

## Trainee Participation in Emergency Surgery What Are the Consequences?

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### Keywords

- Emergency surgery • Residents • Trainees • Outcomes
- Graduate medical education • Operative time • Supervision

### Key points

- Research on the effect of surgical trainee involvement in emergency surgery is mostly retrospective, and focuses on mostly safe, common procedures (appendectomy, cholecystectomy).
- Resident participation in emergency general surgery is associated with longer operative times, and possibly a small increase in postoperative complications.
- Resident involvement does not appear to affect mortality after emergency surgery, although its effect on hospital length of stay is unclear; when length of stay is prolonged, it appears that costs also increase.

## INTRODUCTION

The enactment of the Patient Protection and Affordable Care Act of 2010 has significantly expanded medical coverage [1], whereas an aging population with a greater number of chronic conditions, coupled with only a modest projected expansion in the physician workforce, has led to a widening gap in the clinician supply-and-demand equation [2,3]. At the epicenter of this conundrum is graduate medical education, which is tasked to balance two important needs: provide affordable, efficient, and quality health care to those who need it, and at the same time safely train junior physicians in their specialty of choice. Extensive research has demonstrated both beneficial and adverse effects associated with resident participation in many fields of medicine, including, but not

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limited to, radiology [4], cardiology [5], gastrointestinal medicine [6], and elective surgery [7–10]. Polanczyk and colleagues [11] demonstrated lower mortality after acute coronary events at teaching institutions, and Buchner and colleagues [6] demonstrated higher colonic malignancy-detection rates in endoscopies performed with resident involvement. Contrary to these reports, however, a substantial body of evidence suggests that trainee participation may be associated with adverse outcomes. In a study investigating the diagnostic competency of radiology residents, most junior trainees misidentified prominent trauma abnormalities on imaging [4], and in primary care, adverse outcomes have been linked to more prescribing errors made by junior trainees compared with their senior counterparts [12].

Among the most commonly cited factors for adverse outcomes when trainees are involved are lack of experience and inadequate supervision. These aspects may be even more pronounced in surgical training programs, in which trainees' lack of sophisticated technical skills, experience, and familiarity with complex procedures and evolving surgical technologies may play important roles [7,13]. A growing body of evidence suggests that surgical procedures tend to require longer operative times when trainees are involved, with a small, yet appreciable effect on clinical outcomes related to the longer operating room (OR) stay [14–16]. On the other hand, it appears that resident participation may improve outcomes when complications arise postoperatively, as more health care professionals assess patients with increased frequency, allowing early recognition of potential clinical deterioration [17,18].

The question remains, however, what the trainee effect is in patients undergoing *emergency* surgery. The unique characteristic of this type of surgical intervention is that time is of the essence: total time from presentation to definitive source control may affect outcomes to a greater extent than seen in elective surgery, as an appreciably deranged host physiology and prolongation of the inflammatory phase may exert their deleterious effects [19]. With this article, we aim to review currently available literature on the “resident effect” on outcomes in patients undergoing *emergency* surgery.

## **SUMMARY OF THE “RESIDENT EFFECT” ON SPECIFIC OUTCOMES AND DISCUSSION**

Effect of resident participation on operative time and postoperative morbidity

We recently demonstrated, through an extensive retrospective review and analysis of the American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP), that residents required longer time in the OR to perform common emergency operations ( $75.1 \pm 54.8$  minutes vs  $59.2 \pm 44.8$  minutes,  $P < .001$ ), after matching our resident (RES) and no-resident (NO-RES) cohorts on patient demographic and clinical characteristics, as well as procedure-related factors [19]. A small increase in intraoperative and postoperative morbidity, such as unplanned returns to the OR, need for intraoperative transfusions, surgical site infections and sepsis, and pulmonary and

thromboembolic complications, was also noted (Table 1). We also demonstrated that operative time was another important factor associated with intraoperative and postoperative transfusions; unplanned reoperations; and wound, pulmonary, infectious, and thromboembolic complications, adjusting for baseline comorbidities, case complexity, and resident participation. It appears that when trainees are involved, prolongation of the inflammatory state, OR time, immobility on the surgical table, and time on mechanical ventilation required for general anesthesia, may affect outcomes unfavorably. A limitation of our study, however, was lack of a 1-to-1 procedure matching in the RES and NO-RES

