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Trends in resident operative trauma: How to train future trauma surgeons?

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ABSTRACT

Background: Trauma is an essential content area of general surgery residency. The objective of this study was to assess trends in the operative trauma experience by general surgery residents.
Methods: This was a retrospective review of available ACGME case log reports (the past 29 years) for general surgery residents.
Results: Over the study period, the total operative trauma cases as surgeon decreased from 79.6 to 29.9, ($p < 0.001$), gastrointestinal cases decreased from 10.6 to 4.0, ($p < 0.001$), and vascular cases decreased from 8.6 to 4.5, ($p < 0.001$). The median number of trauma cases in which residents reported a teaching assistant role fell from 5 to 1 ($p < 0.001$) and as a first assistant declined from 17 to 1 ($p < 0.001$).
Conclusions: Over the past 29 years, the operative trauma experience of general surgery residents has **dramatically** decreased. The decline is multifactorial but brings sharp focus on resident education in operative trauma.

Introduction

Trauma is considered an essential content area of general surgery residency by both the Residency Review Committee (RRC) for Surgery and the American Board of Surgery (ABS).[1,2] Due to an increasing number of general surgery residents, resident duty hour regulations, the increasing non-operative nature of trauma, the proliferation of trauma centers, and other factors, there is a growing concern that general surgery residency no longer affords the same caliber of training in operative trauma as in previous years.[3,4]

To better understand the current state of resident education in trauma, we examined the Accreditation Council for Graduate Medical Education (ACMGE) resident case log reports over the past 29 years. The objective of this study was to assess trends in the operative trauma experience by graduating general surgery chief residents. We hypothesized that the operative trauma experience, including exploratory laparotomies, of graduating general surgery chief residents has declined over time.

Materials and methods

This was a retrospective review of the available annual national ACGME case log reports for graduating general surgery residents from the years 1989–1990 through 2017–2018. Those reports break the data down into total overall operative trauma, operative vascular trauma cases, and operative gastrointestinal trauma cases, all of which were evaluated. The cases logged as operative vascular trauma consisted of exposure and repair of any blood vessels as well as fasciotomy. Operative gastrointestinal trauma cases included closure, resection, and exclusion of any segment of the alimentary tract from the esophagus to the colon. Additionally, the number of ACGME-accredited general surgery residency programs as well the number of graduating general surgery residents per year was recorded.

Continuous data were reported as mean and median values. Categorical data are presented as numbers and percentages. Analysis of variance (ANOVA) and simple linear regressions were performed to assess the trends in operative trauma experience by general surgery residents. The level of statistical significance was set at $p < 0.05$. All statistical analyses were conducted using Excel Analysis ToolPak© (Microsoft; Redmond, Washington).

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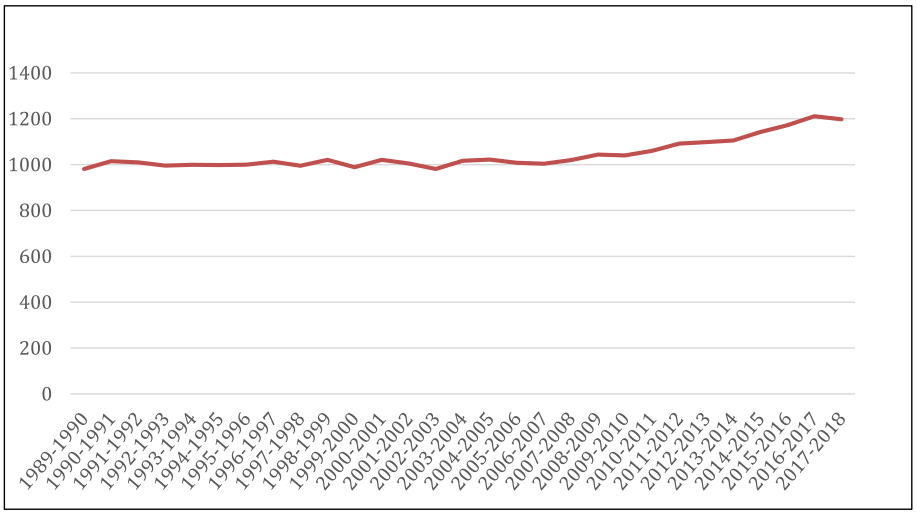

Fig. 1. Total number of graduating general surgery chief residents by year.

