Improving the Intraoperative Educational Experience: Understanding the Role of Confidence in the Resident-Attending Relationship

Juyeon Park, MD,* Siddarth Ponnala†, Eric Fichtel†, Kian Tehranchi*, Shimae Fitzgibbons, MD,‡ Sarah Henrickson Parker, PhD,§ Nathan Lau, PhD,† and Shawn D. Safford, MD, MAS*

*Department of Surgery, Virginia Tech Carilion School of Medicine, Roanoke, Virginia; †Grado Department of Industrial and Systems Engineering, Virginia Tech, Blacksburg, Virgina; ‡Department of Surgery, Georgetown University School of Medicine, Washington, District of Columbia; and §Human Factors Research, Virginia Tech Carilion School of Medicine and Research Institute, Roanoke, Virginia

OBJECTIVE: With recent changes to graduate medical education, the balance between resident autonomy and need for supervision impacts the educational and training experience of residents. The objective of this study was to understand the relationship between the confidence of attendings and residents and their different perspectives of perceived educational experience and autonomy in the operating room (OR). We hypothesized that the attending's confidence in the resident would be an important factor in improving the educational experience and resident's autonomy in the OR.

DESIGN: Self-reported confidence-rating and operative experience surveys were administered to teams of postgraduate year (PGY 1) through PGY 5 surgical residents and attendings in two temporal sets (Early: Sept-Dec 2015, $n = 20$; Late: Jan-Apr 2016, $n = 22$). A second "end-of-year" survey was distributed to residents ($n = 9$, 37.5% response) and attendings ($n = 10$, 35% response) asking questions regarding their educational experience and operative experience during the past year.

SETTING: Large rural teaching hospital.

PARTICIPANTS: Nineteen general surgery residents (PGY 1 - 5) and 14 general surgery attendings.

RESULTS: Resident perception of confidence differs from junior to senior residents, and that there was discordance between resident's confidence and skill as perceived by attendings, particularly in senior residents. Results also showed that attending's confidence in residents was positively correlated with attending's perceived educational experience in the OR. Residents and attendings both indicated attending's confidence in residents as an important factor in increasing resident autonomy in the OR, thus the attending's confidence in residents could have a positive impact on resident autonomy and educational experience in the OR.

CONCLUSIONS: We have demonstrated a relationship between self-confidence for residents and improved confidence from attendings in residents' capabilities. Based on these findings, we would propose identifying methods to expand resident's awareness of surgical situations and develop attending's confidence in residents. (J Surg Ed 76:1187–1199. © 2019 Association of Program Directors in Surgery. Published by Elsevier Inc. All rights reserved.)

KEY WORDS: Resident autonomy, Self-confidence, Perceived skill

COMPETENCIES: Practice-Based Learning and Improvement, Interpersonal and Communication Skills, Systems-Based Practice, Medical Knowledge

INTRODUCTION

Surgical education has a strong concentration on improving the resident experience in the operating room. The gradual assumption of more independence and autonomy is an educational imperative required by the Accreditation Council for Graduate Medical Education (ACGME), with

Funding: This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Correspondence: Inquiries to Shawn Safford MD, Department of Surgery, Carilion Children's Pediatric Surgery, 102 Highland Ave, Roanoke, VA 24013; e-mail: sdsafford@carilionclinic.org

an emphasis placed on proper supervision throughout training (ACGME, 2017). However in the last few decades, graduate medical education policy changes have significantly affected resident autonomy by limiting duty hours to 80 hours a week averaged over 4 weeks.[1–3]

Although the mandated decrease in duty hours has solved many challenging patient safety issues, there have been significant unintended consequences. Specifically, the mandated decrease in resident duty hours raises concern regarding a potential decrease in intraoperative interactions between attending and resident physicians.[4,5] Given the restricted time for intraoperative learning, developing an expedited process to provide a similar level of experience and feedback is necessary. Learners and mentors must successfully balance graduated resident autonomy with adequate supervision. To train unskilled residents, supervision is necessary, and proper supervision has been shown to positively impact patient outcomes.[6] On the other hand, with an increase in supervision is a decrease in resident autonomy, which could potentially limit independent resident experience before fellowship or a private practice.[7]

Studies have not yet explored the confidence of the attending physician in the resident to elucidate the balance between resident autonomy and supervision. In this context, confidence is defined as belief that the resident will act as effectively as is reasonable given their degree of training. Research has investigated the resident's self-confidence or autonomy without the attending physician's perspective.[8–10] In one study by Teman et al. (2014), attending physician's own confidence in the operation and their perception of the resident physician's confidence were found to be important factors in determining resident autonomy. In another study by George et al. (2017), resident readiness for independent practice and the level of guidance provided by attendings were assessed, with results showing residents are generally but not universally ready to independently perform and have limited autonomy.[11]

Previous research has shown discordance between attending's confidence in residents and resident's self-confidence, with attendings specifically having lower confidence in senior residents than the confidence senior residents had in themselves. Previous research has also shown that post-graduate year (PGY), resident self-confidence, and attending's confidence in the resident were all associated with increases in the resident's intraoperative tasks.[12]

While these findings elucidate some questions regarding the relationship between resident autonomy and attending's confidence in the resident, further investigation is necessary to evaluate how the overall autonomy and educational experience is affected by the attending's confidence in the resident and resident confidence. The objective of this study was to discern how confidence of attendings and residents relate with different factors (PGY, time, etc.), its effect on resident's perceived educational experience and autonomy over time, and its importance to attendings and residents. We hypothesized that the attending's confidence in the resident would be an important factor in improving educational experience and resident's autonomy in the OR.

MATERIALS AND METHODS

Following IRB approval for this prospective cohort study, general surgery attendings and general surgery residents based at a large rural teaching hospital, were approached for inclusion in this study. Surveys were administered to participants in two phases: Early – September 2015 to December 2015 ($n = 20$ dyads) and Late – January 2016 to April 2016 ($n = 22$ dyads). Prior to approaching individual participants, the entire Department of Surgery at Carilion Roanoke Memorial Hospital was emailed to raise awareness of the study. After either laparoscopic cholecystectomies or laparoscopic appendectomies, participants were each invited to complete the study survey. The groups of participants were chosen based on the available cases and dyads of that day, not based on the people in the case. Surveys were provided on the day of the case immediately after each procedure. Some groups/people were repeated in the study if the case that was selected to be included in the study happened to have the same participants that day. Surveys were distributed to consented participants immediately after they exited the OR and collected within 1 hour of completion of either laparoscopic cholecystectomies or laparoscopic appendectomies. These two procedures were selected as frequently performed core procedures within the general surgery residency curriculum. Due to logistics related to shifts and rotations, the two participants in the early vs the late groups are not the same set of individuals. Coded identities were assigned in place of respondent names for all collected surveys to preserve anonymity.