**Table 1**  
Clinically relevant 30-day postoperative outcomes

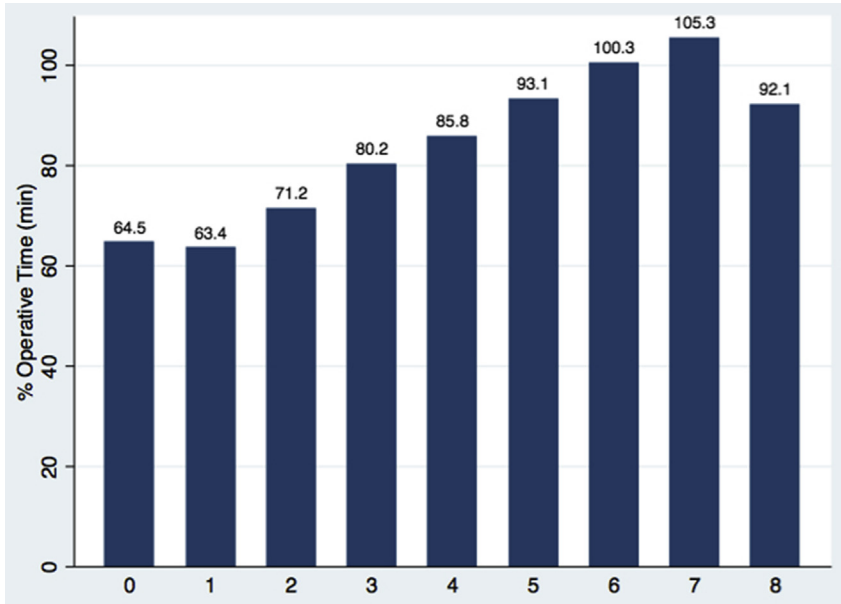
Outcome	Matched cohort, n = 83,790		
	NO-RES, n = 41,895	RES, n = 41,895	P value
Mortality	2.96	3.25	.082
Length of stay	4.59 ± 7.98	4.97 ± 9.63	.019
Operative technique			
Operative time	59.17 ± 44.78	75.10 ± 54.77	<.001
Anesthesia time	99.92 ± 55.45	122.42 ± 66.22	<.001
Intraoperative transfusion	2.55	3.43	<.001
Postoperative bleed requiring transfusion	1.28	1.12	.031
Unplanned return to operating room	3.80	4.22	.002
Wound complications			
Superficial wound infection	2.78	3.50	<.001
Deep wound infection	0.89	0.73	.011
Organ space infection	1.77	2.27	<.001
Wound dehiscence	0.69	0.63	.266
Pulmonary complications			
Postoperative pneumonia	1.67	1.85	.043
Unplanned reintubation	1.15	1.64	<.001
Prolonged ventilation (>48 h)	2.06	2.87	<.001
Cardiovascular complications			
Myocardial infarction	0.26	0.27	.637
Cardiopulmonary arrest	0.32	0.39	.071
Cerebrovascular accident	0.13	0.16	.205
Deep venous thrombosis	0.62	0.80	.002
Pulmonary embolism	0.28	0.43	<.001
Renal complications			
Acute renal failure	0.31	0.34	.427
Renal failure requiring dialysis	0.43	0.37	.209
Urinary tract infection	1.14	1.45	<.001
Life-threatening infectious complications			
Sepsis	2.13	2.42	.005
Septic shock	1.41	1.51	.205

Abbreviations: NO-RES, no-resident cohort; RES, resident cohort.

Adapted from Kasotakis G, Lakha A, Sarkar B, et al. Trainee participation is associated with adverse outcomes in emergency general surgery: an analysis of the National Surgical Quality Improvement Program database. *Ann Surg* 2014;260:486; with permission.

