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Assessing the experience in complex hepatopancreatobiliary surgery among graduating chief residents: Is the operative experience enough?

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Abstract

Introduction—Resident operative autonomy and case volume is associated with posttraining confidence and practice plans. Accreditation Council for Graduate Medical Education requirements for graduating general surgery residents are four liver and three pancreas cases. We sought to evaluate trends in resident experience and autonomy for complex hepatopancreatobiliary (HPB) surgery over time.

Methods—We queried the Accreditation Council for Graduate Medical Education General Surgery Case Log (2003–2012) for all cases performed by graduating chief residents (GCR) relating to liver, pancreas, and the biliary tract (HPB); simple cholecystectomy was excluded. Mean (\pm SD), median [10th–90th percentiles] and maximum case volumes were compared from 2003 to 2012 using R^2 for all trends.

Results—A total of 252,977 complex HPB cases (36% liver, 43% pancreas, 21% biliary) were performed by 10,288 GCR during the 10-year period examined (Mean = 24.6 per GCR). Of these, 57% were performed during the chief year, whereas 43% were performed as postgraduate year 1–4. Only 52% of liver cases were anatomic resections, whereas 71% of pancreas cases were major resections. Total number of cases increased from 22,516 (mean = 23.0) in 2003 to 27,191 (mean = 24.9) in 2012. During this same time period, the percentage of HPB cases that were performed during the chief year decreased by 7% (liver: 13%, pancreas 8%, biliary 4%). There was an increasing trend in the mean number of operations (mean \pm SD) logged by GCR on the pancreas (9.1 ± 5.9 to 11.3 ± 4.3 ; $R^2 = .85$) and liver (8.0 ± 5.9 to 9.4 ± 3.4 ; $R^2 = .91$), whereas those for the biliary tract decreased (5.9 ± 2.5 to 3.8 ± 2.1 ; $R^2 = .96$). Although the median number of cases [10th:90th percentile] increased slightly for both pancreas (7.0 [4.0:15] to 8.0 [4:20]) and liver (7.0 [4:13] to 8.0 [5:14]), the maximum number of cases performed by any given GCR remained stable for pancreas (51 to 53; $R^2 = .18$), but increased for liver (38 to 45; $R^2 = .32$). The median number of HPB cases that GCR performed as teaching assistants (TAs) remained at zero during

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this time period. The 90th percentile of cases performed as TA was less than two for both pancreas and liver.

Conclusion—Roughly one-half of GCR have performed fewer than 10 cases in each of the liver, pancreas, or biliary categories at time of completion of residency. Although the mean number of complex liver and pancreatic operations performed by GCR increased slightly, the median number remained low, and the number of TA cases was virtually zero. Most GCR are unlikely to be prepared to perform complex HPB operations.

Surgical training has long sought to impart graduating residents with a sense of confidence and autonomy in performing operations. The paradigm of a stepwise increase in responsibility and independence has been used to train thousands of surgeons over the past century. Recent factors, however, including patient dictums, the Accreditation Council for Graduate Medical Education (ACGME) duty hour regulations, and attending surgeon perceptions,^{1–3} may have decreased the ability of general surgery residents to gain autonomy due to fewer cases being performed during training. A large body of literature has shown repeatedly that greater procedural volumes of attending surgeons are associated with improved perioperative^{4–16} and long-term^{17,18} outcomes. In fact, based on these volume-outcome relationships, organizations such as the Leapfrog Group, a coalition of health care purchasers in the United States, have encouraged patients to consider individual surgeon volumes when deciding where to undergo a complex surgical procedure.^{19–21} As such, data on operative volumes during surgical residency may help shed light on how well residents are being prepared for independent practice.

