.8)	387 (23.8)	200 (12.3)
Medical procedure				
Abscess drainage	2 (0.1)	0	1 (0.3)	1 (0.5)
Arterial line	211 (13.0)	146 (14.1)	44 (11.4)	21 (10.5)
Arthrocentesis	1 (0.1)	0	1 (0.3)	0
Bladder catheterization	4 (0.2)	2 (0.2)	0	2 (1.0)
Central venous catheterization	462 (28.5)	300 (29.0)	113 (29.2)	49 (24.5)
Chest tube	43 (2.6)	34 (3.3)	5 (1.3)	4 (2.0)
Cricothyroidotomy	2 (0.1)	0	1 (0.3)	1 (0.5)
Electrical cardioversion	21 (1.3)	17 (1.6)	3 (0.8)	1 (0.5)
Foreign body removal	1 (0.1)	1 (0.1)	0	0
Intraosseous infusion	1 (0.1)	0	0	1 (0.5)
Laryngeal mask airway placement	7 (0.4)	5 (0.5)	1 (0.3)	1 (0.5)
Lead CPR	27 (1.7)	0	19 (4.9)	8 (4.0)
Lumbar puncture	110 (6.8)	94 (9.1)	9 (2.3)	7 (3.5)
Naso/orogastric tube placement	3 (0.2)	2 (0.2)	1 (0.3)	0
Orotracheal intubation	446 (27.5)	299 (28.9)	93 (24.0)	54 (27.0)
Pacemaker	27 (1.7)	1 (0.1)	17 (4.4)	9 (4.5)
Paracentesis	65 (4.0)	60 (5.8)	3 (0.8)	2 (1.0)
Pericardiocentesis	2 (0.1)	0	2 (0.5)	0
Peripheral access	71 (4.4)	31 (3.0)	30 (7.8)	10 (5.0)
Peripheral block	66 (4.1)	11 (1.1)	34 (8.8)	21 (10.5)
Reduction of dislocation	3 (0.2)	2 (0.2)	1 (0.3)	0
Thoracentesis	39 (2.4)	28 (2.7)	6 (1.6)	5 (2.5)
Tracheostomy tube exchange	6 (0.4)	3 (0.3)	2 (0.5)	1 (0.5)
Vaginal delivery	3 (0.2)	0	1 (0.3)	2 (1.0)

Results expressed as n (%).

CPR: cardiopulmonary resuscitation.

Success across residency level

Out of the 1,623 procedures performed, only 165 (10.2%) were considered unsuccessful. The intraosseous infusion was the only procedure with 0% success; however, this procedure was performed only once by a third-year resident. All the other 23 types of medical procedures presented at least a 75% success rate (**Figure 1**). More than half (52.5%) of all procedures were performed successfully without difficulties, 29.5% successfully with some difficulties, and 7.8% with great difficulties. The number and prevalence of success of each of the medical procedures performed by medical residents are detailed in **Supplementary Table 1**.

The mean prevalence of successful procedures per resident (regardless of the level of difficulty of the procedure and resident's training) was high, 89.8%. The prevalence of success according to their year of residency varied from 87.3% among those in the first year to 94.6% for those in the second year of residency (**Table 3**).

The prevalence of unsuccessful and successful procedures with respective levels of difficulty was associated with the resident's year of residency (p-value < 0.001) and is presented in **figure 2**. The prevalence of unsuccessful procedures was twice as high among first-years compared to second and third-year residents. In turn, the highest prevalence

Table 2. Mean number of procedures (95% confidence interval) performed by emergency medicine residents in a year according to their year of residency

