The Development of an Innovative Crowdsourced Resident Procedure Team Model to Improve Bedside Procedural Proficiency in the Inpatient Setting

Ysabel C. Ilagan-Ying, MD
Robert Cotter, BS
Chang Su, MD
Benjamin A. Rodwin, MD
John C. Huston, MD

ABSTRACT

Background Bedside procedures are a necessary skill for many residents. Practice changes, including the discontinuation of a minimum number of procedures required by the American Board of Internal Medicine, may have resulted in decreased incentive for residents to seek procedural opportunities.

Objective To improve residents' procedural output and confidence in abdominal paracentesis, arterial and central venous line placement, nasogastric intubation, and ultrasound-guided peripheral intravenous catheter insertions (USPIV).

Methods A novel Resident Procedure Team (RPT) model was created using crowdsourced proficient (having completed ≥5 procedures) near-peers in combination with peer-led USPIV simulation workshops to increase the number of supervising residents available. Procedure logs and the number of residents who became qualified to perform and supervise procedures were tracked from July 2018 to June 2022 and compared before and after the implementation of the RPT in July 2020.

Results Implementing the novel RPT model significantly increased the number of procedures performed (1875 procedures post-RPT vs 1292 pre-RPT; P=.02). Abdominal paracentesis increased from 411 to 482 (17.3%), central venous line placement increased from 344 to 401 (16.6%), USPIV increased from 318 to 389 (22.3%), arterial line placement increased from 189 to 360 (90.5%), and nasogastric intubation increased from 30 to 243 (710.0%). Resident confidence levels increased significantly after RPT-led USPIV workshops (P<.05 for all).

Conclusions Implementation of a novel, crowdsourced, resident-led procedure team and peer-led USPIV workshops helped increase the number of procedures performed by residents.

Introduction

Performing bedside procedures is essential for residents. The Accreditation Council for Graduate Medical Education lists procedural skills as 1 of 6 core competencies.[1] However, subspecialist procedure outsourcing is increasing, and the American Board of Internal Medicine (ABIM) no longer requires minimum numbers of procedures. Subsequently, many residents have less procedural opportunities and competency, limiting their ability to supervise other residents.[2-6]

The ABIM and the American College of Physicians recommend simulation training.[7,8] However, bedside experiences cannot be fully replicated and remain critical to procedural training.[9] Some hospitals have created procedural rotations to improve residents' procedural proficiency, but they require substantial time and resources.[10,11]

DOI: http://dx.doi.org/10.4300/JGME-D-23-00005.1

Editor's Note: The online version of this article contains the survey used in the study.

We evaluated the impact of a novel Resident Procedure Team (RPT) model, comprised of crowdsourced procedurally proficient peers, combined with peer-led simulation training, on residents' procedural output and confidence. We aimed to assess the role of RPT in improving (1) the number of bedside procedures logged and (2) procedural confidence in ultrasound-guided peripheral intravenous catheter insertions (USPIV).

Methods

Setting and Participants

At an urban tertiary care academic medical center, a peer-led, crowdsourced RPT was created from an internal medicine (IM) program consisting of 503 residents (FIGURE) at the beginning of the academic year in July 2020. Residents (junior residents: postgraduate year 1 (PGY-1) and senior residents: PGY-2 and PGY-3) were invited to join RPT each year. RPT residents volunteered to supervise and train others. Supervising residents did not log supervised procedures as their own. Per institutional policy,