Surveys included demographic information, experience level (i.e. years as an attending and PGY level), and previous experience working with specific attending or resident in the OR. Additionally, residents were asked to rate the perceived skill and confidence level of their attending as well as their own self-confidence. Similarly, attendings also rated the perceived skill and confidence level of their resident as well as their own self-confidence (Fig. 1). All respondents were asked to rate the educational experience in the operating room.

In addition to the postoperatively administered survey, a global evaluation of the educational and operative

Rate the following experience in the OR. *

Answer all questions regarding the resident or the attending from your own perspective.

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
The attending is confident in the OR.	○	○	○	○	○
The attending is experienced with the procedure.	○	○	○	○	○
The resident is confident in the OR.	○	○	○	○	○
The resident is experienced with the procedure.	○	○	○	○	○
The resident understands all steps of the procedure.	○	○	○	○	○
The resident understands pathology/pathophysiology.	○	○	○	○	○
The resident knows the patient well.	○	○	○	○	○
The educational experience was excellent.	○	○	○	○	○

	Entire time	Most of the time	Some of the time	Little time	None
How much did the RESIDENT perform the procedure?	○	○	○	○	○

Would you allow this resident perform the procedure on you? *

If resident, answer about the attending.

○ Yes, alone.

○ Yes, but only with assistance.

○ No

FIGURE 1. Body of confidence-rating survey.

experience was elicited. The global survey was administered as an "end-of-year" year survey to all residents ($n = 9$, 37.5% response) and attendings ($n = 10$, 35% response) invited to participate in the study, and contained asking further questions regarding the educational experience and operative experience overall during that same residency year.

A-priori power analysis identified a target sample size of more than 8 samples per group based on an alpha of 0.05, power of 0.80, and difference in Likert-scales of 0.5 between attending physician's and residents' confidence levels in residents. For univariate data analyses, means, medians, and variances were calculated for all confidence ratings. Bivariate analyses comparing either attending or resident physician's confidence ratings over multiple postgraduate years were conducted using nonparametric Wilcoxon rank-sum tests. Multivariate analyses were performed to analyze all different variables measured in the survey (attending physician's confidence in themselves, resident's self-confidence, etc.) using the Kruskal-Wallis test, a nonparametric ANOVA test for multiple variables.

RESULTS

Survey data from 19 residents and 14 attending surgeons involved in 42 attending-resident operating room dyads was collected. In total, 26 dyads involved junior (PGY 1-3) residents (13 early, 13 late) and 16 dyads involved

TABLE 1. Demographic Information of Survey Respondents

Demographics	N	%
Residents	19	
PGY 1	4	21%
PGY 2	5	26%
PGY 3	4	21%
PGY 4	1	5%
PGY 5	5	26%
Sex, Male	13	68%
Attendings	14	
Sex, Male	13	93%

senior (PGY 4-5) residents (7 early, 9 late). A total of 9 residents (response rate 37.5%) and 10 attendings (response rate 35%) completed the final "end of year" survey. Both members of the dyad (attending and resident) needed to complete the survey in order for the data to be included. A summary of data from the first confidence survey is included in Table 1, Table 2, Appendix A1 (early phase dyads), and A2 (late phase dyads).

Confidence Relationship Between Attendings and Residents

Overall, a significant difference was found between the attending's confidence in the resident (3.74), and the resident's self-confidence (4.14) ($p < 0.012$, Fig. 2). When responses were analyzed by early vs late in the academic year, the difference between attending and resident perceptions remained for early survey responses, but not for those collected later in the year.[12]

Junior residents reported lower self-confidence than senior residents (3.85 vs 4.63, $p < 0.0001$, Fig. 3A). No significant difference was seen between residents surveyed in the first half of the year (early) vs the second half (late) (4.00 vs 4.27, $p < 0.086$, Fig. 3B). Finally, attending's confidence in residents and resident's self-confidence were significantly correlated ($r^2 = 0.29$, $p < 0.0002$; Fig. 4).

Perception of Educational Experience Between Attendings and Residents

A significant difference in perception of the operative educational experience was found between attending

TABLE 2. Experience of Attending Respondents

Attendings Years of Postresidency Experience	N	%
0-10	2	14%
11-20	7	50%
21-30	4	29%
31-40	1	7%
Attendings	14	

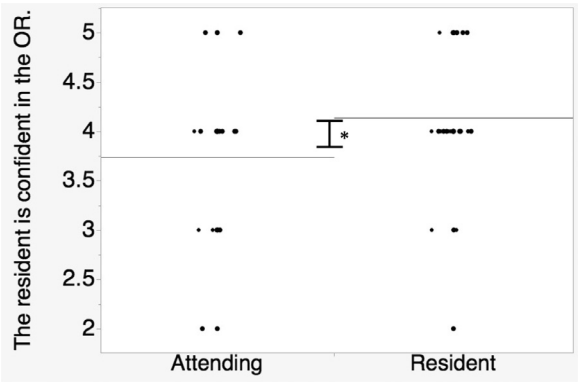

FIGURE 2. Confidence perception differs between attending physicians and residents. Residents reported self-confidence was significantly higher than the attending's perception of resident confidence (4.14 vs 3.74, $p < 0.012$).

and resident surgeons (4.17 vs 4.56, respectively, $p < 0.01$, Fig. 5A). These responses were further broken down by early vs late in the academic year. Early in the academic year, resident surgeons perceived the educational experience in the OR to be significantly higher, or