Results

Over the 29-year study period, the number of ACGME accredited general surgery residency programs decreased from 279 to 251. However, the number of graduating chief residents in general surgery increased from 981 to 1198 ($p < 0.001$; $R^2 = 0.67$). This was statistically significant (Fig. 1). Fig. 2 depicts the trend in mean number of total (surgeon junior plus surgeon chief) operative trauma cases reflecting all categories. There has been a decline from 79.6 to 29.9 cases per graduating chief resident in general surgery ($p < 0.001$; $R^2 = 0.84$).

Overall, operative vascular trauma cases have declined by 47.7% (Fig. 3). Specifically, operative vascular trauma cases including fasciotomies decreased from 8.6 to 4.5 ($p < 0.001$; $R^2 = 0.91$), while operative vascular trauma cases excluding fasciotomies decreased from 6.9 to 2.4 cases ($p < 0.001$; $R^2 = 0.93$). A similar trend was observed in the total number of operative gastrointestinal trauma cases reported ($p < 0.001$; $R^2 = 0.90$). The absolute decrease in operative gastrointestinal trauma cases was from 10.6 to 4.0 cases (Fig. 4).

Interestingly, the total number of exploratory laparotomy cases for trauma remained stable over the study period, following an initial decline and subsequent resurgence. Graduating trainees from 1989 to 1990 logged 10 trauma laparotomies versus 9.4 in 2017–2018 (Fig. 5). The cases logged as teaching assistant and first assistant dramatically declined over the study period (Figs. 6 and 7). The median number of trauma cases in which residents reported a teaching assistant role fell from 5 to 1 ($p < 0.001$), while the median number of trauma cases in which residents reported participating as a first assistant declined most dramatically from 17 to 1 ($p < 0.001$).

Discussion

Trauma is an essential content area for general surgery residency.[1,2] In the current study, we document an overall and progressive decline in operative trauma volume and diversity for graduating general surgery residents over the past 29 academic years (1989–1990 through 2017–2018). This trend is consistent, well documented and began prior to the advent of ACGME duty-hour regulations.[3,4] With this comes a growing concern that graduating general surgery residents are no longer afforded the same caliber of operative trauma training as in previous years.[5]

The decline in resident operative trauma experience is

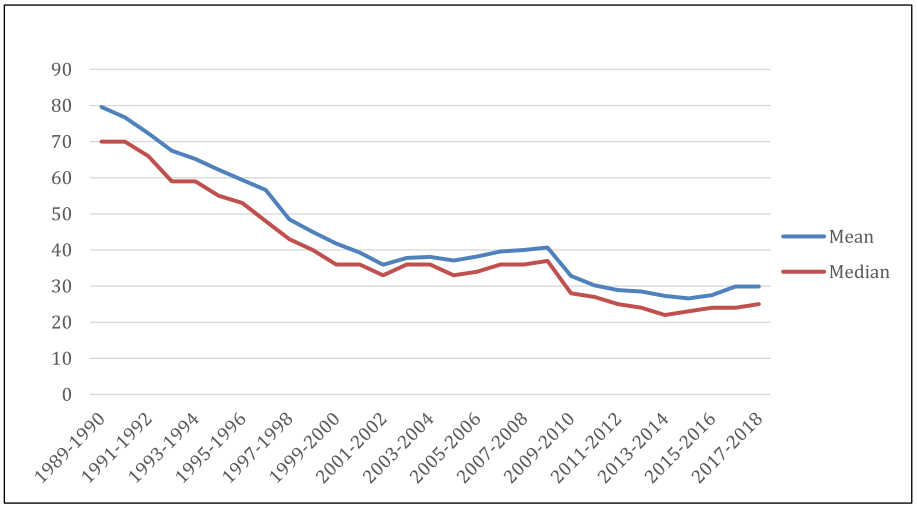

Fig. 2. Trend in overall operative trauma cases (mean and median cases per resident).