For many specialized surgical disciplines, exposure to a given field during general surgery residency is minimal. To that end, integrated residencies in cardiothoracic, plastic, and vascular surgery are becoming more common. Hepatopancreatobiliary (HPB) surgery remains, however, an important domain within the general surgery residency training itself. Although some residents choose to pursue further training in HPB surgery, no further training beyond general surgery is required to practice HPB surgery via HPB fellowships. Furthermore, some individuals have argued that fellowship training in HPB may not be necessary for graduating residents who want to practice HPB surgery post residency.²² Currently, the ACGME requires that chief residents participate in at least four pancreatic and three hepatic operations during their residency in order to graduate, while biliary operations are not specified.²³

Information on the case volume of the graduating chief residents (GCRs) for HPB surgical procedures may not only inform assessments of resident training but also may help elucidate the current appropriateness of the training of future HPB surgeons. The purpose of the present study was to characterize procedure volumes of complex HPB procedures among GCRs. In addition, we sought to identify relative trends in operative volumes of HPB cases performed at both the chief and junior levels among GCRs during a 10-year period.

METHODS

The ACGME maintains a database that provides aggregate data on resident procedural volume.²⁴ The database contains data on all procedures performed by the resident as part of

their training. For each year, the case load of the GCR is tabulated and labeled as: *surgeon chief* (reserved for cases performed during chief year), *surgeon junior* (all cases performed in the preceding years in which the resident was the primary surgeon), *teaching assistant* (where the senior resident guides a junior resident through the case), *first assistant* (where the resident is minimally involved in the operation), and *surgeon total* (the aggregate number of cases for all 5 years). Each of these categories is subdivided into average number of cases, standard deviation and maximum case volume (the greatest number of cases in any category performed by a specific resident for a given year). In addition, the number of each type of operation (eg, pancreatoduodenectomy, distal pancreatectomy, partial hepatectomy, right hepatectomy, etc) is tabulated and stratified by resident operative role (ie, surgeon chief, surgeon junior, etc.) The ACGME database provides values as medians, overall percentiles, and stratified percentiles (10th, 30th, 50th, 70th, and 90th). In turn, on the basis of these data, the total number of operations, mean number of operations, and standard deviations can be derived for any given operative procedure.

In the current study, the ACGME database was queried for all pancreatic, hepatic, and biliary operations performed by graduating chief residents between 2003 and 2012. HPB cases were categorized as liver, pancreas, or biliary. Liver cases were subdivided as anatomic (eg, hemihepatectomy or extended hepatectomy), wedge resection, or other; pancreas procedures were categorized as pancreatoduodenectomy, distal pancreatectomy, or other; biliary procedures were subdivided as common bile duct exploration, choledochenterostomy, or other. Laparoscopic versus open cholecystectomy was not distinguished for the majority of the years available. In the years in which it was distinguishable (2003–2004, 2010–2012), the overwhelming majority of cholecystectomy operations (92%) were recorded as laparoscopic. Therefore, to focus on complex HPB operations, cholecystectomy was excluded from all analyses that examined total case numbers, means, and standard deviations; however, because of the restrictive nature of the database, cholecystectomy could not be separated from median and percentile data, and so cholecystectomies were included under biliary operations when discussing median and percentile data.

Standard measures of operative volume such as mean (\pm standard deviation [SD]), median (10th and 90th percentiles), and maximum case volumes were reported. Median data also were reported; however, the ACGME dataset does not provide 25th and 75th percentiles. Therefore, the interquartile range was not reported, but rather the 10th and 90th percentiles were available and were reported. Trends in overall HPB operative volume, as well as changes in operative volume stratified by resident role (eg, surgeon chief, surgeon junior, etc) were examined over time (2003–2013). Raw data were not available through the ACGME, preventing certain statistical models from being used. However, linear trends in the data were examined by assessing goodness of fit model based on the means presented and were reported as the value of R^2 (range 0–1). Data were analyzed using SAS 9.3 (SAS Corp., Cary, NC).