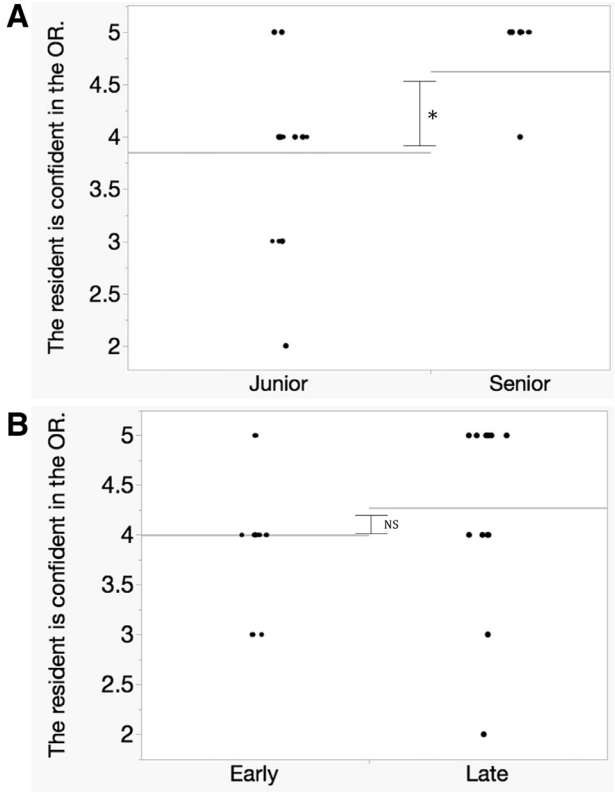

FIGURE 3. Overall, self-confidence of residents is significantly different between junior and senior residents, but no difference is seen when compared between early and late dyads. (A) There is a significant difference in resident's self-confidence between junior and senior residents throughout the year. (B) There is no significant difference when comparing between early and late dyads of residents throughout 1 year.

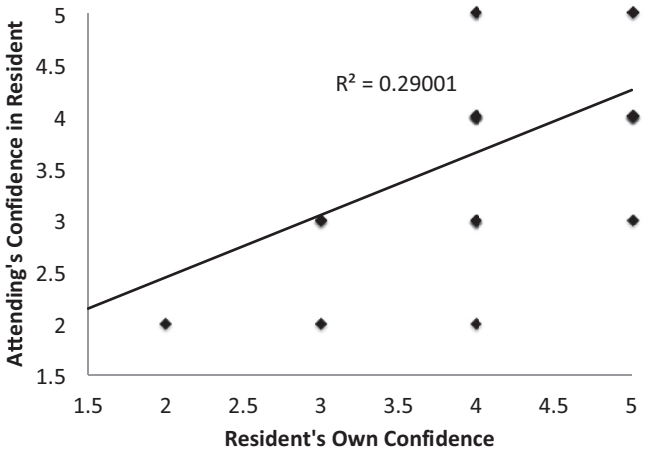

FIGURE 4. Attending's confidence in resident and resident's own confidence are significantly related to each other.

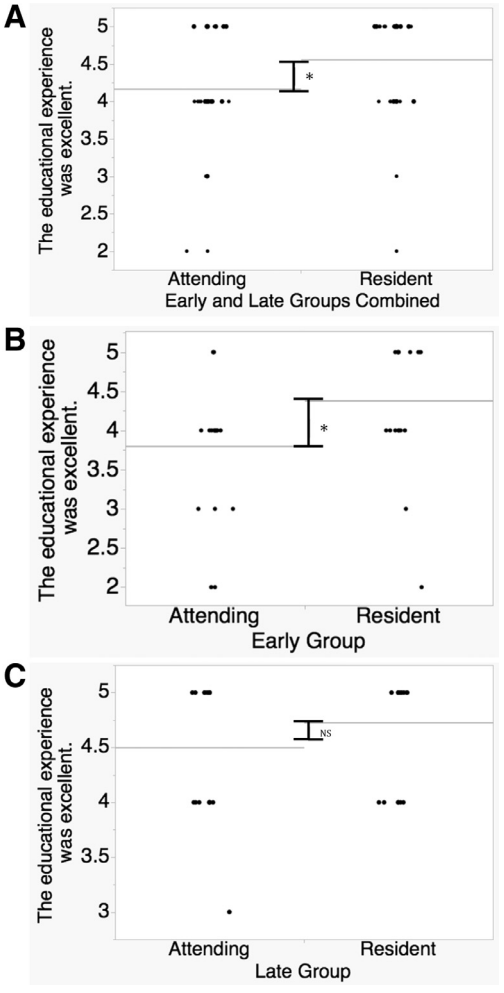

FIGURE 5. Perception of educational experience differs between attendings and resident surgeons. (A) Over 1 year, attending's perception of educational experience was significantly lower than the resident's perspective. (B) Early in the year, perception of educational experience is significantly different between attendings and residents. (C) However, this significance is lost later in the year.

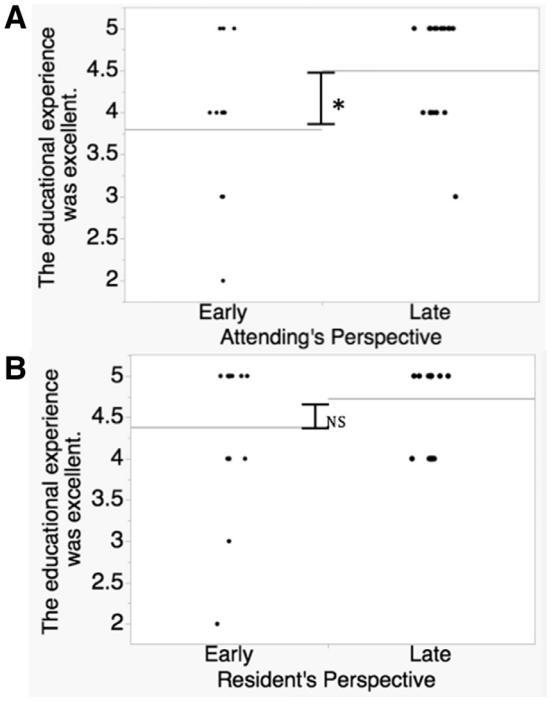

FIGURE 6. Attending physicians' perception of educational experience improves over time. (A) Perception of the educational experience for the attending improved significantly at the end of the year for the late dyads in comparison to that of the early dyads. (B) There was no significant difference in the perceived educational experience observed between early and late dyads of residents.

"more excellent," than attending surgeons (3.80 vs 4.38, $p < 0.01$, Fig. 5B). Late in the academic year, this significance was lost with both attending and resident surgeons perceiving excellent operative educational experiences (attending: 4.50, resident 4.38, $p < 0.19$, Fig. 5C). This appears to be due to an increase, over time, in the attending's perception of the educational experience (early: 3.80 vs late: 4.50, $p < 0.004$, Fig. 6A) with no significant increase for residents over time (early: 4.38 vs late: 4.72, $p < 0.13$, Fig. 6B).