	Overall	Year of residency		
		First	Second	Rhird
Peripheral access	2.2 (0.8-3.5)	2.6 (0.4-4.8)	2.5 (-0.4-5.4)	1.1 (0.2-2.0)
Arthrocentesis	0.0 (0.0-0.1)	0.0	0.1 (-0.1-0.3)	0.0
Peripheral block	2.0 (0.8-3.2)	0.9 (0.0-1.9)	2.8 (0.1-5.6)	2.3 (0.0-4.7)
Electrical cardioversion	0.6 (0.2-1.1)	1.4 (0.5-2.4)	0.3 (0.0-0.5)	0.1 (-0.1-0.3)
Central venous catheterization	14.0 (9.8-18.2)	25.0 (18.2-31.8)	9.4 (5.9-13.0)	5.4 (2.4-8.5)
Laryngeal mask airway placement	0.2 (0.0-0.4)	0.4 (0.0-0.8)	0.1 (-0.1-0.3)	0.1 (-0.1-0.3)
Cricothyroidotomy	0.1 (0.0-0.1)	0.0	0.1 (-0.1-0.3)	0.1 (-0.1-0.3)
Abscess drainage	0.1 (0.0-0.1)	0.0	0.1 (-0.1-0.3)	0.1 (-0.1-0.3)
Chest tube	1.3 (0.7-1.9)	2.8 (1.9-3.8)	0.4 (0.1-0.7)	0.4 (-0.2-1.1)
Orotracheal intubation	13.5 (9.1-17.9)	24.9 (17.0-32.8)	7.8 (4.8-10.7)	6.0 (2.8-9.2)
Lead CPR	0.8 (0.2-1.5)	0.0	1.6 (-0.1-3.2)	0.9 (0.4-1.4)
Arterial line	6.4 (4.0-8.8)	12.2 (7.5-16.8)	3.7 (2.0-5.4)	2.3 (1.0-3.6)
Pacemaker	0.8 (0.5-1.2)	0.1 (-0.1-0.3)	1.4 (0.8-2.0)	1.0 (0.2-1.8)
Paracentesis	2.0 (0.3-3.6)	5.0 (1.0-9.0)	0.3 (0.0-0.5)	0.2 (-0.1-0.5)
Vaginal delivery	0.1 (0.0-0.2)	0.0	0.1 (-0.1-0.3)	0.2 (-0.2-0.7)
Pericardiocentesis	0.1 (0.0-0.1)	0.0	0.2 (-0.1-0.4)	0.0
Intraosseous infusion	0.0 (0.0-0.1)	0.0	0.0	0.1 (-0.1-0.3)
Lumbar puncture	3.3 (1.7-4.9)	7.8 (5.0-10.6)	0.8 (0.0-1.5)	0.8 (0.3-1.2)
Reduction of dislocation	0.1 (0.0-0.2)	0.2 (-0.1-0.4)	0.1 (-0.1-0.3)	0.0
Foreign body removal	0.0 (0.0-0.1)	0.1 (-0.1-0.3)	0.0	0.0
Naso/orogastric tube placement	0.1 (0.0-0.2)	0.2 (-0.1-0.4)	0.1 (-0.1-0.3)	0.0
Bladder catheterization	0.1 (0.0-0.3)	0.2 (-0.1-0.4)	0.0	0.2 (-0.2-0.7)
Thoracentesis	1.2 (0.7-1.7)	2.3 (1.5-3.2)	0.5 (0.2-0.8)	0.6 (0.1-1.0)
Tracheostomy tube exchange	0.2 (0.0-0.3)	0.3 (0.0-0.5)	0.2 (-0.2-0.5)	0.1 (-0.1-0.3)

CPR: cardiopulmonary resuscitation.