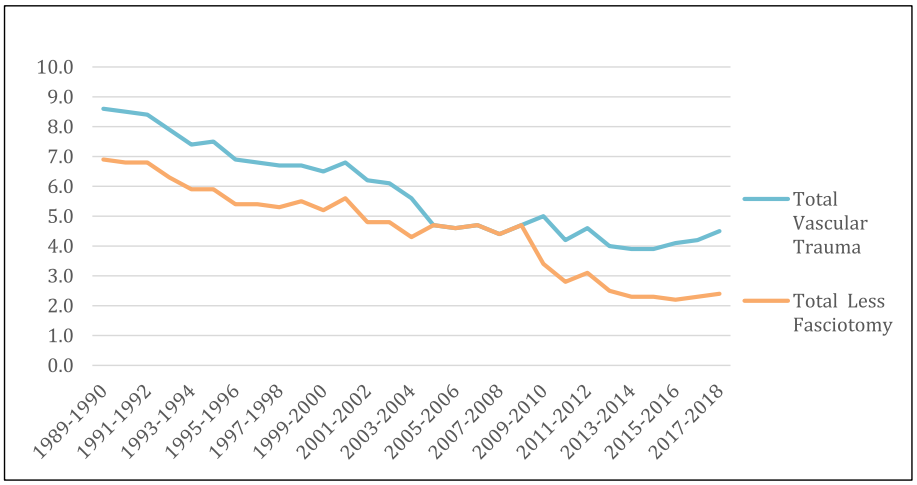

Fig. 3. Trends in operative vascular trauma cases (mean cases per resident).

multifactorial. The increasing number of general surgery residents, resident duty hour regulations, the proliferation of trauma centers (many of which do not train residents), and the increasingly non-operative nature of trauma supplemented by advancements in radiographic imaging and interventional radiology each contribute to that decline.[6,7]

The growth of United States (US) trauma centers over the past 20 years has been dramatic. There were 471 trauma centers in the US in 1991 and by the year 2002 there were 1152.[8] While this may have ameliorated access to trauma care throughout the US, it has definitely impacted the opportunity for general surgery residents to participate in the care of injured patients. Many general surgery residency programs are partners with Level I trauma centers. However, the greatest proliferation of trauma centers has occurred at the Level II and Level III trauma center levels. The majority of such facilities do not train general surgery residents.

While the number of exploratory laparotomies for trauma did not decline in the current study, the diversity of such cases most certainly dwindled. In contrast, operative vascular trauma profoundly declined. This is most disconcerting because apart from non-technical skills and sound judgment, vascular exposure, control and repair is at the pinnacle of skills mandated of a trauma surgeon. In many settings, trained vascular surgeons will eventually be consulted to deal with vascular injuries. However, a general surgeon is usually the first line of treatment for patients with vascular injuries and, in many settings, the general surgeon is the only person available to treat life-threatening vascular injuries. It is however unclear if contemporary general surgeons are losing the technical ability to intervene on injured blood vessels.

The observed trends parallel the emphasis in non-operative management of solid organ injuries. This has been made possible by technological advancement epitomized by high-resolution computed tomography (CT) imaging coupled with nationwide availability and access to angioembolization.[9,10] Utilization of arteriography and transcatheter embolization gained wide acceptance in the 1990s.[10–12] Open splenectomies and nephrectomies once routinely performed are now rare. In addition, the management of hepatic injuries is now mostly non-operative thus making trauma hepatectomies almost obsolete.[13,14] Routine laparotomies after a positive diagnostic peritoneal lavage (DPL) have long since receded from common surgical practice. Many patients who would have undergone exploratory laparotomy in the past are now spared an operation due to reliable high-resolution CT imaging supplemented by careful observation in monitored care units.[7,9]

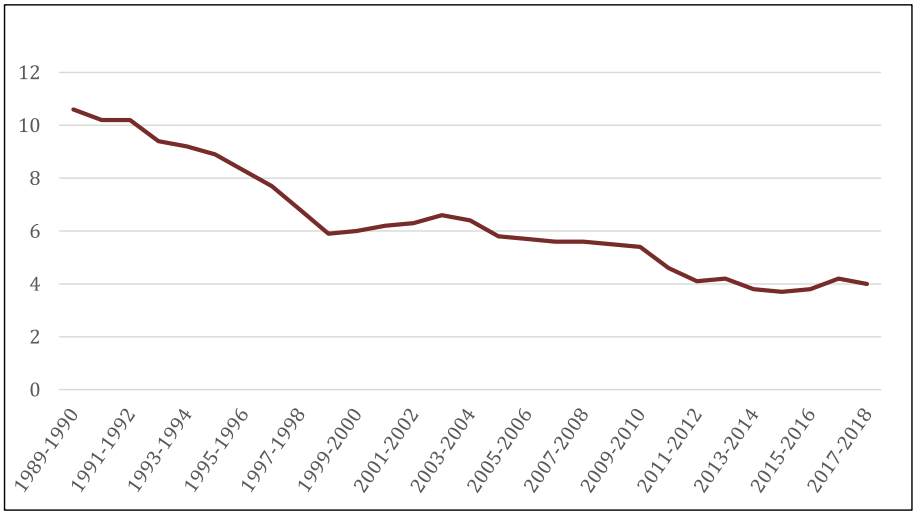

Fig. 4. Trend in operative gastrointestinal trauma cases (mean cases per resident).