Over the academic year, attendings perception of the educational experience in the operating room did not differ when comparing cases performed with junior vs senior residents (With junior residents: 4.04, vs with senior residents: 4.38, $p < 0.18$, Fig. 7A). Interestingly, junior residents had a significantly lower perception of the educational experience in the operating room when compared to senior residents (4.41 vs 4.81, respectively, $p < 0.05$, Fig. 7B).

Confidence and the Perceived Educational Experience

Evaluating how the different factors of perceived educational experience are affected by confidence perceptions, a correlation was found between the attending's

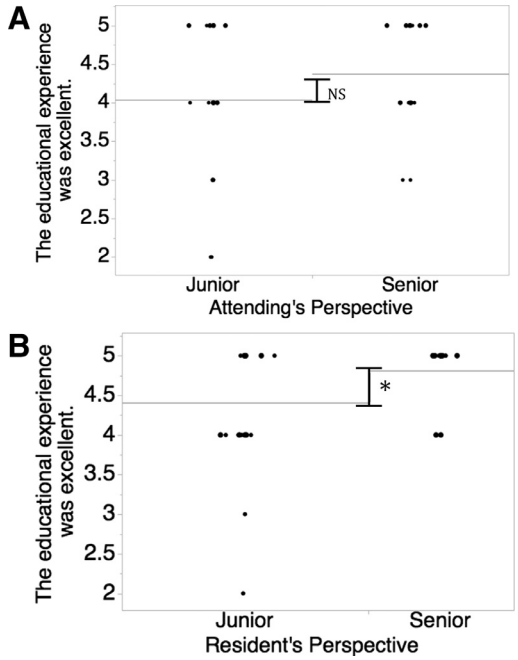

FIGURE 7. Junior residents perceive a lower perception of educational experience than senior residents. (A) Attending's perspective of the educational experience in working with junior or senior residents was not significantly different. (B) Between junior and senior residents, junior residents had a significantly lower perception of the educational experience that they had with attendings than senior residents perceived.

perception of the operative educational experience and their own confidence in the resident ($r^2 = 0.22$, $p < 0.0015$, Fig. 8). No such correlation was found between either the resident's self-confidence or the attendings self-confidence and the perceived educational experience in the OR. Additionally, no significant correlation was found between attending's confidence in resident and the resident's perception of educational experience.

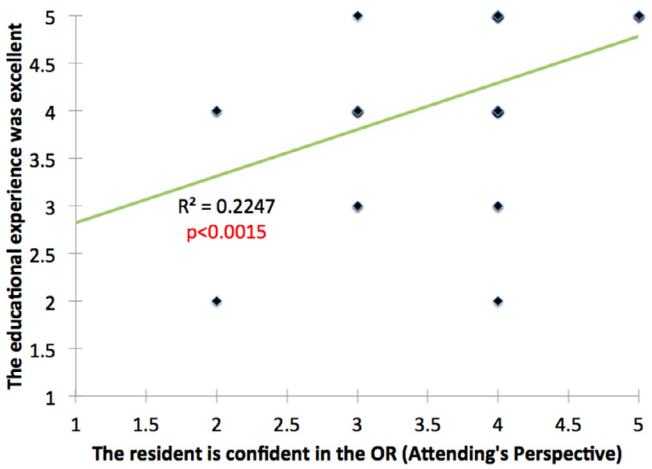

FIGURE 8. Attending's confidence in residents has a positive correlation with attending's perceived educational experience.

From the "end-of-year" survey, numerous factors were listed for participants to rate on a 5-point Likert scale from "not at all important" to "extremely important." For factors affecting the resident and attending's perceived educational experience in the OR (Fig. 9), patient outcome (2.40 vs 4.50, $p < 0.004$), difficulty of cases (3.50 vs 4.40, $p < 0.05$), and resident's skills (3.50 vs 4.40, $p < 0.05$) were the three factors affecting educational experience that attendings perceived to be more important in affecting the educational experience than residents perceived. The three most important factors for residents were the attending's teaching style, the resident's case preparation, and the amount residents do in the case. Both attendings and residents saw confidence of attendings and resident's confidence as moderate to very important, but not the most important factor.

Confidence and Resident Autonomy

Also from the "end-of-year" survey, both attendings and residents rated the "attendings confidence in the resident" as the most important factor in determining a resident's ability to "do more" in the operating room (Fig. 10). The other important factors for both residents and attendings included the difficulty of the operation, resident's knowledge of the case, resident's skills, attending's self-confidence, and the attending's knowledge of the case.

Residents perceived that their PGY level (3.67 vs 2.70, $p < 0.0097$), their reputation (3.33 vs 1.40, $p < 0.0005$), their desire to do more (3.78 vs 2.80, $p < 0.038$), and their length of time on the service (3.25 vs 2.20, $p < 0.014$) were more important in impacting their ability to "do more" in the operating room than the attendings believed. Attending surgeons did not indicate those factors as important in impacting resident's ability to do more in the OR.

For factors that prevent increasing the resident's ability to do more and have increased responsibility in the OR (Fig. 11), the highest rated factor by both attendings and residents was risk of complication. Time efficiency of cases was also a highly rated factor. Two factors only residents perceived to be a reason why they are prevented from doing more in the OR were focus on patient outcomes with the case (attendings: 2.5, residents: 3.9, $p < 0.03$) and residency duty hour time restrictions (attendings: 1.5, residents: 2.6, $p < 0.042$).