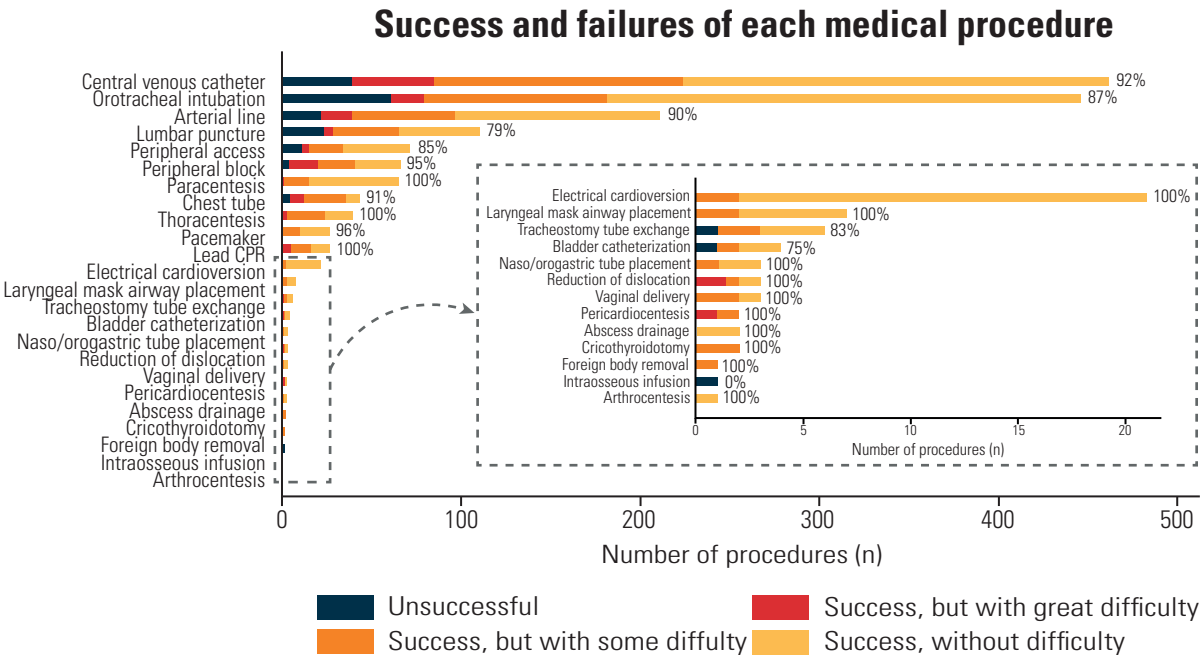

Figure 1. Unsuccessful and successful medical procedures, according to reported difficulty, and respective prevalence of success.

Table 3. Description of the emergency medicine residents studied, and their mean success rate

	n	% (95%CI)	Prevalence of success % (95%CI)
Number of residents	33	-	89.8 (86.3-92.5)
Year of residency			
First	12	36.4 (21.5-54.4)	87.3 (82.2-91.1)
Second	12	36.4 (21.5-54.4)	94.6 (91.0-96.8)
Third	9	27.3 (14.5-45.4)	94.0 (90.4-96.3)

95% CI: 95% of confidence interval.

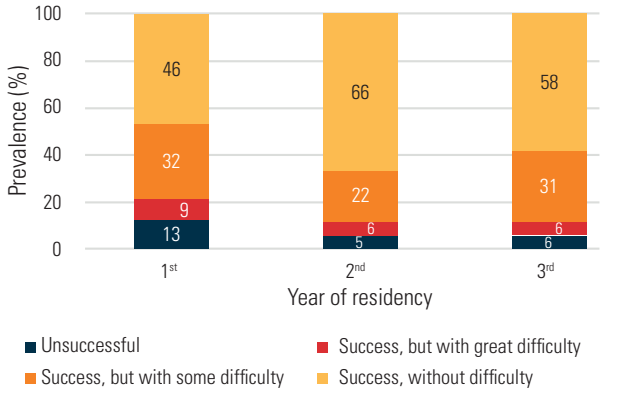

Figure 2. Prevalence of success by level of difficulty and according to year of residency.

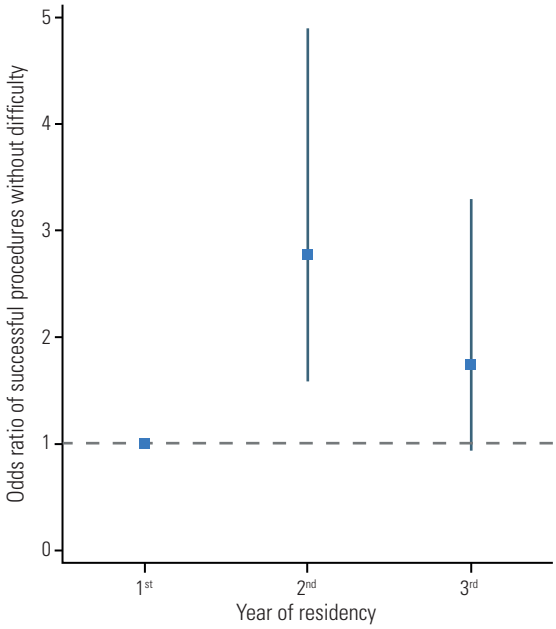

Figure 3. Odds ratio of successful procedure compared to unsuccessful and successful procedures with great or some difficulty according to resident's year of residency.

of successful procedures without difficulty was found among second-year residents (66%), which was 20 and 8 percentage points higher compared to residents in the first and third years, respectively. Detailed prevalence with respective 95% confidence intervals is provided in **Supplementary Table 2**.

The odds ratio of performing successful procedures without difficulty compared to performing unsuccessful or successful procedures with great or some difficulty is presented in **figure 3**. The association between the year of residency and the odds of performing successful procedures without difficulty was significant at a p-value equals to 0.002. Second-year residents had 2.79 times higher odds (95%CI = 1.58 - 4.94) of performing successful procedures without difficulty compared to those in the first year. For third-year residents, the odds were 1.74 time higher compared to first-year residents; however, this difference was not statistically significant, as the 95% confidence interval ranged from 0.92 to 3.28.

The seven most performed procedures, which had both unsuccessful and successful outcomes, were selected for specific analysis, as shown in **table 4**. Statistically significant associations were found when comparing first-year and second-year residents, but not when comparing first-year and third-year residents. Second-year residents had 4.31 times higher odds of successfully performing central line insertions, 2.58 times higher odds for intubations, and 2.95 times higher odds for arterial line procedures without difficulties, compared to first-year residents.