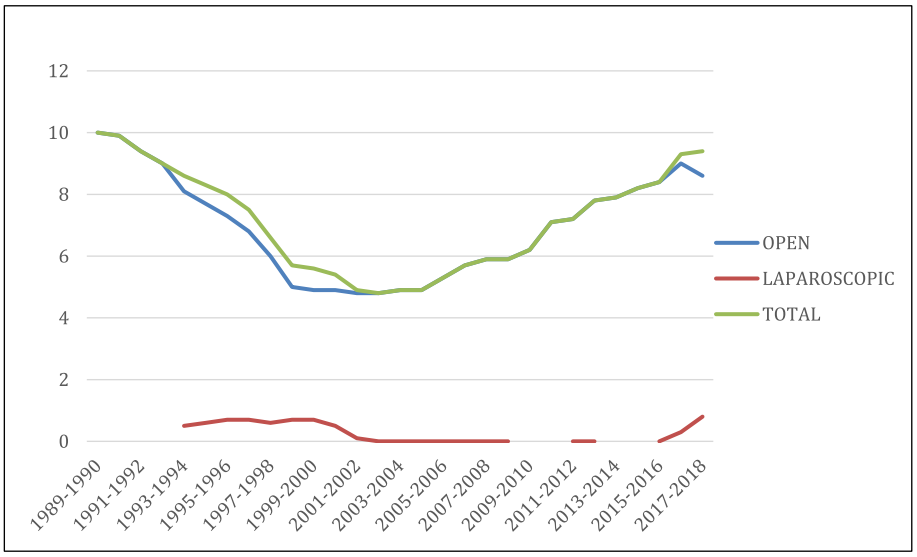

Fig. 5. Trends in trauma exploratory laparotomy cases (mean cases per resident).

It is axiomatic that contemporary general surgery residents are being trained in an era far more complex than that of their predecessors. The surgical landscape has changed convincingly, but the approach to training has not.[15] General surgery training still derives its roots from the Halsted model whose inception was over a century ago.[16] This model thrives on opportunity and the mantra "see one, do one, teach one" which colloquially expresses a logical and important educational progression.[3] Operative trauma opportunity has diminished. In addition to this, regulatory requirements driven by patient safety initiatives, quality metrics, billing criteria, and institutional rules have culminated into severely restricted trainee autonomy.[17] This unprecedented lack of progressive autonomy in an era of "diminishing operative trauma opportunity" needs consideration in addressing the training of contemporary general surgeons. Supervision is critical to trainees' development and patient's safety but it has to be "appropriate" and carefully calibrated in a way that fosters technical competence and confidence.[17]

Of greatest significance in this study was the profound decline in the number of cases logged as first and teaching assistant by graduating residents. High patient census and complex patient management have been cited as some of the reasons hindering junior residents from coming to the operating room for observational experience.[18] The contribution of duty hour regulations or the participation of fellows in trauma cases cannot be elucidated from these data. Regardless of the cause, this decline in first and teaching assistant cases is immensely concerning because trainees achieve and demonstrate surgical mastery by transitioning from being an assistant to a simulated attending surgeon's role by acting as teaching assistant to their junior colleagues. This cannot be overemphasized because "to teach is to learn twice" and in acting as teaching assistants, chief residents become cognizant of their own technical and/or clinical deficiencies.[17]

The observed trends undeniably beg the commitment of program directors and chairs in training technically and clinically