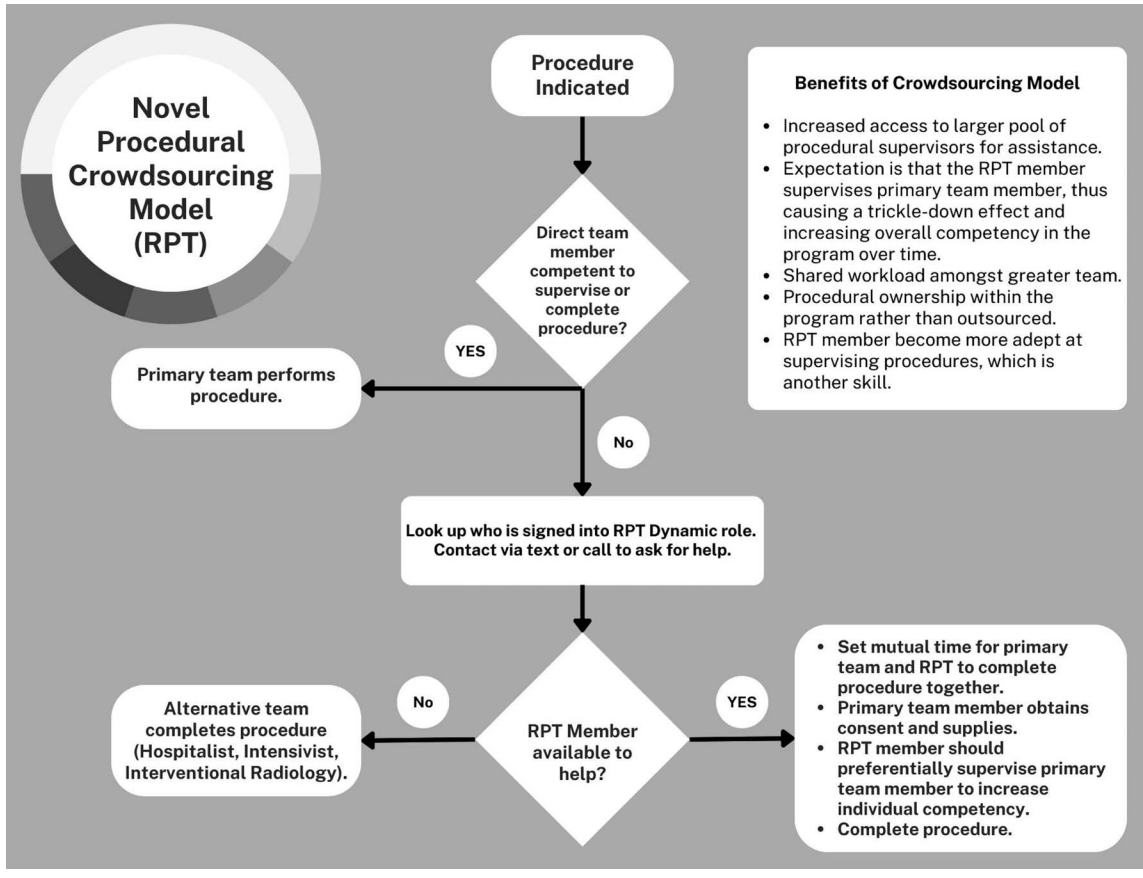

FIGURE
Flow Diagram and Benefits of the Novel Resident Procedure Team (RPT) Model

residents who had completed a procedure 5 or more times under supervision were considered "signed off" and could supervise others.

Interventions

An electronic repository of all residents who were "signed off" was created and made available to all residents, enabling residents to search for colleagues able to supervise procedures each day. Additionally, RPT instituted a "Dynamic Role" in our hospital-wide communication software, where 6 members of the group could designate themselves as "on call" supervising residents. Resident volunteers were given roles 1 to 6, with roles 1 to 3 prioritized for the newest supervising residents to gain teaching opportunities and roles 4 to 6 for more experienced backup supervisors.

After the first year of RPT, 4 USPIV workshops were piloted (February and July 2022). The peer-led simulation training was instituted following an informal needs assessment where venous access was the most consistently requested RPT procedure. One-hour optional workshops were taught by 2 RPT members. Thirty-four residents participated in these workshops. Each workshop included a lecture and 3 workstations with live feedback: (1) ultrasound techniques with anatomic vessel identification; (2) peripheral IV insertions on simulation arms; and (3) USPIV insertion practice on simulation arms, adapted from emergency medicine and IM-based ultrasound procedural workshop teaching for content validity.[7,12] These interventions were not modified during the study, delivered as originally planned, and not adapted for the learners.