DISCUSSION

Previous studies investigating resident supervision and autonomy have focused on the resident's confidence or autonomy without addressing how the attending physician's perspectives may affect the educational experience

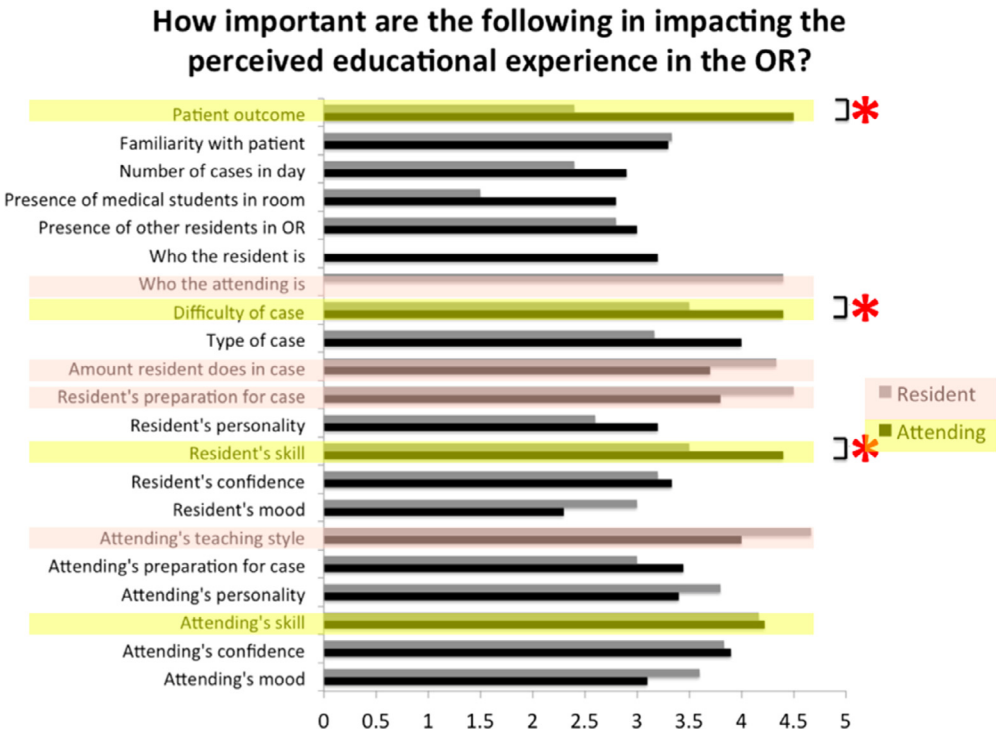

FIGURE 9. Attending and resident surgeons view different factors to be important in impacting perceived educational experience. Yellow boxes show the top four factors most important to attendings and pink boxes show the top four factors most important for residents.

of resident.[8–10] This lack of understanding on how the attending's confidence in the resident affects the educational experience of the surgical resident may limit the ability to maximize resident education in a system of limited training. Studies show both attendings and residents separately understand that resident's confidence is an important factor in resident's education to become attendings, but no study shows whose confidence of residents is most impactful for improving resident's autonomy and education.[3,9,13–16] Further information about the surgeon-resident dyad will improve the resident's educational experiences and autonomy.

Our objective was to investigate the interplay of confidence of attendings in residents and residents' self-confidence and the effect on residents' operative experience over time. In surgical education, surgeons ultimately determine the level of involvement of a resident within the operating room, balancing learning opportunity and patient safety. Thus, an attending's confidence in residents could have an important impact on resident's autonomy.

This study showed that attendings were consistently scoring residents to be less confident than how residents thought of themselves. Other studies identified relationships showing that junior residents equalized their own confidence with that of attending's perceptions later in the year, but senior residents still rated themselves to have higher confidence than attendings perceived of the resident.[12] This could be because attending physicians just overall gained more confidence in junior residents in the year. However, it is hard to determine whether this relationship is because senior residents are not meticulously observed by attending physicians, or because senior residents overall just believe their confidence in the OR is better than attendings perceive, or because of other multifactorial issues.

Educational experience could encompass any interaction between teachers and novices from the classic understanding within the confines of a classroom to the teaching experience between attendings and residents in the operating room. This vague interaction has not been studied objectively and fully between resident and attending surgeons, but information of differing views of educational experience perception could aid in bettering future interactions of attendings or residents over time. Resident's operative experience has been shown to be a strong predictor of autonomy, but other factors have been implicated outside of the resident performance.[17–19] Our data suggest that perhaps confidence may represent these secondary factors impacting autonomy.

We found an equalization of the perception of educational experience between attendings and residents over time. From early to late in a year, attending physicians have showed an improvement in their perception of educational experience when working with both

