# Accreditation Council for Graduate Medical Education (ACGME) Surgery Resident Operative Logs

## *The Last Quarter Century*

*Frederick Thurston Drake, MD, MPH,*† Shahram Aarabi, MD,‡ Brandon T. Garland, MD,‡ Ciara R. Huntington, MD,§ Jarod P. McAteer, MD, MPH,* Morgan K. Richards, MD, MPH,* Nicole Kansier Zern, MD,* and Kenneth W. Gow, MD¶*

**Study Objective:** To describe secular trends in operative experience for surgical trainees across an extended period using the most comprehensive data available, the Accreditation Council for Graduate Medical Education (ACGME) case logs.

**Background:** Some experts have expressed concern that current trainees are inadequately prepared for independent practice. One frequently mentioned factor is whether duty hours' restrictions (DHR) implemented in 2003 and 2004 contributed by reducing time spent in the operating room.

**Methods:** A dataset was generated from annual ACGME reports. Operative volume for total major cases (TMC), defined categories, and four index laparoscopic procedures was evaluated.

**Results:** TMC dropped after implementation of DHR but rebounded after a transition period (949 vs 946 cases, $P$ = nonsignificance). Abdominal cases increased from 22% of overall cases to 31%. Alimentary cases increased from 21% to 26%. Trauma and vascular surgery substantially decreased. For trauma, this drop took place well before DHR. The decrease in vascular surgery also began before DHR but continued afterward as well: 148 cases/resident in the late 1990 s to 107 currently.

**Conclusions:** Although total operative volume rebounded after implementation of DHR, diversity of operative experienced narrowed. The combined increase in alimentary and abdominal cases is nearly 13%, over a half-year's worth of operating in 5-year training programs. Bedrock general surgery cases—trauma, vascular, pediatrics, and breast—decreased. Laparoscopic operations have steadily increased. If the competence of current graduates has, in fact, diminished. Our analysis suggests that operative volume is not the problem. Rather, changing disease processes, subspecialization, reductions in resident autonomy, and technical innovation challenge how today's general surgeons are trained.

**Keywords:** duty hours' restrictions, operative volume, surgery residency, surgery training, surgical education, workweek

(*Ann Surg* 2017;265:923–929)

From the *Department of Surgery, University of Washington, Seattle, WA; †Department of Surgery, Division of Endocrine Surgery, University of California, San Francisco, CA; ‡Department of Surgery, Division of Vascular Surgery, University of Washington, Seattle, WA; §Department of Surgery, Carolinas Medical Center, Charlotte, NC; and ¶Department of Surgery, Division of Pediatric Surgery, University of Washington, Seattle, WA.

Disclosure: No funding was received for this research project.

The authors declare no conflicts of interest.

Reprints: Frederick Thurston Drake, MD, MPH, Department of Surgery, University of California, 1600 Divisadero Avenue, C-347, Box 1674, San Francisco, CA. E-mail: frederick.drake@ucsf.edu.

Kenneth W. Gow, MD, Department of Surgery, Division of Pediatric Surgery, University of Washington, 4800 Sand Point Way NE, Seattle, WA 98105. E-mail: kenneth.gow@seattlechildrens.org.



ISSN: 0003-4932/16/26505-0923

DOI: 10.1097/SLA.0000000000001738

Over the last 25 years, surgical education has been buffeted by major changes such as resident duty hours' restrictions (DHR), patient expectations in terms of supervision, increasing sub-specialization, medical and percutaneous management of conditions previously treated by surgery, and innovations in technology and technique.[1,2,3] We present 24 years of general surgery resident operative volume to quantify and characterize how surgical training has been affected by these changes.

The specific goal of this project was to identify and describe secular trends in surgical training across an extended period using the most comprehensive dataset available, the Accreditation Council for Graduate Medical Education (ACGME) case logs. The analysis addresses two questions. First, were any changes temporally associated with the controversial mandating of DHR in academic year (AY) 2003–2004. Second, have there been any changes in the operative experience during residency—in number or in diversity of cases—such that the surgeon who graduates from residency today has a substantially different skill set than the surgeon who graduated 10 or 20 years ago?

## METHODS

Case log data for general surgery residents was obtained from the ACGME for AY 1989–1990 through AY 2012–2013. Individual resident case logs contain a record of the cases performed during the entire 5 years of residency. The ACGME aggregates individual case logs and provides an annual report containing summary statistics for that year's graduating cohort. In addition to overall 5-year case volume (total major cases, TMC), the reports summarize the volume of certain specific operations and subcategories of operative experience known as defined categories (DC) (Table 1).