Outcomes and Analysis

Resident procedure logs were reviewed 2 years prior to RPT implementation (July 2018-June 2020, pre-RPT) and 2 years following implementation (July 2020-June 2022, post-RPT). Logs of abdominal paracentesis, arterial line placement, central venous line placement, nasogastric intubation, and USPIV were queried via an institutional procedure log software program.[13] Logs were analyzed by resident level, procedure type, academic year, and pre- or post-RPT status. Pre- and post-RPT data were compared using a paired, parametric 2-tailed *t* test.

TABLE
Increase in Number of Procedures and Number of Users "Signed Off" Since Implementation of Resident Procedure Team (RPT)

Pre-RPT (July 2018-June 2020), n=244 residents				Post-RPT (July 2020-June 2022), n=233 residents			
Procedure	No. of Procedures	Average Procedures/ Resident	Signed Off, n (%)	No. of Procedures	Average Procedures/ Resident	Signed Off, n (%)	% Change in No. of Procedures
Abdominal paracentesis	411	1.68	38 (15.6)	482	2.07	49 (21.0)	17.3
Central venous line placement	344	1.41	25 (10.2)	401	1.72	31 (13.3)	16.6
USPIV	318	1.30	40 (16.4)	389	1.67	30 (12.9)	22.3
Arterial line placement	189	0.77	10 (4.1)	360	1.55	26 (11.2)	90.5
Nasogastric intubation	30	0.12	1 (0.4)	243	1.04	17 (7.3)	710.0
Total	1292	5.30	114	1875	8.05	153	45.1

Abbreviation: USPIV, ultrasound-guided peripheral intravenous catheter insertion.

For the USPIV workshops, participants completed a 6-point Likert scale (0=not confident, 5=extremely confident) to evaluate confidence levels before and after the workshop in ultrasound principles, vasculature identification, and USPIV placement (online supplementary data). The survey was based on previous Likert-based simulation studies in a retrospective pre-post survey designed to evaluate similar skills.[14] Each participant was verified to perform the procedure correctly and independently. Pre- and post-workshop confidence was analyzed using Wilcoxon matched-pairs signed rank tests. Statistical significance was defined as $P<.05$. The study was reported according to the Guideline for Reporting Evidence-based practice Educational interventions and Teaching (GREET) and STrengthening the Reporting of OBservational studies in Epidemiology (STROBE) guidelines.[15,16]

Workshop participants provided informed consent and could opt out by verbal or written request. All surveys and procedure records were deidentified, except participants' PGY. The academic medical center's Institutional Review Board deemed this study to be exempt.

Results

Of all IM residents (503) from 2018-2022 academic years, 477 (94.8%) logged at least one procedure studied (244 pre-RPT and 233 post-RPT). An average of 791.75 procedures were logged annually by an average of 119.25 residents. As shown in the TABLE, the average number of procedures per resident increased from 5.30 pre-RPT to 8.05 post-RPT (P=.01). The 3 most logged procedures were abdominal paracentesis, central venous line placement, and USPIV. Nasogastric intubation increased the most from 30 to 243 procedures logged (710.0%). Pre-RPT, only 114 out of the 1220 (244 residents $\times$ 5 potential procedure sign-offs) possible sign-offs occurred (9.3%; TABLE). Post-RPT, 153 out of 1165 (233 residents) sign-off opportunities occurred (13.1%).

Overall, 34 of 129 residents participated in 1 of the 4 USPIV workshops (26.4% program-wide participation rate). All residents reported significantly improved confidence in every measured skill category: 2.07 to 3.79, 1.67 to 3.53, 3.18 to 4.11, and 2.01 to 4.01 in vessel identification, peripheral IV access, ultrasound terminology, and USPIV, respectively ($P<.05$ for all).

Discussion

Our study showed that the RPT model involving crowdsourced, peer-led initiatives improved the number of bedside procedures performed by residents significantly and increased those signed off on 5 or more procedures by more than a third. This model remains in place at our institution.