RESULTS

Between 2003 and 2013, there were 10,288 GCRs with reported data in the ACGME database. During this period, graduating chief residents logged 252,977 complex HPB operations as either the surgeon chief or surgeon junior. In turn, the mean number of HPB cases performed by a graduating chief resident during the 5 years of training was 24.6 ($SD \pm 5.9$) (Table I). The majority of HPB cases ($n = 143,516$; 56.7%) were performed during the final chief year. HPB cases performed during training included pancreatectomy (109,477; 43.2%), liver resection (91,145; 36.0%), and biliary procedures (52,355; 20.7%). Mean HPB procedure case numbers were pancreatectomy (10.6 ± 4.2), liver resection (8.8 ± 3.7), and biliary procedure (5.1 ± 2.2). Regarding the specific type of HPB cases, most pancreatic procedures involved either a pancreatoduodenectomy ($n = 49,980$; 45.7%) or distal pancreatectomy ($n = 28,144$; 25.7%), whereas most liver procedures were an anatomic ($n = 47,132$; 51.7%) or wedge ($n = 30,314$; 33.3%) resection (Table II).

The total number of complex HPB cases performed by GCRs increased from 22,516 in 2003 to 27,191 in 2012. During this period, the mean number of HPB cases increased from 23.0 cases per resident to 24.9 ($R^2 = .88$). The median number of pancreatic cases performed increased minimally from 7.0 to 8.0 (Fig 1), and the 10% and 90% percentile number of cases increased slightly (2003: 4 and 15 vs 2012: 4 and 20, respectively). During the study, there was an increasing trend in the mean number of pancreas operations logged by graduating chief residents (9.2 ± 5.9 to 11.4 ± 4.3 ; $R^2 = .85$) (Fig 2). Of these, the mean number of major pancreatic resections (distal pancreatectomy, proximal pancreatoduodenectomy, and total pancreatectomy) also increased (5.9 ± 3.2 to 8.7 ± 4.1 ; $R^2 = .86$) (Fig 3). Regarding liver cases, the median number of cases slightly increased from 7.0 in 2003 to 8.0 in 2012 (Fig 1), with the 10% and 90% percentile number of cases similarly increasing by one (2003: 4.0 and 13.0 vs 2012: 5.0 and 14.0). When we examined the mean number of liver cases performed, GCRs performed slightly more liver cases over time (8.1 ± 5.9 to 9.5 ± 3.4 ; $R^2 = 0.91$). Overall, the total maximum number of operations performed by a GCR on the pancreas (2003: 51 vs 2012: 53; $R^2 = 0.18$) and liver (2003: 38 vs 2012: 45; $R^2 = 0.32$) increased somewhat over time, albeit with low R^2 values. In contrast, the mean number of complex biliary operations decreased over time (5.9 ± 2.5 to 4.4 ± 2.1 ; $R^2 = .96$), whereas the maximum could not be determined from the data available.

Although the overall number of cases during resident training increased to some extent over the time periods examined, the proportion of HPB cases performed during the chief year decreased by 7%. Specifically, the total number of cases performed by residents went from 920,376 cases (244,360 chief year/676,016 junior years) in 2003 to 1,072,636 cases (261,104 chief/811,532 junior) in 2012. The largest decrease in HPB cases performed in the chief year was in complex liver operations (13% decrease) followed by pancreas (8%) and biliary (4%) operations. The mean number of pancreas, liver, and biliary operations performed in the chief resident year was 7.0 ± 3.3 , 4.5 ± 2.5 , and 2.5 ± 1.6 , respectively. Of note, the median number of cases in which the GCR participated as a teaching assistant (Table III) remained zero for liver cases during the 10-year period, varied between 0 and 1 for pancreatic operations and varied between three and four for biliary operations—the majority of which were likely laparoscopic cholecystectomy. Furthermore, the 90th

percentile of graduating chief residents performed few if any liver or pancreas operations as a teaching assistant.