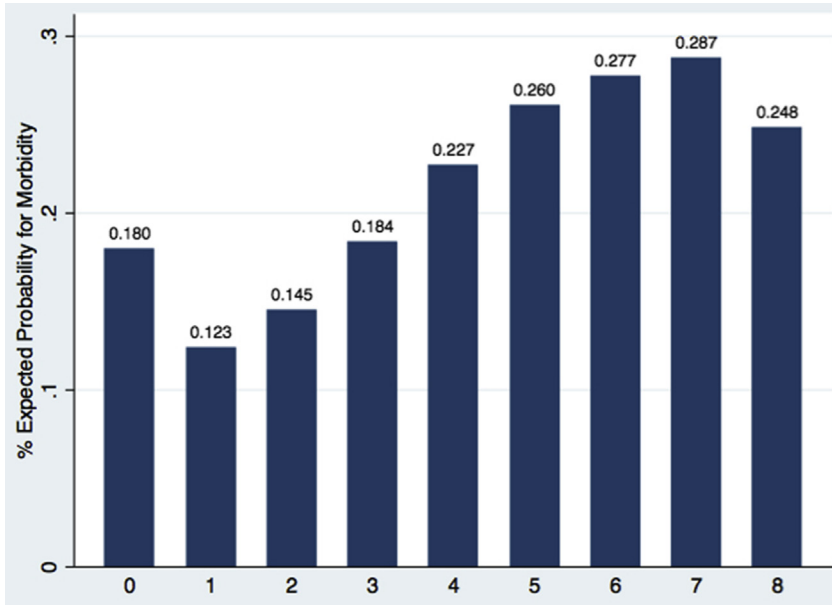
groups. Scarborough and colleagues [20] similarly showed an increased incidence of serious and overall postoperative complications when appendectomies were performed with resident participation, adjusting for baseline comorbidities and total operative time. However, they demonstrated that operative times and risk for postoperative morbidity increased with postgraduate year of training, and attributed this effect to the increased level of autonomy senior residents enjoy in the operating theater. However, they did not risk-adjust these 2 outcomes in their analysis for such a conclusion to be definitively drawn. Contrasting this finding is the study by Papandria and colleagues [16], which also reviewed a subset of the ACS-NSQIP dataset. Papandria and colleagues [16] assessed the effect of resident participation on the 3 most commonly performed general surgery procedures, namely laparoscopic appendectomy and cholecystectomy, and open inguinal herniorrhaphy. Even though they did not investigate the trainee effect specifically on emergency procedures, most appendectomies were classified as emergent (>72%), and so were a significant number of cholecystectomies (>4000 cases) and inguinal herniorrhaphies (300). The investigators demonstrated longer operative times in all cases performed with resident involvement, even after controlling for potential confounders ( $P < .001$ ). Interestingly, they did not find a difference in operative times between cases performed by junior versus senior residents, a result they ascribed to senior residents enjoying greater autonomy in the OR. In our own study, we found that operative times may indeed be prolonged when senior trainees are involved, but this seems to be a result of resident self-selection to more complex cases (Figs. 1 and 2). Similar results were echoed in other ACS-NSQIP analyses also, yet with more modest operative time and morbidity increases [21].

The group at the University of Texas at Austin established their surgical residency training program in 2009 and retrospectively studied the trainee effect on certain procedures, including laparoscopic and open cholecystectomies and appendectomies [22]. Although the investigators did not divide their cases into elective versus urgent ones, they demonstrated that, of the 4 procedures, only laparoscopic cholecystectomies took longer to perform when trainees were involved ( $71 \pm 32$  minutes RES vs  $66 \pm 28$  minutes NO-RES,  $P = .02$ ). However, the investigators did not adjust for case complexity, which may have been an important factor as evidenced by the wide SDs, or for attending seniority. The latter can be an important confounder also, as the increased efficiency in the OR that is expected of attending surgeons with growing experience, may counteract the lack of advanced laparoscopic skills of junior residents. A more consistent increase in operative times when trainees were involved was identified in a study by Castillo and colleagues [23] in a new surgical residency program in Florida. Even though the investigators did not divide laparoscopic cholecystectomies into elective versus urgent ones, they demonstrated a significant increase in operative time in both laparoscopic cholecystectomies and appendectomies whenever residents were involved ( $53.4 \pm 19.9$  minutes RES vs  $37.2 \pm 18.4$  minutes NO-RES,  $P < .001$ , and  $45.4 \pm 14.6$  minutes RES vs  $30.6 \pm 14.6$  minutes NO-RES,  $P < .001$ , respectively).