Secular trends were evaluated in two complementary analyses. One was an overall, year-by-year analysis using mean and median cases per resident. The other combined the yearly data into periods to smooth the impact of any individual year on overall trends and to group residents into similar training eras:

- Period 1 (AY 1989–1990 to AY 1993–1994)
- Period 2 (AY 1994–1995 to AY 1998–1999)
- Period 3 (AY 1999–2000 to AY 2002–2003)
- Period 4 (AY 2003–2004 to AY 2006–2007)
- Period 5 (AY 2007–2008 to AY 2010–2011)
- Period 6 (AY 2011–2012 to AY 2012–2013)

Period 3 represents the last four classes of residents who trained almost entirely without DHR (some programs began to implement DHR the year before ACGME requirements). Period 4 was transitional, representing those who trained in both the unrestricted era and the DHR era. Period 5 represents the first four

**TABLE 1.** ACGME Defined Categories and Current Minimums

| Defined Category | Minimum |
|---|---|
| Skin, soft tissue, breast | 25 |
| Head and neck | 24 |
| Alimentary tract | 72 |
| Abdominal | 65 |
| Vascular | 44 |
| Endocrine | 8 |
| Operative trauma | 10 |
| Thoracic | 15 |
| Pediatric | 20 |
| Plastic surgery | 5 |
| Laparoscopic basic* | 60 |
| Laparoscopic complex* | 25 |
| Total major cases | 750 |
| Endoscopy** | 85 |
| Nonoperative trauma** | 20 |

*Cases that count in these laparoscopic categories count in separate Defined Category as well (and do not count twice towards the total of 750).

**These cases are required for graduation, but do not count towards total operative cases (TMC).

graduating classes of residents who trained entirely under the new ACGME DHR, and Period 6 is made up of residents who graduated after a major Resident Review Committee (RRC) rule change in which two residents could claim credit for different parts of the same case (not previously permitted).

To generate cumulative data for each period, yearly averages and standard deviations (SDs) were combined into period averages and period SDs. This was done for TMCs and for most DCs. This could not be done for alimentary tract, abdominal, or vascular DCs because SDs were not provided in all of the ACGME reports. To evaluate changes in the mean number of cases performed during each period, a one-way analysis of variance (ANOVA) was performed for Periods 1 through 6 using the Stata ''aovsum'' command (Stata, version 12, StataCorp.), which can generate a statistical model from summary statistics (mean, SD, number). We chose the conservative Bonferroni adjustment for multiple comparisons, and significance was set at $\alpha = 0.05$.

Trends in the overall, year-by-year data were evaluated using simple linear regression (SLR). Ninety-five percent confidence intervals (CI) are reported for each regression β-coefficient. We chose a consistent break-point for all SLR analyses: between AY 2002–2003 and AY 2003–2004, which marks implementation of the 80-hours work week. This also parallels the analysis by period such that Periods 1, 2, and 3 match the ''before'' SLR and Periods 4, 5, and 6 match the ''after'' SLR.

Finally, we chose four index laparoscopic cases—cholecystectomy, appendectomy, groin hernia repair, and colectomy—and evaluated secular trends. These cases were chosen because they have been fairly consistently coded starting in 1993 (except for an unexplained combination of open and laparoscopic cholecystectomy over several years in the mid 2000 s), and they represent a substantial component of the modern general surgeon's practice.

## RESULTS

### Total Major Cases

A total of 24,432 surgery residents graduated between 1990 and 2013 and submitted case logs to the ACGME. Analysis of reported TMC reveals two dominant trends (Figure 1). From AY 1989–1990 until AY 2002–2003 (the last year before DHR), there was an overall increase in case volume of 4.8 cases per year (SLR, 95% CI 2.1–7.6). This is despite an ACGME coding change in AY 2001–2002 that caused an apparent but artificial[1] drop in cases. Total case numbers did drop after DHR (especially in the second year after implementation). However, over the subsequent 9 years, there was an overall increase of 8.8 cases per year by SLR (95% CI 3.6–14.0). Moreover, in the last 2 years of Period 5, case volumes were essentially identical to those towards the end of unrestricted duty hours: 960 and 966 cases/resident on average in AY 2009–2010 and AY 2010–2011 (compared with 966 in AY 1999–2000 and 962 in AY 2000–2001, the 2 years before the artificial drop in AY 2001–2002 and several years before the initiation of DHR in AY 2003–

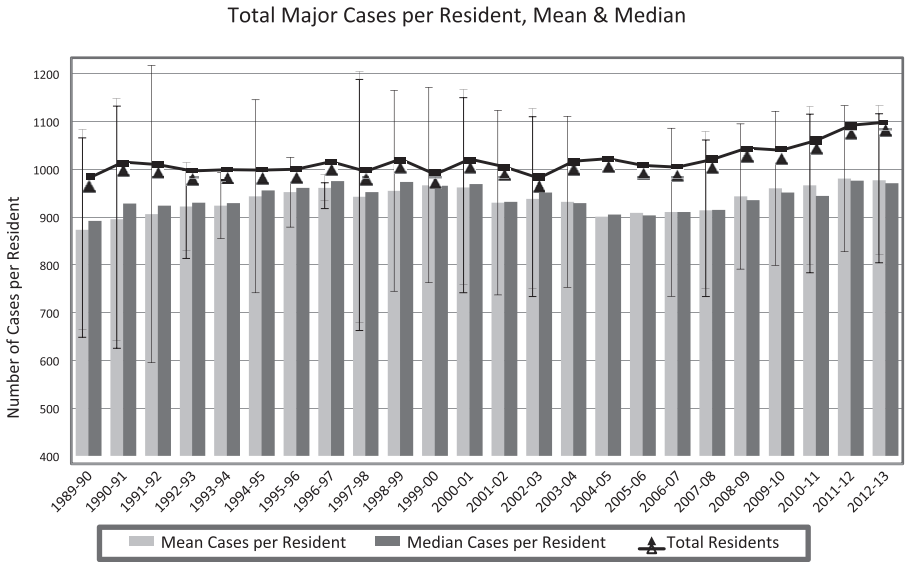



**FIGURE 1.** Total Major Cases per Resident, Mean, and Median. Average and median case volume per resident (cumulative over the entire 5 years of residency) by year of graduation. The dark line indicates the total number of chief residents who graduated in that year.