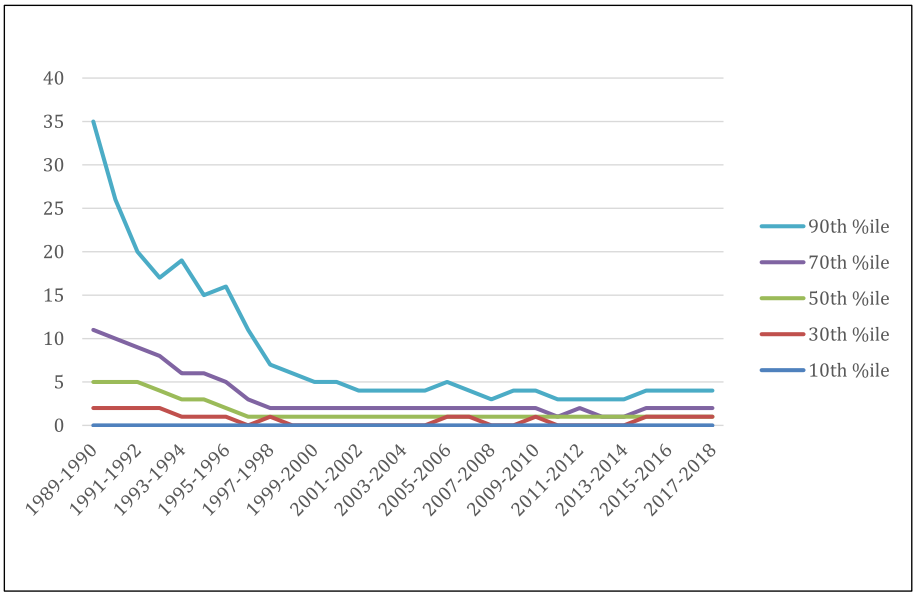

Fig. 6. Operative trauma cases logged as a teaching assistant.

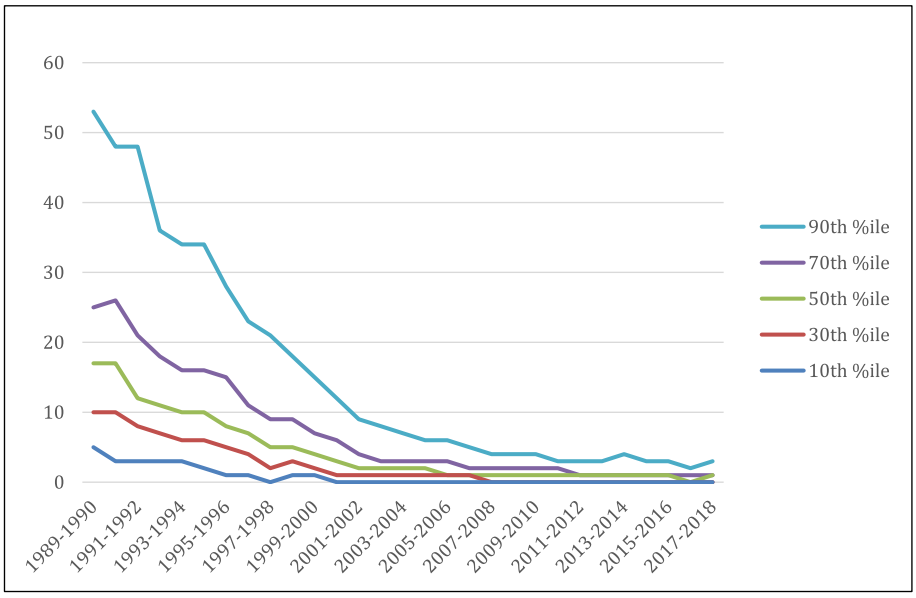

Fig. 7. Operative trauma cases logged as a first assistant.

proficient general surgeons. This can only be done with an honest review of residency program structures and policies. Operative trauma opportunity may continue to decline, even though the length of residency remains fixed. This poses a steeper learning curve than before. However, technical skills utilized in operative trauma are extrapolated from skills learned in all of a residents' training duration. Time in the operating room needs to be maximized. To curb "inappropriate supervision", residency programs need to structure longer rotations especially those that are operatively heavy. This will subsequently allow faculty to identify trainee deficits, correct them, and offer reasonable autonomy. Chief residents should not be placed on rotations in which most cases are done by fellows. In addition, the integration of non-physician practitioners to surgical services may help offset the workload perceived to be hindering junior residents from participating in cases.[19,20] The chief resident year is the most formative time of a trainee and should not be spent "watching" operations.

Apart from maximizing the learning opportunities in the operating room, innovative training paradigms can be adopted. Robust and individualized chief year simulation in the wet laboratory with emphasis on vascular exposure and control may be an invaluable adjunct.[21] Institution based trauma technical skills courses may be needed.[22] To account for geographical variability, individual residency programs may need to evaluate their own trends and make necessary adjustments to their respective curricula. Additionally, post-residency training such as Acute Care Surgery fellowships may aid on this front.

There are several limitations to this study. It is retrospective in nature and has all of the inherent flaws as such. The case log data is self-reported by residents and are thus limited by the accuracy of their reporting. Finally, while the study is representative of the overall trends in general surgery resident operative trauma experience, it does not account for geographical, programmatic, or individual variability.[23] As such, the results may not directly correlate to all general surgery residency programs or all residents in those programs.

Conclusions

Over the past 29 years, surgical training in the US has witnessed a profound decline in the overall operative trauma experience of graduating general surgery residents and the diversity, thereof. It is thus imperative for the surgical community to maximize learning opportunities and to be innovative in order to appropriately train residents to proficiency in operative trauma.

Disclosures

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