**Fig. 1.** Operative time (minutes) versus postgraduate year (year 0 corresponds to cases performed by attending surgeons alone). (Adapted from Kasotakis G, Lakha A, Sarkar B, et al. Trainee participation is associated with adverse outcomes in emergency general surgery: an analysis of the National Surgical Quality Improvement Program database. *Ann Surg* 2014;260:488; with permission.)

Looking specifically at appendectomies, Hwang and associates [24,25] also demonstrated that both laparoscopic and open appendectomies that were performed with resident involvement required longer time (58.9 minutes RES vs 44.4 minutes NO-RES,  $P < .05$ , and 63.3 minutes RES vs 48.0 minutes NO-RES,  $P < .05$ , respectively). This study, although also retrospective, occurred at a unique setting, where 2 groups of staff surgeons, 1 with resident coverage and 1 without, alternate call at the same institution and manage surgical emergencies as they present. This study also identified a higher complication rate in laparoscopic appendectomies when trainees were involved (5.9% vs 4.4%,  $P < .05$ ) [25]. Although this setting may be ideal in helping eliminate patient and disease severity-related differences between the RES and NO-RES groups, a skill differential across the 2 attending groups may still exist. Graat and colleagues [26] also found residents required longer operative times if appendectomies were performed by unsupervised trainees compared with staff surgeons alone at a teaching institution in the Netherlands ( $50.0 \pm 18.3$  minutes RES vs  $46.7 \pm 17.1$  minutes NO-RES,  $P = .019$ ). The same study also found no difference in major complications, even though staff surgeons and supervised residents were more likely to operate on patients with higher American Society of Anesthesiology (ASA) class and with perforated appendicitis.



**Fig. 2.** Expected probability of morbidity versus postgraduate year (year 0 corresponds to cases performed by attending surgeons alone). (Adapted from Kasotakis G, Lakha A, Sarkar B, et al. Trainee participation is associated with adverse outcomes in emergency general surgery: an analysis of the National Surgical Quality Improvement Program database. *Ann Surg* 2014;260:488; with permission.)

When Naiditch and colleagues [27] and Mizrahi and colleagues [28] assessed the effect of trainee participation on pediatric laparoscopic appendectomies, they too found that longer operative times were needed in cases performed by junior residents. However, although the study by Naiditch and colleagues [27] demonstrated a greater incidence of organ space infection requiring intervention (odds ratio 2.31 compared with supervised junior residents,  $P = .02$ ) when fellows were involved, Mizrahi and colleagues [28] did not identify a difference in overall complications (5% RES vs 7% NO-RES,  $P = .29$ ) or readmission rates (2% RES vs 5% NO-RES,  $P = .52$ ). Advani and colleagues [29] demonstrated both longer operative times for laparoscopic appendectomies when trainees participated (49 [interquartile range 38–64] minutes RES vs 35 [27–46] minutes NO-RES,  $P < .001$ ), and greater incidence of overall and specific complications (Table 2).

Singh and colleagues [30], retrospectively analyzing a multicenter, prospectively collected dataset of appendectomies mostly from the United Kingdom, published one of the few studies that demonstrated higher morbidity (pelvic abscess) in cases performed by attending surgeons; however, it appears that these cases involved older subjects with higher ASA scores.

**Table 2**

Complication profile of laparoscopic appendectomies performed with and without resident involvement

Laparoscopic appendectomy	Resident involvement, n = 11,451, %	No resident involvement, n = 5398, %	P value
Serious morbidity	1.8	1.3	.01
Overall morbidity	3.7	2.8	.004
Return to the operating room	0.7	1	.03
Infectious complications	3	2	.01
Wound complications	3	2	.02
Cardiac complications	0.4	0.2	.02
Vascular complications	0.1	0.1	.96
Neurologic and renal complications	0.3	0.3	.48
Septic complications	0.7	0.5	.07

*Adapted from Advani V, Ahad S, Gonczy C, et al. Does resident involvement effect surgical times and complication rates during laparoscopic appendectomy for uncomplicated appendicitis? An analysis of 16,849 cases from the ACS-NSQIP. Am J Surg 2012;203(3):349; with permission.*