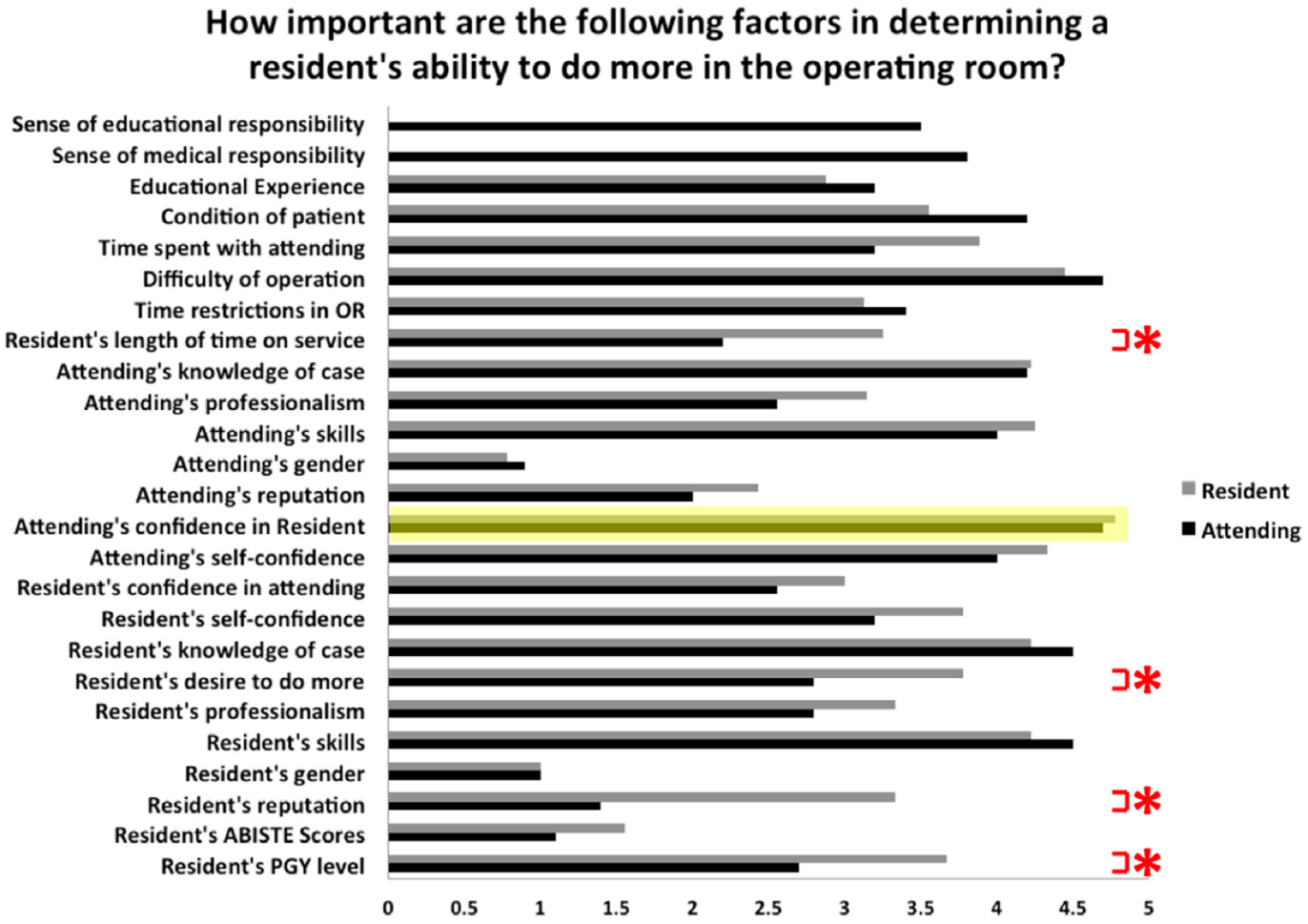

FIGURE 10. Attending and resident surgeons view different factors to be important in impacting a resident's ability to do more in the OR.

junior and senior residents. This finding provides an interesting facet to attending's perspectives. Of note is the relationship of the attending's confidence in residents having a positive correlation with the attending's perception of educational experience. Attendings thought factors affecting patient outcome and the outcome of the case were more important than the actual teaching opportunity in the OR, while residents seemed to have a greater focus on the teachings and education they could obtain from the OR experience with the attending. Although these priorities may be valued differently, ultimately attending-resident intraoperative interactions must simultaneously achieve both patient safety and educational teaching objectives. This difference of perspectives could be reflecting the different goals of the attendings and residents: attendings wanting to focus on taking care of the patient and residents, while caring for the patient, desire more from gaining experience. Perhaps attending physicians are more malleable in gaining increased confidence in residents over time as they see residents can provide adequate patient safety, and thus provide an improved educational experience for themselves and the resident. In addition, attendings may gain more confidence in residents over time, which could allow the attending to provide more work and experience to the resident. More focus has to be put to make sure both viewpoints, whether the focus is stronger on patient safety or educational teachings, are taken into account when establishing simulations and activities to improve the teaching relationship between residents and attendings.

Our study shows that attendings increase their confidence in junior residents through the span of 1 year, but our study does not address how to change confidence of the attending in the resident. There is a complex relationship between the attending's confidence in the resident and the resident's self-confidence. The highest rated factor in determining a resident's ability to do more in the OR was the attending's confidence in the resident. To increase confidence, there are a number of possible interventions, well established in the literature. Increased interaction in the early years through

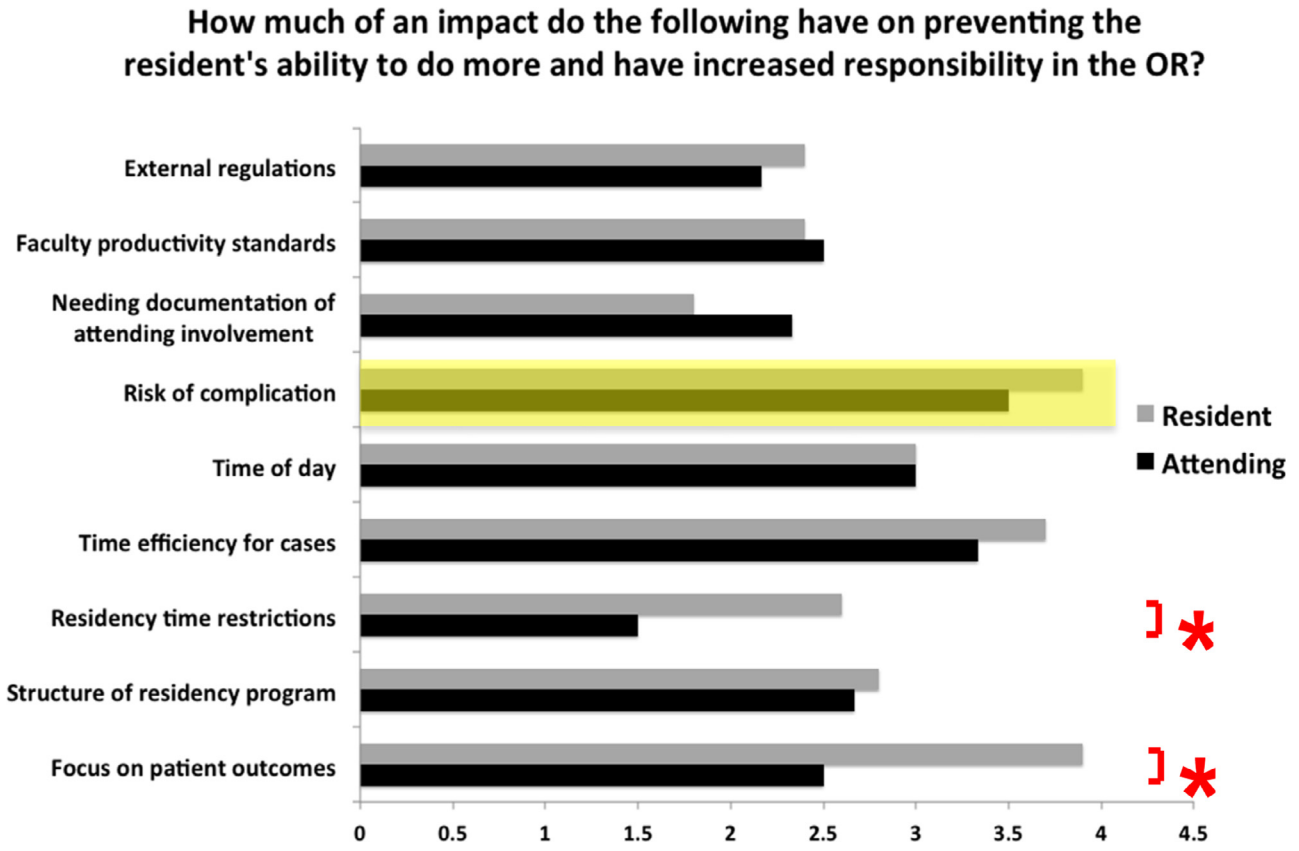

FIGURE 11. Factors preventing resident's ability to do more in the OR is most limited by risk of complication of the procedure. Yellow boxes show the top factor and red asterisk shows values differing between attendings and residents significantly.