2004) (Figure 1). It is worth noting that the last 2 years of the dataset actually show increases over pre-DHR levels, but it is difficult to make comparisons with earlier eras because of the additional changes in how cases counted. Because case numbers per resident are not normally distributed, medians are included with the means in Figure 1. Both of these summary statistics followed similar secular patterns.

Table 2 shows these data grouped into periods, and the grouped data also demonstrate a significant decrease in TMC from Period 3 to transition Period 4 with a subsequent rebound from transition Period 4 to Period 5, and a continued increase in Period 6. For our main comparison of interest, there was no significant difference (by ANOVA) between TMC in Period 3 and Period 5, with total cases of 949 and 946, respectively.

## Defined Categories

Within the analysis by period (Table 2), the primary comparison of interest was between Period 3 (the last period before DHR were implemented) and Period 5 (the first 4 years of residents who trained entirely or primarily within the 80-hrs work week). Period 6 was delineated out from Period 5 because of the major case logging changes that began in AY 2011–2012 (described above). Endocrine cases increased by almost 10 cases, on average, per resident. Skin and soft tissue cases increased by almost 50%. Breast cases decreased (74 vs 64) as did pediatric surgery cases (41 vs 34). All changes were significant by ANOVA testing with $P < 0.001$. Thoracic and operative trauma were unchanged from Period 3 to Period 5. Thoracic has been essentially unchanged over the entire data series. Trauma demonstrated substantial early declines (well before DHR), and there was no significant difference between Period 3 and Period 5.

As explained above, significance testing was not available for the vascular, abdominal, and alimentary tract DCs. However, case volume changes in these categories were substantial when Period 3 is compared with Period 5. There was a decline in vascular surgery experience (by nearly 24 cases, on average, per resident) whereas intraabdominal experience increased from 250 to 272 cases and alimentary tract experience increased from 217 to 246 cases per resident. Alimentary tract operations have mostly been large bowel cases (many of these, appendectomies), which have substantially increased over the entire time course of the dataset (Figure 2A). Abdominal cases have been dominated by biliary cases and hernia repairs, which have also shown consistent increases (Figure 2B). Figures 2A and 2B show secular trends for the various subcategories of the alimentary tract and abdominal DCs, which make up over half of all operative experience during residency.

The ACGME vascular data is particularly difficult to analyze. Over the last 24 years, more than 150 individual case codes have been listed at some time or another in the Vascular DC alone. To generate the totals seen in Table 2, we excluded some cases such as peritoneovenous shunt placement and percutaneous dialysis access procedures because these involved large numbers of procedures that were not consistently included in the annual case log reports (this explains why some of the earlier totals are less than what appear in the raw ACGME reports from the 1990 s). Although vascular experience increased over the early 1990 s, it began to diminish before the advent of DHR and has continued to do so since (Table 2). A more granular look at the data showed that certain classic operations such as open abdominal aortic aneurysm (AAA) repair declined from around 10 cases/resident in the mid 1990s to less than two by the end of this data review; although endovascular aneurysm repair (EVAR) experience has increased, the most current national case logs report only about 3 cases/resident. Recent ACGME data suggests that the subcategories of cerebrovascular disease (14 cases/resident), peripheral occlusive disease (21 cases), amputations (16 cases), and dialysis access procedures (26 cases) make up the majority of current vascular experience.

## Diversity of Cases

An additional metric by which to evaluate changes in diversity of operative experience—a metric that is somewhat independent of overall case numbers—is percent case mix. In Period 1, abdominal cases made up 22.2% of overall cases, in Period 3 (immediately before the 80-hours work week) this was 26.4%, and in Period 6 (most current) intraabdominal cases made up 30.7% of overall operative experience. Alimentary tract cases showed similar patterns; in Period 1 this was 21.4% of overall operative experience; in Period

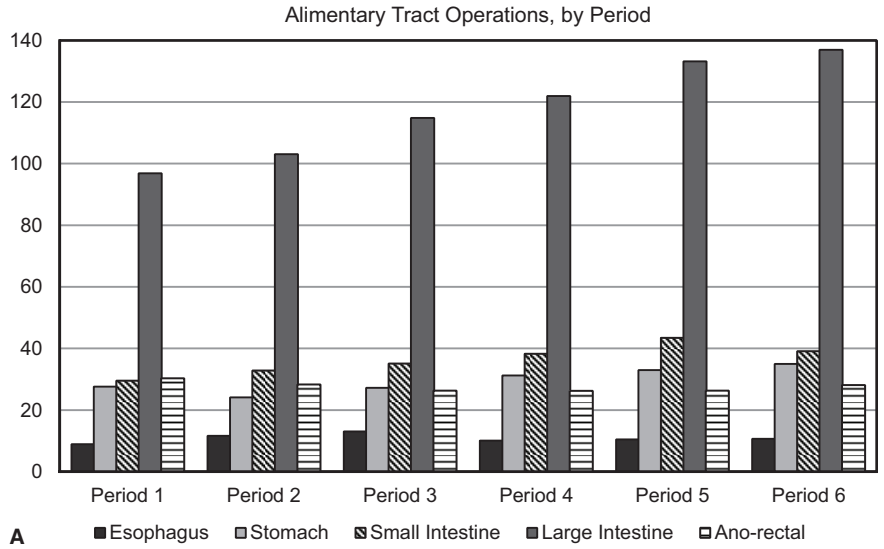
**TABLE 2.** Average Cases Within Each Defined Category by Training Period