Regarding laparoscopic cholecystectomy, another commonly performed, occasionally urgent procedure, Kauvar and colleagues [31] demonstrated that junior residents took longer to complete the case compared with their senior counterparts and regardless of surgeon seniority. Similarly, Bencini and colleagues [14] showed that in their institution, laparoscopic cholecystectomies took longer when residents were involved (67 minutes RES vs 50 minutes NO-RES,  $P < .001$ ), even though fewer additional procedures were required (3% RES vs 7% NO-RES,  $P = .009$ ) and patients were less complicated in the trainee group (ASA group 3 or 4, 2% RES vs 8% NO-RES,  $P = .04$ ). Thankfully, the incidence of iatrogenic bile duct injury was not found to be greater when residents were involved [32,33], even though, with such a rare complication, very large sample sizes would be needed, which both the aforementioned studies lack. Finally, Kauvar and associates [31] demonstrated that at the Brooke Army Medical Center in San Antonio, TX, resident seniority influenced operative time, and cases with junior resident assistance had a higher complication rate (5.6% RES vs 0.78% NO-RES,  $P < .05$ ), most commonly cystic duct leak.

#### Effect of trainee involvement on mortality

Most literature on emergency surgery is concentrated on procedures with low mortality (typically appendectomies and cholecystectomies), and currently available data do not suggest an association between trainee participation and higher mortality after emergency surgery. Uecker and colleagues [22] showed no difference in mortality (0.17% RES vs 0.35% NO-RES,  $P = .45$ ) in their studied appendectomized or cholecystectomized subjects, a finding that was also echoed in the article by Hwang and colleagues [24] (0% mortality for both cholecystectomies and appendectomies). In our review of a larger list of emergency operations, including procedures with non-

negligible mortality (such as exploratory laparotomy, bowel resection, repair of perforated viscus, and abdominal wall hernia repairs), we noted a trend toward slightly higher mortality (3.25% RES vs 2.96% NO-RES,  $P = .082$ ); however, this did not reach statistical significance [19]. One additional caveat of most currently available research is that essentially all studies assess in-hospital or 30-day deaths, not mortality that may have occurred outside this short window, and may still be associated with the index surgical disease or procedure.

#### Effect of resident participation on hospital length of stay and associated costs

The “resident effect” on hospital length of stay is somewhat more controversial, and conflicting reports suggesting an increase or shortening of the length of stay, or no effect whatsoever, all exist. Uecker and associates [22] demonstrated that shorter hospital stays were achieved after the establishment of the residency program (2.6 days RES vs 3.7 days NO-RES,  $P < .001$ ), a finding they attributed to a greater number of health care providers rounding on patients more frequently and helping their care move along. However, improvements in the quality of care and hospital/OR workflow efficiency that typically occur with time in mature institutions were not looked into. Mizrahi and colleagues [28] reported a similar finding in pediatric patients after appendectomy when trainees were involved ( $4.0 \pm 0.2$  days RES vs  $4.5 \pm 0.2$  days NO-RES,  $P = .03$ ).

On the other hand, Hwang and colleagues [24,25] demonstrated that resident involvement was associated with longer hospital stays in 5 index procedures, which included cholecystectomy and appendectomy, and higher costs, when procedures were performed by staff surgeons who had resident coverage. They attributed the increased costs to the longer hospital stays, as resource utilization was otherwise largely similar in the 2 groups. However, attending seniority and efficiency metrics were not assessed, and emergency procedures were lumped with elective ones.

In contrast, Kazaure and colleagues [21] demonstrated that, after adjusting for patient baseline characteristics and operative factors, there was no resident effect on hospital length of stay. Similarly, even though we identified a minimal increase in length of stay of questionable clinical significance ( $4.97 \pm 9.63$  days RES vs  $4.59 \pm 7.98$  days NO-RES,  $P = .019$ ), in our multivariate analysis, trainee involvement was not identified as an independent risk factor for longer hospital stays (odds ratio 0.07, 95% confidence interval  $-0.04$ – $0.17$ ,  $P = .242$ ), when patient characteristics and procedure-related factors were controlled for [19]. Reconciling these findings, it is unlikely that resident participation significantly affects length of stay in a meaningful way, but when it does, higher costs are likely incurred.