DISCUSSION

The concept and parameters of modern surgical training were first introduced by William Stewart Halsted at the turn of the century.²⁵ At the Johns Hopkins Hospital, Halsted started the first surgical residency program with an emphasis on formal, structured integration of anatomic and physiologic principles with intensive technical training. For years, the Halsted model emphasized operative case experience to allow residents the opportunity to develop their operative skills, technical abilities, as well as intraoperative judgment. In the past, surgical residency was characterized by long hours, a large amount of repetition, and high operative volumes. In recent years, important changes in ACGME regulations have limited resident work hours and have potentially decreased the opportunity for residents to participate in operative cases.^{26,27} Although these changes were deemed to be appropriate and necessary, the impact on resident operative experience warrants attention and study. Previous papers have documented a well-established, volume-outcomes relationship among attending surgeons—with increasing case volume yielding improved perioperative results.^{7,28,29} As such, an “adequate” volume of operative cases would similarly seem to be necessary for residents to acquire competency around certain procedures, especially technically challenging operations like HPB cases. The current report is important because we were able to characterize and quantify the procedural volumes of complex HPB procedures among GCRs. Of note, the mean number of complex HPB cases performed by a GCR was only about 25. Furthermore, the mean number of pancreas or liver cases performed at the time of residency completion was less than 10 for either type of procedure. In examining trends over time, we noted a modest increase in the mean overall number of HPB cases performed (2003: 23.2 vs 2012: 25.3). Perhaps more interestingly, however, was the finding that the proportion of HPB cases performed during the chief year decreased by 7%, and the 90th percentile of GCRs performed few, if any, liver or pancreas operations as a teaching assistant.

Currently, the ACGME requires chief residents to participate in at least seven complex HPB operations in order to graduate as a “competent” surgeon in this domain. HPB operations are, however, complex and technically demanding. Several investigators have demonstrated that a learning curve exists even among HPB surgeons who have completed their training.³⁰ Specifically, with increased operative experience there is a dramatic decrease in operative time, estimated blood loss, and duration of stay. Importantly, Tseng et al³⁰ reported that the number of cases needed before the learning curve plateaued was 60. In the current study, we noted that the mean number of complex HPB cases logged by a GCR was 24.6, well below the 60 cases suggested as necessary. Although the goal of residency is not necessarily to ensure “mastery” of any one domain of surgery, the low mean number of HPB cases (liver: 8.8 and pancreas: 10.6) calls into question whether residents with such low case numbers are competent to perform these types of operations after graduation. Although the average number of cases increased slightly over time, the medians changed very little, suggesting the increase was driven by a small percentage among GCRs who were at high-volume HPB centers. Furthermore, the increases seen in liver and pancreas operations were mostly during

the junior years, whereas a decrease was seen more recently in the chief year. This decrease may reflect an effect of duty hours restriction; indeed, as others have noted that duty hour restrictions may affect adversely operative case number.³¹ In sum, data from the current study suggest that few—if any—GCR have great-enough case numbers to handle complex HPB cases without further training.

In turn, this apparent lack of target case numbers has perhaps led to a lack of confidence—real or perceived—by graduating residents.³² This finding may explain in part why the percentage of GCRs continuing on to fellowship is increasing and now approaches 80%.³³ The self-confidence, autonomy, and competency that was traditionally gained in residency seems to have shifted toward fellowship training.^{34,35} This shift effectively has extended clinical surgery training from 5 years to 7 or more, depending on the fellowship chosen. Recently, the Flexibility in Surgical Training (FIST) program of the American Board of Surgery has begun to examine the benefit of earlier subspecialization. FIST deviates from the focus of traditional residencies by allowing up to 12 months of flexible rotations in the last 36 months of general surgery training. FIST provides an opportunity for a more focused learning experience for residents and may foster an experience that leads to more emphasis and operative exposure to certain subspecialties such as HPB and advanced gastrointestinal, as well as vascular or cardiac surgery. Regardless of an individual's training experience, there remains, however, a steep learning curve for complex gastrointestinal operations during the first several years of practice. As such, all surgeons (fellowship trained or not) should seek appropriate mentor-ship until they are well beyond this curve whatever the number of cases required.