| | PERIOD 1 | PERIOD 2 | PERIOD 3 | PERIOD 4 | PERIOD 5 | PERIOD 6 |
|---|---|---|---|---|---|---|
| | AY 1989–1990 to AY 1993–1994 | AY 1994–1995 to AY 1998–1999 | Pre Duty Hours Restrictions AY 1999–2000 to AY 2002–2003 | Transition Period AY 2003–2004 to AY 2006–2007 | Post Duty Hours Restrictions AY 2007–2008 to AY 2010–2011 | Post Major Case-logging Change AY 2011–2012 to AY 2012–2013 |
| Total Major Cases | 904.1 (210) | 950.6 (178.9) | 949.2 (198.0) | 912.7 (176.7) | 946.0 (162.1); $P$ = NS | 978.5 (154.5) |
| Breast | 72.7 (33.8) | 74.9 (32.7) | 73.7 (30.3) | 68.7 (29.2) | 63.8 (26.8); $P < 0.001$ | 63.5 (28.5) |
| Endocrine | 18.1 (10.2) | 21.7 (11.5) | 25.8 (14.4) | 30.0 (17.1) | 34.5 (19.8); $P < 0.001$ | 34.7 (20.5) |
| Pediatric | 47.7 (27.3) | 42.7 (23.2) | 40.6 (19.5) | 37.6 (17.9) | 33.8 (17.6); $P < 0.001$ | 30.6 (16.5) |
| Skin and Soft Tissue | 13.8 (11.3) | 19.5 (13.5) | 21.1 (17.0) | 35.1 (16.7) | 38.6 (17.4); $P < 0.001$ | 44.7 (19.6) |
| Thoracic | 34.0 (23.9) | 37.9 (23.6) | 37.7 (21.3) | 35.7 (18.5) | 38.5 (20.8); $P$ = NS | 39.8 (23.5) |
| Trauma (operative) | 72.5 (45.7) | 54.5 (34.0) | 39.3 (18.9) | 38.6 (20.3) | 39.9 (23.0); $P$ = NS | 29.1 (16.5) |
| Vascular | 134.2 | 148.4 | 132.8 | 115.4 | 109.0 | 106.9 |
| Abdominal | 200.5 | 230.4 | 250.5 | 251.1 | 271.8 | 300.0 |
| Alimentary Tract | 193.3 | 199.9 | 216.6 | 227.8 | 246.4 | 249.8 |

Mean (standard deviation) number of cases per graduating resident for total number of cases (TMC) and ACGME defined categories. For all defined categories with complete summary statistics (TMC through trauma), statistical testing performed using ANOVA across all six categories followed by the Bonferroni adjustment for multiple comparisons. The primary comparison was between Period V (all residents trained under 80-hours work week) versus Period III (all residents trained with unrestricted work hours); these comparisons are denoted by grey shading.

The vascular, abdominal, and alimentary tract defined categories are divided into multiple subcategories, and summary statistics for the overall defined categories are not consistently available in the ACGME reports (therefore, unable to test differences for statistical significance using ANOVA).

NS indicates nonsignificance.



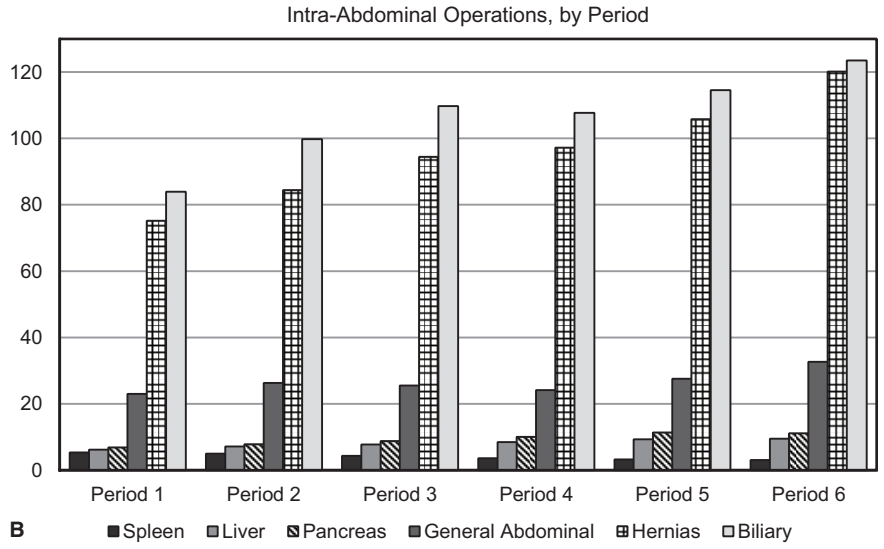




**FIGURE 2. A**. Alimentary tract operations, by period. **2B.** Intraabdominal operations by period. Average case volume per resident graduating within each time period (period designations described in text) is presented for two major defined categories, alimentary tract operations and abdominal operations; these are subdivided into their constituent subcategories, and trends in average operative volume for these subcategories are presented by period.