#### Issues with current research and summary

Even though the main associations with various clinical outcomes when surgical residents are involved in emergency procedures were stated earlier, it has to

be remembered that the quality of currently available evidence, from which these conclusions were drawn, is mediocre. Essentially all research is based on retrospective, observational reviews or secondary analyses of prospectively collected databases that were not specifically designed to assess the “resident effect.” In the era of the 80-hour work week and the resulting restricted operative time for surgical trainees, conducting a prospective trial in which subjects are randomized to resident or no-resident involvement would be unethical and likely to be met with upheaval from the trainee bodies. In addition, a large body of evidence is derived from analysis of data from the ACS-NSQIP database, which although well validated and highly reliable, are skewed toward larger, tertiary medical centers that perform more complex procedures, whereas smaller hospitals may be underrepresented. The residents’ autonomy and how it is recorded is subject to significant observation bias, and in addition may fluctuate significantly depending on case complexity (trainees may enjoy much greater autonomy in the OR in abscess-drainage procedures and appendectomies, for example, as opposed to colon resections for malignancy or laparotomies for hollow viscus perforations). Finally, a large number of studies either lump urgent and emergency procedures with elective ones, or assess the effect of trainee participation on relatively safe procedures (appendectomies, cholecystectomies).

Keeping these limitations in mind, currently available data suggest that resident involvement is associated with longer operative times, and possibly a small increase in postoperative complications (pulmonary, wound-related, and thromboembolic) as a direct consequence of the prolonged time under general anesthesia, immobility, and wound exposure. This effect is likely more pronounced in emergency surgery, as patients are already typically in an inflammatory state and frequently underresuscitated and underfed, compared with their elective counterparts. While still in this inflammatory phase, they receive an additional inflammatory insult (that of surgery) that appears to account for the outcome differential between emergency and elective procedures. Unnecessary prolongation of this secondary insult may be the link to the slightly worse outcomes when trainees are involved. Surgery resident involvement does not appear to adversely affect mortality, whereas the effect on hospital length of stay is still a topic of debate.

## References

- [1] Blumenthal D, Collins SR. Health care coverage under the affordable care act—a progress report. *N Engl J Med* 2014;371:275–81.
- [2] Grover A, Niecko-Najjum LM. Physician workforce planning in an era of health care reform. *Acad Med* 2013;88:1822–6.
- [3] Dall TM, Gallo PD, Chakrabarti R, et al. An aging population and growing disease burden will require a large and specialized health care workforce by 2025. *Health Aff* 2013;32:2013–20.
- [4] McLauchlan CA, Jones K, Guly HR. Interpretation of trauma radiographs by junior doctors in accident and emergency departments: a cause for concern? *J Accid Emerg Med* 1997;14:295–8.