DISCUSSION

In this study, we evaluated the procedural experiences of EM residents in Brazil, focusing on the types and frequencies of procedures performed and success rates across residency levels. Our findings showed that first-year residents performed

Table 4. Odds ratio of a successful without difficulty procedure according to year of residency for specific medical procedures

	Year of residency			p-value
	First OR (95%CI)	Second OR (95%CI)	Third OR (95%CI)	
Central venous catheterization	1.00	4.31 (1.94-9.56)	2.05 (0.78-5.38)	0.002
Orotracheal intubation	1.00	2.58 (1.33-5.03)	1.64 (0.77-3.49)	0.018
Arterial line	1.00	2.95 (1.15-7.57)	3.20 (0.97-10.57)	0.028
Lumbar puncture	1.00	5.19 (0.60-45.10)	3.79 (0.47-30.63)	0.200
Peripheral access	1.00	1.46 (0.57-3.78)	1.60 (0.39-6.54)	0.667
Peripheral block	1.00	2.72 (0.41-18.04)	5.43 (0.75-39.28)	0.246
Chest tube	1.00	4.23 (0.40-44.63)	4.41 (0.24-81.77)	0.360

the majority of procedures (63.8%), with central venous catheter insertions and orotracheal intubations being the most common. Although the overall success rate was high at 89.8%, success rates improved significantly with advancing residency years. Second-year residents had higher odds of performing procedures successfully without difficulty compared to first-year residents, particularly in central venous catheter insertions, orotracheal intubations, and arterial line placements. These findings highlight the progression of procedural competence among EM residents as they advance through their training.

Our study provides a detailed analysis of the procedural experiences of EM residents, particularly focusing on central venous catheterizations and orotracheal intubations. Central venous catheterizations accounted for 28.5% of all procedures, with residents performing a mean of 14 central lines per year. This aligns with the findings of Bucher et al., who reported an average of 16.7 central lines performed per resident per year, highlighting the critical role of this procedure in residency training.[8] First-year residents performed the majority of these procedures and showed a significant increase in success rates with experience – from 87.3% in the first year to 94.6% in the second year and 94.0% in the third year.

In terms of intubations, which constituted 27.5% of all procedures, residents performed an average of 13.5 intubations per year, totaling approximately 40.5 over 3 years. First-year residents had a mean of 24.9 intubations in one year, with success rates improving markedly with senior residents. Bucher et al. found that EM residents performed an average of 28.9 intubations per year, emphasizing the importance of this procedure in developing procedural skills.8 While our residents met the ACGME requirement of 35 total intubations, some studies suggest that up to 200 intubations may be necessary for true proficiency.[12,13] The improvement in success rates with increased experience in our study supports the notion that more procedural exposure enhances competence.

Bernhard et al. demonstrated that first-pass success rates in intubations increased significantly with the number of attempts, from 67 to 83% after 200 intubations.[12] Similarly, our second-year residents had 2.79 times higher odds of performing successful procedures without difficulties compared to first-year residents. Third-year residents also showed higher success rates, although the difference was not statistically significant compared to second-year residents, possibly due to the smaller sample size and complexity of cases they encountered. This improvement with experience underscores the importance of sustained practice and advanced training in achieving procedural proficiency.

Arterial line placement emerged as the third most common procedure, representing 13% of all procedures. This is comparable to findings by Bucher et al., where arterial lines were frequently performed with an average of 4.8 times per resident per year.[8] The consistency across studies

emphasizes the essential nature of these procedures in EM training and the need for residents to gain ample experience to achieve competence.

It is equally important to address the limited exposure residents had to rare but critical interventions. Procedures such as cricothyroidotomy, pericardiocentesis, intraosseous infusion, and vaginal delivery were performed fewer than ten times during the study period, with some, like intraosseous infusion and cricothyroidotomy, recorded only once or twice. These procedures are often life-saving and demand proficiency despite their infrequency in routine practice. Given the limited opportunities to perform these interventions during residency, reliance on clinical exposure alone is insufficient for developing the necessary skills. Incorporating high-fidelity simulation-based training into residency programs is essential to ensure residents are adequately prepared for these scenarios. Simulation provides a safe, controlled environment for deliberate practice, immediate feedback, and the opportunity to build competence and confidence in managing rare but high-stakes emergencies. Addressing these gaps in procedural training alongside clinical opportunities will ensure EM residents graduate with a comprehensive skill set capable of handling both common and rare emergencies.