3, 22.8%; and in Period 6, 25.5%. The combined increase in the proportion of overall operative experience made up of alimentary or intraabdominal cases is nearly 13%.

## Index Cases

We chose four laparoscopic operations as index cases (Figure 3). All four have shown consistent increases since AY 1993–1994 when laparoscopic cases were first separately designated in the case logs. Looking at Figure 3 in the context of Figure 2B, it is clear that laparoscopic cholecystectomy is the major component of the biliary subcategory (over 90% of biliary cases). The increase in laparoscopic appendectomy (from less than 10 in the early 1990 s to over 50 most recently) reflects shifts in the operative management of appendicitis and reflects how substantial a component is appendectomy within the large intestine subcategory (see Figure 2A). To summarize, today's residents (on average) perform approximately 110 laparoscopic cholecystectomies, 50 laparoscopic appendectomies, 30 laparoscopic groin hernia repairs, and 20 laparoscopic colectomies—all major components of the current general surgery practice.

## DISCUSSION

This analysis of nearly a quarter century of national data makes three decisive observations regarding the operative experience of current surgical residents compared with their predecessors.

Operative volume transiently decreased after implementation of DHR, but average reported case numbers have now rebounded to levels equal to those before the 80-hours workweek.

Diversity of operative experience has narrowed; abdominal and alimentary tract operations now make up a greater proportion of residents' experience, and they have lost experience in vascular, trauma, pediatric, and breast surgery, some of the bedrock cases for previous generations of general surgeons.[3]

Laparoscopic operations have demonstrated sustained increases, a trend that reflects one of the central challenges of

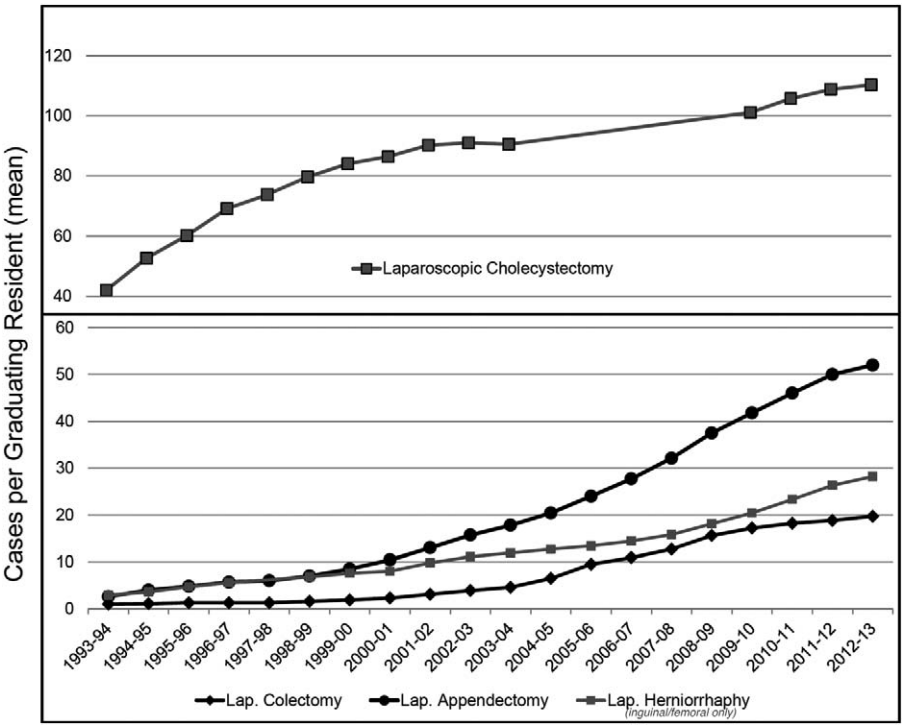



**FIGURE 3.** Secular trends in index laparoscopic cases. Average case volume per resident in four specific laparoscopic cases is presented by year of graduation. This data was only available for AY 1993–1994 onward. The four cases are laparoscopic cholecystectomy, colectomy, appendectomy, and groin hernia repair. [During one 5-year period, laparoscopic and open cholecystectomy were combined in the ACGME case log reports, which is indicated by the lack of markers during that time period on the graph.] Note that because the volume of laparoscopic cholecystectomy is so much higher than the other index cases, it is presented on a separate Y-axis.

modern surgical training: residents have to learn two technical approaches to the same operation and have to be capable of delivering high quality surgical outcomes for both.[3–6]