- [5] Sandhu A, Moscucci M, Dixon S, et al. Differences in the outcome of patients undergoing percutaneous coronary interventions at teaching versus non-teaching hospitals. *Am Heart J* 2013;166:401–8.
- [6] Buchner AM, Shahid MW, Heckman MG, et al. Trainee participation is associated with increased small adenoma detection. *Gastrointest Endosc* 2011;73:1223–31.
- [7] Davis SS Jr, Husain FA, Lin E, et al. Resident participation in index laparoscopic general surgical cases: impact of the learning environment on surgical outcomes. *J Am Coll Surg* 2013;216:96–104.
- [8] Iannuzzi JC, Chandra A, Rickles AS, et al. Resident involvement is associated with worse outcomes after major lower extremity amputation. *J Vasc Surg* 2013;58:827–31.e1.
- [9] Iannuzzi JC, Rickles AS, Deeb AP, et al. Outcomes associated with resident involvement in partial colectomy. *Dis Colon Rectum* 2013;56:212–8.
- [10] Kern SQ, Lustik MB, McMann LP, et al. Comparison of outcomes after minimally invasive versus open partial nephrectomy with respect to trainee involvement utilizing the American College of Surgeons National Surgical Quality Improvement Program. *J Endourol* 2014;28:40–7.
- [11] Polanczyk CA, Lane A, Coburn M, et al. Hospital outcomes in major teaching, minor teaching, and nonteaching hospitals in New York State. *Am J Med* 2002;112:255–61.
- [12] Ryan C, Ross S, Davey P, et al. Prevalence and causes of prescribing errors: the PRescribing Outcomes for Trainee Doctors Engaged in Clinical Training (PROTECT) study. *PLoS One* 2014;9:e79802.
- [13] Tseng WH, Jin L, Canter RJ, et al. Surgical resident involvement is safe for common elective general surgery procedures. *J Am Coll Surg* 2011;213:19–26 [discussion: 26–8].
- [14] Bencini L, Bernini M, Martini F, et al. Safety of laparoscopic cholecystectomy performed by surgical residents. *Chir Ital* 2008;60:819–24.
- [15] Kiran RP, Ahmed Ali U, Coffey JC, et al. Impact of resident participation in surgical operations on postoperative outcomes: National Surgical Quality Improvement Program. *Ann Surg* 2012;256:469–75.
- [16] Papandria D, Rhee D, Ortega G, et al. Assessing trainee impact on operative time for common general surgical procedures in ACS-NSQIP. *J Surg Educ* 2012;69:149–55.
- [17] Ferraris VA, Bolanos M, Martin JT, et al. Identification of patients with postoperative complications who are at risk for failure to rescue. *JAMA Surg* 2014;149(11):1103–8.
- [18] Bukur M, Singer MB, Chung R, et al. Influence of resident involvement on trauma care outcomes. *Arch Surg* 2012;147:856–62.
- [19] Kasotakis G, Lakha A, Sarkar B, et al. Trainee participation is associated with adverse outcomes in emergency general surgery: an analysis of the National Surgical Quality Improvement Program database. *Ann Surg* 2014;260:483–90 [discussion: 90–3].
- [20] Scarborough JE, Bennett KM, Pappas TN. Defining the impact of resident participation on outcomes after appendectomy. *Ann Surg* 2012;255:577–82.
- [21] Kazaure HS, Roman SA, Sosa JA. The resident as surgeon: an analysis of ACS-NSQIP. *J Surg Res* 2012;178:126–32.
- [22] Uecker J, Luftman K, Ali S, et al. Comparable operative times with and without surgery resident participation. *J Surg Educ* 2013;70:696–9.
- [23] Castillo A, Zarak A, Kozol RA. Does a new surgical residency program increase operating room times? *J Surg Educ* 2013;70:700–2.
- [24] Hwang CS, Pagano CR, Wichterman KA, et al. Resident versus no resident: a single institutional study on operative complications, mortality, and cost. *Surgery* 2008;144:339–44.
- [25] Hwang CS, Wichterman KA, Alfrey EJ. The cost of resident education. *J Surg Res* 2010;163:18–23.
- [26] Graat LJ, Bosma E, Roukema JA, et al. Appendectomy by residents is safe and not associated with a higher incidence of complications: a retrospective cohort study. *Ann Surg* 2012;255:715–9.

- [27] Naiditch JA, Lautz TB, Raval MV, et al. Effect of resident postgraduate year on outcomes after laparoscopic appendectomy for appendicitis in children. *J Laparoendosc Adv Surg Tech A* 2012;22:715–9.
- [28] Mizrahi I, Mazeh H, Levy Y, et al. Comparison of pediatric appendectomy outcomes between pediatric surgeons and general surgery residents. *J Surg Res* 2013;180:185–90.
- [29] Advani V, Ahad S, Gonczy C, et al. Does resident involvement effect surgical times and complication rates during laparoscopic appendectomy for uncomplicated appendicitis? An analysis of 16,849 cases from the ACS-NSQIP. *Am J Surg* 2012;203:347–51 [discussion 51–2].
- [30] Singh P, Turner EJ, Cornish J, et al, National Surgical Research Collaborative. Safety assessment of resident grade and supervision level during emergency appendectomy: analysis of a multicenter, prospective study. *Surgery* 2014;156:28–38.
- [31] Kauvar DS, Braswell A, Brown BD, et al. Influence of resident and attending surgeon seniority on operative performance in laparoscopic cholecystectomy. *J Surg Res* 2006;132:159–63.
- [32] Schwartz SI, Yaghoobian AT, Andacheh ID, et al. Senior residents as teaching assistants during laparoscopic cholecystectomy in the 80-hour workweek era: effect on biliary injury and overall complication rates. *J Surg Educ* 2013;70:796–9.
- [33] Harrison VL, Dolan JP, Pham TH, et al. Bile duct injury after laparoscopic cholecystectomy in hospitals with and without surgical residency programs: is there a difference? *Surg Endosc* 2011;25:1969–74.