Limitations

Our study has several limitations that warrant consideration. Firstly, the exclusion of point-of-care ultrasound from data collection likely omits one of the most frequently performed procedures during residency, limiting our findings regarding overall procedural exposure. Additionally, the study's observational design and cross-sectional approach prevent us from establishing causality or conducting a within-resident comparison over three years; instead, we compared procedural success among different residents across postgraduate years. This approach may not fully capture individual skill progression over time. Furthermore, potential confounders such as variations in supervision, case complexity, and prior experience could have influenced success rates, while the reliance on self-reported data introduces a risk of inaccuracies in procedure counts or outcomes. The study also disproportionately focused on more invasive procedures, underrepresenting less common but essential skills, and the absence of longitudinal data limits our ability to track individual development. In Brazil, where EM is a relatively new specialty, competition for procedures with residents from other disciplines further constrain EM residents' access to a diverse procedural repertoire. These limitations emphasize the need for cautious interpretation of our findings and point to areas for future research, such as more comprehensive and longitudinal assessments of procedural competence and strategies to address disparities in training opportunities.

CONCLUSION

In summary, our study demonstrates that EM residents acquire significant procedural experience and improve their success rates as they progress through their training years. The data suggest that increased exposure and practice contribute to enhanced competence, particularly after the first year of residency. These insights can inform curriculum development and highlight the importance of providing residents with ample opportunities to perform critical procedures to ensure they achieve the proficiency necessary for independent practice.

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Supplementary Table 1. Success of each of the medical procedures performed by medical residents

	Unsuccessful	Success, but with great difficulty	Success, but with some difficulty	Success, without difficulty
Abscess drainage	0	0	0	2 (100.0)
Arterial line	21 (10.0)	18 (8.5)	58 (27.5)	114 (54.0)
Arthrocentesis	0	0	0	1 (100.0)
Bladder catheterization	1 (25.0)	0	1 (25.0)	2 (50.0)
Central venous catheterization	39 (8.4)	46 (10.0)	139 (30.1)	238 (51.5)
Chest tube	4 (9.3)	8 (18.6)	24 (55.8)	7 (16.3)
Cricothyroidotomy	0	0	2 (100.0)	0
Electrical cardioversion	0	0	2 (9.5)	19 (90.5)
Foreign body removal	0	0	1 (100.0)	0
Intraosseous infusion	1 (100.0)	0	0	0
Laryngeal mask airway placement	0	0	2 (28.6)	5 (71.4)
Lead CPR	0	5 (18.5)	12 (44.4)	10 (37.0)
Lumbar puncture	23 (20.9)	5 (4.5)	38 (34.5)	44 (40.0)
Naso/orogastric tube placement	0	0	1 (33.3)	2 (66.7)
Orotracheal intubation	60 (13.5)	19 (4.3)	103 (23.1)	264 (59.2)
Pacemaker	1 (3.7)	0	9 (33.3)	17 (63.0)
Paracentesis	0	1 (1.5)	15 (23.1)	49 (75.4)
Pericardiocentesis	0	1 (50.0)	1 (50.0)	0
Peripheral access	11 (15.5)	3 (4.2)	21 (29.6)	36 (50.7)
Peripheral block	3 (4.5)	17 (25.8)	21 (31.8)	25 (37.9)
Reduction of dislocation	0	1 (33.3)	1 (33.3)	1 (33.3)
Thoracentesis	0	2 (5.1)	23 (59.0)	14 (35.9)
Tracheostomy tube exchange	1 (16.7)	0	2 (33.3)	3 (50.0)
Vaginal delivery	0	0	2 (66.7)	1 (33.3)

Results expressed as n (%).

CPR: cardiopulmonary resuscitation.

Supplementary Table 2. Prevalence of unsuccessful and successful procedures with respective levels of difficulty according to resident's year of residency.

	Unsuccessful	Success, but with great difficulty	Success, but with some difficulty	Success, without difficulty
Year of residency	% (95%CI)	% (95%CI)	% (95%CI)	% (95%CI)
First	12.7 (9.0-17.8)	8.8 (6.3-12.2)	32.0 (24.6-40.5)	46.4 (36.1-57.1)
Second	5.4 (3.2-9.0)	6.2 (3.8-10.0)	22.0 (16.4-28.7)	66.4 (58.0-73.9)
Third	6.0 (3.7-9.5)	5.5 (3.3-8.9)	30.5 (23.3-38.8)	58.0 (51.4-64.3)

Association significant at p-value < 0.001.

95%CI: 95% of confidence interval