Several studies have evaluated case log data to evaluate the impact of the 80-hours work week on resident operative experience; these have included single-institution studies as well as analyses of national data. Findings have been conflicting, with some seeing no overall change,[2,7] but most others detecting a decrease in operative experience.[8–14] These disparate findings are not surprising when one surveys the entire 24 years of data presented in the current study; depending on where a snapshot of the data is taken, or how the years are grouped, a different picture may emerge. Indeed, the ACGME suggested in 2010 that several more years were necessary before definitively describing the impact of DHR on case numbers.[12] Although one recent study evaluated case log data from 2010 and 2011,[15] to the best of our knowledge, the most recent of the prior studies comparing operative volume before and after DHR have presented national data only through AY 2007–2008.[12,14] The current study includes a full 9 years of data since implementation of DHR, and we consider this a relatively complete accounting for how US surgical training programs responded to this major change in graduate medical education. Indeed, these findings should be seen as an update to papers from the late-2000 s at which time only a downturn was able to be perceived. Since then, training programs appear to have adjusted and compensated so that total case numbers have been restored to the levels seen before DHR. Importantly, these rebounds in case numbers came before a change allowing more than one resident to claim credit for separate procedures within the same operation (which impacts only Period 6 in this study).

Setting aside total numbers, residents today clearly have a different operative experience than did their forebears. This relates both to changes in disease management (eg, medical management of peptic ulcer disease and nonoperative management of blunt trauma[16]), the rise of minimally invasive techniques,[4,13,17] increases in subspecialization,[18] and proliferation of fellowships and integrated subspecialty residencies. Many of these changes in case mix appear largely independent of work hours. We have previously shown that the trend in decreasing pediatric surgery, which was mostly a reduction in herniorraphy, well-preceded DHR.[18] That long-term trend was interpreted to arise from the regionalization of pediatric surgery to children's hospitals away from community hospitals and broadly-practicing general surgeons and to the rise in pediatric surgery fellowships.[18,19] Trauma surgery volume has been reduced by such epidemiologic factors as safer cars and reduced violence and nonoperative management of solid organ injuries in blunt trauma.[16] Similar to trauma and pediatric surgery, vascular showed a decline in operative volume before the advent of DHR (see Table 2) but this decline continued well past the transition period. Our analysis and that of others has concluded that both changes in disease management[13] and the rise of subspecialty fellows and integrated residents[3,20] have changed vascular experience for general surgery residents. DHR may also have exacerbated these changes, as general surgery residents may spend more time on general surgery rotations and less time on vascular services.[2] The trends seen in breast surgery are more recent and are temporally associated with DHR. As with vascular, changes in disease management (eg, fewer total mastectomies and fewer axillary lymph node dissections) and the presence of subspecialty fellows may have impacted the breast surgery experience for general surgery residents.[15] Notably, the post-DHR decrease in breast cases may be even more pronounced given that the 2009–2010 ACGME coding changes should have increased recorded case numbers.[21] Aside from alimentary tract and intraabdominal cases, only endocrine and skin/soft tissue cases have increased in number (the latter by over 100%).

As case volume in breast, pediatrics, trauma, and vascular has diminished, not surprisingly, the diversity of resident operative

experience has narrowed: in the early 1990 s, alimentary tract and intraabdominal cases made up 43.6% of all operative experience; now, these two categories make up over half (56.2%). Although this difference (13%) might not seem noteworthy, it is almost 130 cases for residents who currently average 980 cases over their entire training—well over a half-year's worth of operating in a 5-year residency. Although this may mirror contemporary changes as the ''typical'' general surgeon moves away from nonabdominal and nonalimentary tract cases, the broadly trained general surgeon is still necessary in many underserved communities and in the military.[22–24] If today's graduates are unable to replace more broadly-practicing general surgeons as they retire, the surgeon shortage predicted by many may be magnified.[25,26]

This study has several limitations. Over the 24 years of this review, there have been changes to the case logs that may have impacted reported case volumes, and we strove to document those that could be detected. When the ACGME developed an electronic case log based on CPT codes, there were some coding changes; indeed, the RRC hypothesized that this led to the sudden decrease in TMC for those residents graduating at the end of AY 2001–2002 (2 years before the initiation of the 80-hours work week).[1] Starting in AY 2009–2010, the ACGME also reconfigured how certain CPT codes ''mapped'' to the case logs and, at the same time, changed some of the cases that counted as ''major'' (ie, cases that contribute to the 750 required for graduation). A 2012 paper by Murthy et al[21] evaluated this change via National Surgery Quality Improvement Project (NSQIP) surgical volumes, and identified certain breast, bariatric, and hernia procedures, open appendectomy, and amputations as the five most common procedures that switched from ''minor'' to ''major'' in this transition. The authors noted that many of these cases would have been logged under other categories and counted all along, but it is reasonable to suspect that these changes impacted reported case volumes. Burn surgery was moved from trauma to plastic surgery in AY 2009–2010, which explains the sudden drop in trauma experience between Periods 5 and 6. Abdominal experience increased substantially (from 272 to 300 average cases) over a relatively brief interval from Period 5 to Period 6. In part, this may be related to the fact that, in Period 6, residents were able to claim credit for different portions of the same case; for example, junior residents who assist in opening can claim credit for an exploratory laparotomy (coded in the Abdominal defined category). This may have already been happening, which would lessen the impact of the new ACGME rules, but it is not possible to verify or quantify this. Case log data are self-reported and we are unable to account for changes in how likely residents were to log all of their cases. One possibility is that residents who reached the required minimum may have stopped logging cases as diligently; if this was more common in earlier eras, stability in operative experience might be an artifact of case logging practices. In addition, program directors themselves submitted case numbers to the ACGME until 2000 and may have entered more complete data leading to higher case numbers earlier on (a conservative influence on our conclusions) but this is impossible to assess.