simulations and more careful oversight in the first few years of residency plus additional one-on-one feedback may improve performance and confidence.[2,6,20-22]

This study was conducted at one institution and has not yet been replicated. The time limit of the first part of the study was limited to two sets in 3-month intervals. Expanding data collection over more than 1 year could provide more information on confidence of residents as they individually progress throughout their residencies. From the surveys that were collected, there remain limitations based on the self-reported nature of the study. Additionally, 13 of the 14 attendings survey respondents were male. This male majority is another notable limitation of this study since findings may not apply in a gender-balanced group of attendings. There is a decreased likelihood that memory issues were involved since surveys were taken immediately after OR procedure. There remains the possibility that some self-reported information could have been exaggerated in their answers or participants moods and attitudes of the day could have skewed the results. Although appendectomies and cholecystectomies are very common procedures, each individual case presents set of circumstances that may impact self-reported information. Another possible limitation of this study is the potential that since early and late group respondents are not the same set of participants, the increased confidence seen over 1 year may be confounded by the differences in the residents involved in each phase. Overall an increase in participants to more institutions and spanning more years of data collection could ameliorate these concerns and provide a stronger data set. Correlating survey results of more subjective issues to more concrete measurements could improve the study results and provide further information to better resident OR operative experience and confidence levels of attendings and residents.

CONCLUSION

This study shows that attending surgeons' confidence in residents, especially senior residents, is discordant from resident's self-perceived confidence. To improve resident autonomy, the difference in confidence should be narrowed. Though post graduate year, resident's perceived self-confidence, and attending's confidence in the resident are all associated with increased resident autonomy, more effort should be placed specifically into creating more

opportunities for residents to gain the attending's confidence. This study suggests that the increased attending confidence in residents may lead to increased autonomy in the operating room. Perception of educational experience also differs between residents and attendings, and more focus can be made to increase attending's confidence in the resident to provide an improved educational experience for the attending and ultimately the resident. To improve confidence of attendings and residents, surgical education could focus on increasing confidence of attending surgeons via preoperative interactive training. One possible way this could be done is to incorporate new technology in first simulated, then real-time, situations that can offer attending physicians a way to better view resident's awareness of surgical situations and outcomes. In the end, the final goal will be to increase attendings physicians' confidence in residents within a short time in order to increase resident autonomy, positively impact the educational experience, and overall improve the resident's future surgical career and the attending's teaching abilities.

REFERENCES

1. ACGME, 2017. Common Program Requirements Section VI with Background and Intent 1−19.
2. Kennedy TJT, Regehr G, Baker GR, Lingard La. Progressive independence in clinical training: a tradition worth defending? *Acad Med*. 2005;80:S106–S111. https://doi.org/10.1097/00001888-200510001-00028.
3. Teman NR, Gauger PG, Mullan PB, Tarpley JL, Minter RM. Entrustment of general surgery residents in the operating room: factors contributing to provision of resident autonomy. *J Am Coll Surg*. 2014;219:778–787. https://doi.org/10.1016/j.jamcollsurg.2014.04.019.
4. Buch KE, Genovese MY, Conigliaro JL, et al. Non-physician practitioners' overall enhancement to a surgical resident's experience. *J Surg Educ*. 2008;65:50–53. https://doi.org/10.1016/j.jsurg.2007.07.002.
5. Romanchuk K. The effect of limiting residents' work hours on their surgical training: a Canadian perspective. *Acad Med*. 2004;79:384–385. https://doi.org/10.1097/00001888-200405000-00005.
6. Kilminster SM, Jolly BC. Effective supervision in clinical practice settings: a literature review. *Med Educ*. 2000;34:827–840. https://doi.org/10.1046/j.1365-2923.2000.00758.x.
7. Mattar SG, Alseidi AA, Jones DB, Jeyarajah R, Swanstrom LL. General Surgery residency inadequately prepares trainees for fellowship. *Ann Surg*. 2013;258:440–449. https://doi.org/10.1097/SLA.0b013e3182a191ca.
8. Bucholz EM, Sue GR, Yeo H, Roman Sa, Bell RH, Sosa Ja. Our trainees' confidence: results from a national survey of 4136 US General Surgery Residents. *Arch Surg*. 2011;146:907–914. https://doi.org/10.1001/archsurg.2011.178.
9. Elfenbein DM. Confidence crisis among general surgery residents: a systematic review and qualitative discourse analysis. *JAMA Surg*. 2016. https://doi.org/10.1001/jamasurg.2016.2792.
10. Fonseca AL, Reddy V, Longo WE, Udelsman R, Gusberg RJ. Operative confidence of graduating surgery residents: a training challenge in a changing environment. *Am J Surg*. 2014;207:797–805. https://doi.org/10.1016/j.amjsurg.2013.09.033.
11. George BC, Bohnen JD, Williams RG, et al. 2017. Readiness of US general surgery residents for independent practice. *Ann Surg*. 266:582-594.
12. Park J, Parker SH, Safford SD. Surgical trainees' confidence in the operating room improves over time with a corresponding increase in responsibility. *Am Surg*. 2017;83:E421–E423.
13. Geoffrion R, Lee T, Singer J. Validating a self-confidence scale for surgical trainees. *J Obstet Gynaecol Can*. 2013;35:355–361. https://doi.org/10.1016/S1701-2163(15)30964-6.
14. Fonseca AL, Reddy V, Longo WE, Gusberg RJ. Graduating general surgery resident operative confidence: perspective from a national survey. *J Surg Res*. 2014;190:419–428. https://doi.org/10.1016/j.jss.2014.05.014.
15. Meyerson SL, Teitelbaum EN, George BC, Schuller MC, DaRosa DA, Fryer JP. Defining the autonomy gap: when expectations do not meet reality in the operating room. *J Surg Educ*. 2014;71:e64–e72.
16. Kempenich JW, Willis RE, Rakosi R. How do perceptions of autonomy differ in general surgery training between faculty, senior residents, hospital administrators, and the general public? A multi-institutional study. *J Surg Educ*. 2015;72:e193–e201.
17. Williams RG, George BC, Meyerson SL, et al. What factors influence attending surgeon decisions about resident autonomy in the operating room? *Surgery*. 2017;162:1314–1319.
18. Williams RG, et al. Is the operative autonomy granted to a resident consistent with operative

performance quality. *Surgery*. 2018;164:566–570. https://doi.org/10.1016/j.surg.2018.04.034.