Some hospitals have hospitalist procedure teams to improve the timeliness and safety of bedside procedures.[17] This model is efficient but can siphon procedural opportunities from residents. Other residency programs dedicate entire resident rotations to bedside procedures, which can be difficult to establish due to resource constraints.[10,18] The traditional model of senior residents supervising juniors' procedures is insufficient because residents in recent years often were not deemed competent based on institutional policies and felt uncomfortable performing and supervising procedures.[19]

Our RPT-led simulation workshops increased residents' confidence significantly in USPIV techniques.

These improvements were achieved without interrupting residents' clinical duties, additional financial expenditures, or faculty support. Our approach was feasible by starting with a small group of senior residents with established procedural competence to serve as RPT leadership who facilitate workshops and supervise peers.

There are several limitations. The workshops assessed self-reported levels of confidence among residents with procedure logs as a proxy for competency, and procedures were supervised by near-peers rather than faculty members. However, the strengths of our model are that it is pragmatic, requires no faculty support or funding, and does not disturb the residency program's rotation structure. Procedure-based training programs such as general surgery commonly document volume-based logs with supervisors to assess progress. We acknowledge the innovation of national societies to promote formal competency testing, though such assessment is currently beyond the scope of a resident-run teaching model.[20] Increasing the number of logged procedures represents potential growth toward improving procedural competence, but more formal assessments of confidence, competence, and program impact should be pursued to better evaluate such outcomes moving forward. Another limitation is that only USPIV procedure workshops were implemented, which was due to time constraints and resources. Finally, our study did not assess the number of procedure-related complications, as our institution has no formal tracking mechanism for resident-related procedures.

The RPT model has high acceptability by residents as well as leadership within the program. Future directions include collaborating to expand the RPT model to other affiliated hospitals and to incorporate USPIV and nasogastric intubation into intern orientation. We also aim to develop a standardized rubric with faculty-level supervision on a dedicated hospitalist model teaching service to formally assess and ensure learners' procedural competency pre- and post-workshops, and we are discussing institutional-level analyses of resident-contributed adverse events in relation to RPT activity.

Conclusions

Implementation of a novel, crowdsourced, resident-led procedure team, and peer-led USPIV workshops helped increase the number of procedures logged by residents, the number of qualified peer procedural supervisors, and self-reported confidence ratings with USPIV placement.

References

1. Accreditation Council for Graduate Medical Education. Internal Medicine Program Requirements and FAQs. Accessed September 22, 2022. https://www.acgme.org/globalassets/pfassets/programrequirements/140_internalmedicine_2023.pdf
2. Nofi C, Roberts B, Demyan L, et al. A survey of the impact of the COVID-19 crisis on skill decay among surgery and anesthesia residents. *J Surg Educ*. 2022;79(2):330-341. doi:10.1016/j.jsurg.2021.09.005
3. American Board of Internal Medicine. The evolution of ABIM procedural requirements—internal medicine. Accessed September 22, 2022. https://blog.abim.org/wp-content/uploads/2019/03/Evolution-of-Procedural-Requirements-for-IM-1.pdf
4. Wigton RS, Alguire P, American College of Physicians. The declining number and variety of procedures done by general internists: a resurvey of members of the American College of Physicians. *Ann Intern Med*. 2007;146(5):355-360. doi:10.7326/0003-4819-146-5-200703060-00007
5. Huang GC, Smith CC, Gordon CE, et al. Beyond the comfort zone: residents assess their comfort performing inpatient medical procedures. *Am J Med*. 2006;119(1):71.e17-24. doi:10.1016/j.amjmed.2005.08.007
6. Mourad M, Kohlwes J, Maselli J, Auerbach AD, Group M. Supervising the supervisors—procedural training and supervision in internal medicine residency. *J Gen Intern Med*. 2010;25(4):351-356. doi:10.1007/s11606-009-1226-z
7. Vusse LV, Shepherd A, Bergam B, Andros J, Morris A. Procedure training workshop for internal medicine residents that emphasizes procedural ultrasound: logistics and teaching materials. *MedEdPORTAL*. 2020;16:10897. doi:10.15766/mep_2374-8265.10897
8. Fulton N, Buethe J, Gollamudi J, Robbin M. Simulation-based training may improve resident skill in ultrasound-guided biopsy. *AJR Am J Roentgenol*. 2016;207(6):1329-1333. doi:10.2214/AJR.16.16161
9. Caton JB, Pelletier SR, Shields HM. Asking what do residents value most: a recent overview of internal medicine residents' learning preferences. *Adv Med Educ Pract*. 2018;9:509-518. doi:10.2147/AMEP.S165717
10. Mourad M, Ranji S, Sliwka D. A randomized controlled trial of the impact of a teaching procedure service on the training of internal medicine residents. *J Grad Med Educ*. 2012;4(2):170-175. doi:10.4300/JGME-D-11-00136.1
11. Buell KG, Hayat MH, Walsh DW, Wooldridge KT, Vasilevskis EE, Heller LT. Creation of a medical procedure service in a tertiary medical center: blueprint and procedural outcomes. *J Hosp Med*. 2022;17(8):594-600. doi:10.1002/jhm.12901
12. Society for Academic Emergency Medicine. Goett H. Introduction to bedside ultrasound. Accessed 15 April, 2023. https://www.saem.org/about-saem/academies-interest-groups-affiliates2/cdem/for-students/online-education/m3-curriculum/bedside-ultrasonagraphy/introduction-to-bedside-ultrasound