These data raise questions in addition to providing answers. Although case numbers rebounded, the system has become time constrained, and other aspects of surgical education may have been lost. That is, residents may now get to the OR at the expense of other duties they previously balanced with performing operations. For example, does the presence of physician extenders such as ARNPs reduce busy-work and augment learning or does this reduce opportunities for junior residents to gain exposure to disease processes and autonomy in clinical management on the ward and in the ICU? Indeed, two prominent surgical educators have argued that recent ABS certifying examination failure rates may reveal some diminution in critical thinking and judgment skills.[3] Changes in ACGME coding regulations—that is, which cases count—did serve to augment case numbers, but not all of these operations are equally educational. Is the incision and drainage of a soft tissue abscess as educational as a major intraabdominal case? Does a junior resident gain skill by initiating the laparotomy for a case his or her senior is doing? Does a fourth year resident, whom the RRC allows to operate with a fellow, actually learn from holding the camera while the fellow and attending perform an advanced laparoscopic case? In each of these scenarios, benefit is variable, and no universal rule applies.[27] When a senior resident is teaching an intern how to open an abdomen, or plan an incision, there is likely substantial benefit for both individuals, particularly in this era of dwindling autonomy for senior residents. If the same intern then stands there for 5 hours, largely out of the field of view, waiting to assist in closure, that is unlikely an effective use of time. Building an awareness of efficiency and efficacy into the planning of who does what and when on a surgical service is precisely how hours can be reduced without compromising education.[27,28]

Several authors have expressed concern that recent graduates appear less capable than their predecessors.[3,28] One often cited fact to support this is the high number of residents who now pursue fellowship training, which is purported to reflect a lack of confidence to enter independent practice. Seventy to 80% of residents in a 2008 publication indicated plans to pursue fellowship,[29] and, in a 2011 survey, 26% of residents reported concerns that they would not be able to operate independently by the end of training.[30] A recent survey of fellowship directors also did not reflect well on current trainees. When asked about new fellows, just after graduation from residency, 30% of fellowship directors thought fellows incapable of completing a laparoscopic cholecystectomy independently and 43% disagreed or strongly disagreed that residents could conduct 30 minutes of a major operation independently. Encouragingly, nearly all fellowship directors (89%) felt that residents could practice independently by the end of fellowship, and that much of the catching up necessary resulted from lack of autonomy and independence during residency.[31] Moreover, a recent national survey of graduating chief residents found that most felt confident to practice independently, especially when asked about cases considered essential-common and essential-uncommon.[32]

Survey studies are always vulnerable to bias, particularly nonresponse bias where those who really ''have something to say'' are more likely to take the survey and are more vocal in open-ended comments (for example, concerns about professionalism in the Mattar et al[32] qualitative analysis came from just 8 comments). That said, other than the recent chief resident survey, much of the current surgical education literature reflects a pervasive sense that general surgery training needs new thinking and innovation to accomplish its mission of producing a well-qualified surgical workforce.[3,6,15,28]

If the competence of current graduates has in fact diminished, this comprehensive review of ACGME case logs suggests that operative volume is not the problem. These data demonstrate preserved, if not increased, total case numbers. However, there is a clear narrowing of the general surgery training experience, with an increased focus on abdominal and alimentary procedures and decreased experience in vascular, trauma, breast, and pediatric surgery. Laparoscopic operations are increasingly common, possibly to the detriment of experience in open surgery. Changing disease processes, major reductions in resident autonomy, and the rapid expansion of technology and subspecialization also challenge how we train today's general surgeons. Several innovations currently under implementation and investigation include the Flexibility In

Duty Hour Requirements for Surgical Trainees (FIRST) Trial, the SCORE curriculum, the ACGME Benchmark Program, flexible rotations for senior surgical residents, dedicated rural surgery rotations, and the American College of Surgeons (ACS) Transition to Practice Fellowship. Each of these initiatives, and others, may provide models for necessary improvements. The ABS, the RRC for Surgery, the Association for Program Directors in Surgery, and the ACS should continue their ongoing support for creativity and innovation in surgical education.