19. Chen X, Williams R, Smink D. Dissecting attending surgeons' operating room guidance: factors that affect guidance decision making. *J Surg Educ*. 2015;72:e137–e144.

20. Darosa Da, Zwischenberger JB, Meyerson SL, et al. A theory-based model for teaching and assessing residents in the operating room. *J Surg Educ*. 2013;70:24–30. https://doi.org/10.1016/j.jsurg.2012.07.007.

21. Fallon WF, Wears RL, Tepas JJ. Resident supervision in the operating room: does this impact on outcome? *J Trauma*. 1993;35:556–561. https://doi.org/10.1017/S000748530002229X.

22. Torbeck L, Williams RG, Choi J, Schmitz CC, Chipman JG, Dunnington GL. How much guidance is given in the operating room? Factors influencing faculty self-reports, resident perceptions, and faculty/resident agreement. *Surgery*. 2014;156:797–805. https://doi.org/10.1016/j.surg.2014.06.069.

APPENDIX

A1. Early Data Set Summary

Within each PGY columns, data column in order from left to right: Resident, Attending

PGY 1-PGY3
(n of residents=7, n of attendings=9, total 13 groups)

# Cases Worked With Attending		
none	0.0%	
1 to 5	21.4%	
5 to 20	78.6%	
>20	0.0%	

# Cases Worked With Resident		
none		0.0%
1 to 5		30.8%
5 to 20		46.2%
>20		23.1%

How much of this procedure was performed by the resident?		
none (0%)	0.0%	0.0%
some (25%)	36.4%	20.0%
half (50%)	18.2%	20.0%
most (75%)	9.1%	30.0%
entire (100%)	36.4%	30.0%
avg	61.4%	67.5%

Would you allow this resident to perform the procedure on you?		
Yes, alone		0.0%
Yes, w/ assistance		92.3%
No		7.7%

Average Likert Scale Scores		
The attending is confident in the OR	4.929	4.615
The attending is experienced with the procedure	4.929	5.000
The resident is confident in the OR	3.786	3.385
The resident is experienced with the procedure	3.786	3.769
The resident understands all steps of the procedure	4.286	3.769
The resident understands pathology/pathophysiology	4.429	4.000
The resident knows the patient well	3.786	2.923
The educational experience was excellent	4.286	3.923

PGY 4-PGY5
(n of residents=5, n of attendings=6, total 7 groups)

# Cases Worked With Attending		
none	0.0%	
1 to 5	14.3%	
5 to 20	28.6%	
>20	57.1%	

# Cases Worked With Resident		
none		0.0%
1 to 5		0.0%
5 to 20		57.1%
>20		42.9%

How much of this procedure was performed by the resident?		
none (0%)	0.0%	0.0%
some (25%)	0.0%	0.0%
half (50%)	14.3%	0.0%
most (75%)	0.0%	50.0%
entire (100%)	85.7%	50.0%
avg	92.9%	87.5%

Would you allow this resident to perform the procedure on you?		
Yes, alone		42.9%
Yes, w/ assistance		57.1%
No		0.0%

Average Likert Scale Scores		
The attending is confident in the OR	4.714	4.714
The attending is experienced with the procedure	4.714	4.714
The resident is confident in the OR	4.429	3.857
The resident is experienced with the procedure	4.143	3.429
The resident understands all steps of the procedure	4.571	4.000
The resident understands pathology/pathophysiology	4.857	4.714
The resident knows the patient well	4.571	3.857
The educational experience was excellent	4.857	4.000

A2. Late Data Set Summary

Within each PGY columns, data column in order from left to right: Resident, Attending

PGY 1-PGY3

(n of residents=9, n of attendings=10, total 13 groups)

# Cases Worked With Attending		
none	0.0%	
1 to 5	15.4%	
5 to 20	38.5%	
>20	46.2%	

# Cases Worked With Resident		
none		7.7%
1 to 5		7.7%
5 to 20		38.5%
>20		46.2%

How much of this procedure was performed by the resident?		
none (0%)	7.7%	0.0%
some (25%)	0.0%	16.7%
half (50%)	30.8%	0.0%
most (75%)	23.1%	33.3%
entire (100%)	38.5%	50.0%
avg	71.2%	79.2%

Would you allow this resident to perform the procedure on you?		
Yes, alone		15.4%
Yes, w/ assistance		61.5%
No		23.1%

Average Likert Scale Scores		
The attending is confident in the OR	5.000	4.846
The attending is experienced with the procedure	5.000	5.000
The resident is confident in the OR	3.923	3.846
The resident is experienced with the procedure	3.769	3.769
The resident understands all steps of the procedure	4.231	3.769
The resident understands pathology/pathophysiology	4.462	4.231
The resident knows the patient well	3.769	3.538
The educational experience was excellent	4.692	4.385

PGY 4-PGY5

(n of residents=5, n of attendings=6, total 9 groups)

# Cases Worked With Attending		
none	0.0%	
1 to 5	0.0%	
5 to 20	33.3%	
>20	66.7%	

# Cases Worked With Resident		
none		0.0%
1 to 5		0.0%
5 to 20		22.2%
>20		77.8%

How much of this procedure was performed by the resident?		
none (0%)	0.0%	0.0%
some (25%)	0.0%	0.0%
half (50%)	0.0%	0.0%
most (75%)	0.0%	11.1%
entire (100%)	100.0%	88.9%
avg	100.0%	97.2%

Would you allow this resident to perform the procedure on you?		
Yes, alone		44.4%
Yes, w/ assistance		44.4%
No		11.1%

Average Likert Scale Scores		
The attending is confident in the OR	5.000	5.000
The attending is experienced with the procedure	5.000	5.000
The resident is confident in the OR	4.778	4.000
The resident is experienced with the procedure	4.889	4.556
The resident understands all steps of the procedure	4.889	4.667
The resident understands pathology/pathophysiology	4.889	4.667
The resident knows the patient well	4.556	3.889
The educational experience was excellent	4.778	4.667