13. MedHub. Version 2022.3. Accessed July 26, 2023. https://www.medhub.com/
14. Beckman TJ, Cook DA, Mandrekar JN. What is the validity evidence for assessments of clinical teaching? *J Gen Intern Med*. 2005;20(12):1159-1164. doi:10.1111/j.1525-1497.2005.0258.x
15. Cheng A, Kessler D, Mackinnon R, et al. Reporting guidelines for health care simulation research: extensions to the CONSORT and STROBE statements. *Adv Simul (Lond)*. 2016;1:25. doi:10.1186/s41077-016-0025-y
16. Turatsinze S, Willson A, Sessions H, Cartledge PT. Medical student satisfaction and confidence in simulation-based learning in Rwanda—pre and post-simulation survey research. *Afr J Emerg Med*. 2020;10(2):84-89. doi:10.1016/j.afjem.2020.01.007
17. Patel SA, Pierko K, Franco-Sadud R. Ultrasound-guided bedside core needle biopsy: a hospitalist procedure team's experience. *Cureus*. 2019;11(1):e3817. doi:10.7759/cureus.3817
18. Smith CC, Gordon CE, Feller-Kopman D, et al. Creation of an innovative inpatient medical procedure service and a method to evaluate house staff competency. *J Gen Intern Med*. 2004;19(5 Pt 2):510-513. doi:10.1111/j.1525-1497.2004.30161.x
19. Erbil DG. A review of flipped classroom and cooperative learning method within the context of Vygotsky Theory. *Front Psychol*. 2020;11:1157. doi:10.3389/fpsyg.2020.01157
20. Cullinan DR, Schill MR, DeClue A, Salles A, Wise PE, Awad MM. Fundamentals of laparoscopic surgery: not only for senior residents. *J Surg Educ*. 2017;74(6):e51-e54. doi:10.1016/j.jsurg.2017.07.017

Ysabel C. Ilagan-Ying, MD, is a Resident Physician, Department of Medicine, Yale School of Medicine; **Robert Cotter, BS,** is a Medical Student, Yale School of Medicine; **Chang Su, MD,** is a Resident Physician, Department of Medicine, Yale School of Medicine; **Benjamin A. Rodwin, MD,** is Assistant Professor, Department of Medicine, Yale School of Medicine and VA Connecticut Healthcare System; and **John C. Huston, MD,** is a Fellow, Department of Pulmonary, Critical Care, and Sleep Medicine, Yale School of Medicine.

Funding: The authors report no external funding source for this study.

Conflict of interest: The authors declare they have no competing interests.

Disclaimer: The views expressed in this article are those of the authors and do not necessarily reflect the position or policy of the Department of Veterans Affairs or the US Government.

Corresponding author: John C. Huston, MD, Yale School of Medicine, john.huston@yale.edu, Twitter @md_huston

Received December 29, 2022; revisions received May 1, 2023, and July 17, 2023; accepted July 20, 2023.