## REFERENCES


1. Bland KI, Stoll D, Richardson JD, et al. Brief communication of the Residency Review Committee-Surgery (RRC-S) on residents' surgical volume in general surgery. *Am J Surg*. 2005;190:345–350.
2. Drake FT, Horvath KD, Goldin AB, et al. The General Surgery Chief Resident Operative Experience. *JAMA Surg*. 2013;148:841–847.
3. Lewis FR, Klingensmith ME. Issues in General Surgery Residency Training—2012. *Ann Surg*. 2012;256:553–559.
4. Richards MK, Mcateer JP, Drake FT, et al. National review of the frequency of minimally invasive surgery among general surgery residents assessment of ACGME case logs during 2 decades of general surgery resident training. *JAMA Surg*. 2015;150:169–172.
5. Horvath KD, Pellegrini CA. Commentary on: ''Impact of the European Working Time Directive (EWTD) on the operative experience of surgical residents.''. *Surgery.* 2015;157:642–644.
6. Chung RS, Ahmed N. The impact of minimally invasive surgery on residents? open operative experience. *Ann Surg*. 2010;251:205–212.
7. Bruce PJ, Helmer SD, Osland JS, et al. Operative volume in the new era: A comparison of resident operative volume before and after implementation of 80-hour work week restrictions. *J Surg Educ*. 2010;67:412–416.
8. Carlin AM, Gasevic E, Shepard AD. Effect of the 80-hour work week on resident operative experience in general surgery. *Am J Surg*. 2007;193:326–330.
9. Damadi A, Davis AT, Saxe A, et al. ACGME duty-hour restrictions decrease resident operative volume: a 5-year comparison at an ACGME-accredited university general surgery residency. *J Surg Educ*. 2007;64:256–259.
10. Kairys JC, McGuire K, Crawford AG, et al. Cumulative operative experience is decreasing during general surgery residency: a worrisome trend for surgical trainees? *J Am Coll Surg*. 2008;206:804–811.
11. Christmas AB, Brintzenhoff RA, Sing RF, et al. Resident work hour restrictions impact chief resident operative experience. *Am Surg*. 2009;75:1065–1068.
12. Simien C, Holt KD, Richter TH, et al. Resident operative experience in general surgery, plastic surgery, and urology 5 years after implementation of the ACGME duty hour policy. *Ann Surg*. 2010;252:383–389.
13. Eckert M, Cuadrado D, Steele S, et al. The changing face of the general surgeon: national and local trends in resident operative experience. *Am J Surg*. 2010;199:652–656.
14. Fairfax L, Christmas B, Green J, et al. Operative experience in the era of duty hour restrictions: is broad-based general surgery training coming to an end? *Am Surg*. 2010;76:578–583.
15. Malangoni MA, Biester TW, Jones AT, et al. Operative experience of surgery residents: Trends and challenges. *J Surg Educ*. 2013;70:783–788.
16. Drake FT, Van Eaton EG, Huntington CR, et al. ACGME case logs: Surgery resident experience in operative trauma for two decades. *J Trauma Acute Care Surg*. 2012;73:1500–1506.
17. Kansier N, Varghese TKJ, Verrier ED, et al. Accreditation Council for Graduate Medical Education case log: general surgery resident thoracic surgery experience. *Ann Thorac Surg*. 2014;98:455–459.
18. Gow K, Drake FT, Aarabi S, et al. The ACGME case log: general surgery resident experience in pediatric surgery. *J Pediatr Surg*. 2013;42:1643–1649.
19. Snyder RA, Phillips SE, Terhune KP. Impact of implementation of a pediatric surgery fellowship on general surgery resident operative volume. *J Surg Educ*. 2012;69:753–758.
20. Yan H, Maximus S, Kim JJ, et al. General surgery resident vascular operative experience in the era of endovascular surgery and vascular fellowships. *Am Surg*. 2014;1093–1096.
21. Murthy R, Shepard A, Swartz A, et al. Effect of the new standards for case logging on resident operative volume: Doing better cases or better numbers? *J Surg Educ*. 2012;69:113–117.
22. Landercasper J, Bintz M, Cogbill TH, et al. Spectrum of general surgery in rural America. *Arch Surg*. 1997;132:494–497.
23. Lynge DC, Larson EH. Workforce issues in rural surgery. *Surg Clin North Am*. 2009;89:1285–1291.
24. Deveney K, Deatherage M, Oehling D, et al. Association between dedicated rural training year and the likelihood of becoming a general surgeon in a small town. *JAMA Surg*. 2013;148:817.
25. Stitzenberg KB, Sheldon GF. Progressive specialization within general surgery: Adding to the complexity of workforce planning. *J Am Coll Surg*. 2005;201:925–932.
26. Decker MR, Dodgion CM, Kwok AC, et al. Specialization and the current practices of general surgeons. *J Am Coll Surg*. 2014;218:8–15.
27. Ahmed N, Devitt KS, Keshet I, et al. A systematic review of the effects of resident duty hour restrictions in surgery: impact on resident wellness, training, and patient outcomes. *Ann Surg*. 2014;259:1041–1053.
28. Bell RH. Why Johnny cannot operate. *Surgery.* 2009;146:533–542.
29. Borman KR, Vick LR, Biester TW, et al. Changing demographics of residents choosing fellowships: longterm data from the american board of surgery. *J Am Coll Surg*. 2008;206:782–788.
30. Bucholz EM, Sue GR, Yeo H, et al. Our trainees' confidence. *Arch Surg*. 2011;146:907–914.
31. Mattar S, Alseidi A, Jones D, et al. General surgery residency inadequately prepares trainees for fellowship: results of a survey of fellowship directors. *Ann Surg*. 2013;258:440–449.
32. Friedell ML, VanderMeer TJ, Cheatham ML, et al. Perceptions of graduating general surgery chief residents: are they confident in their training? *J Am Coll Surg*. 2014;218:695–703.