The role of teaching assistant is important role for a GCR to experience. Acting as a teaching assistant provides the chief resident the opportunity to “set up” the case, take initiative in directing the operation, while also leading junior residents through the steps of the procedure.³⁶ Providing chief residents a “safe and supervised” environment to act as teaching assistant during challenging operative cases can be an important pedagogic exercise to enhance independence. Unfortunately, in recent years, the number of teaching assistant cases performed by GCRs has decreased by as much as 66% percent across all disciplines.³¹ For example, Feanny et al³⁷ noted a 42% overall decrease in teaching assistant cases for senior residents, which increased to 82% when only major abdominal trauma procedures were considered. In a separate study, Carlin et al³⁸ noted a 78% reduction in teaching assistant cases among PGY-5 residents, whereas Kairys et al³¹ noted a 67% decrease. In the current study, we noted a similar paucity of HPB cases in which the chief resident acted as a teaching assistant. Given the frequent complexity of HPB cases, one might expect a relative low number of teaching assistant cases. We found that the median number of cases in which the GCR participated as a teaching assistant (Table III) remained zero for liver cases during the 10-year period, varied between 0 and 1 for pancreatic operations and varied between 3 and 4 for biliary operations, which were likely all laparoscopic cholecystectomy. Perhaps more surprisingly was the finding that even the 90th percentile of GCRs performed few if any liver or pancreas operations as a teaching assistant. In aggregate, these data strongly suggest that virtually all GCRs have never experienced the role of primary “teacher” in the operating room during an HPB case.

The current paper has several limitations. As with all retrospective studies, there were certain limitations to the analyses of the ACGME database. For example, operative logs were dependent on the accuracy and reliability of the residents entering these data into the ACGME database. Any reporting bias was, however, likely a failure to log operative cases (eg, an underreporting bias). As such, if anything, the point estimates for HPB cases reported may have been an underestimation of operative volumes among graduating chief residents. For example, residents may have under-reported or failed to log cases in which they participated as a teaching assistant in particular. As such, these data need to be interpreted with this in mind. Another limitation of the dataset was the lack of more specific data on operative cases during the PGY1 through PGY4, which are only summarily referred to as “junior surgeon” in the ACGME database. Finally, data on biliary procedures also were somewhat limited as medians and percentiles for complex biliary operations exclusive of laparoscopic cholecystectomy were not available.

In conclusion, residency training requires exposure to a robust operative experience with an adequate volume of cases to ensure competency. HPB cases can be particularly complex and technically challenging with a steep learning curve even for attending surgeons.^{30,39,40} Data from the current paper demonstrate that many surgical residents are graduating with a low number of HPB cases (<25). In addition, the number of cases logged by GCRs as teaching assistant was extremely low, suggesting few, if any, graduating chief residents have successfully performed an HPB operation in the “attending” role. Consideration of data presented herein may help to focus efforts on training paradigms, as well as tailor mentoring programs, for those graduating residents interested in HPB surgery.

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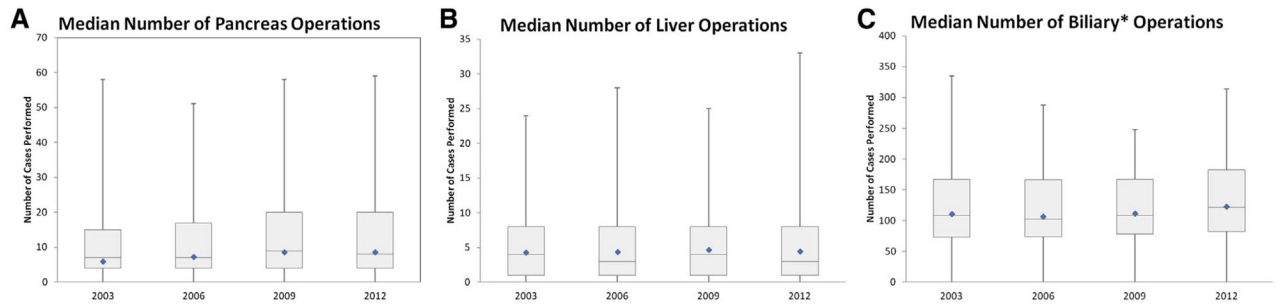


Fig 1.

Box plots showing the median (with 10th and 90th percentiles) as well as the range (whiskers) and means (diamond), of (A) pancreas, (B) liver, and (C) biliary cases* performed over 5 years of training by graduating chief residents (2003–2012). *Includes cholecystectomy.

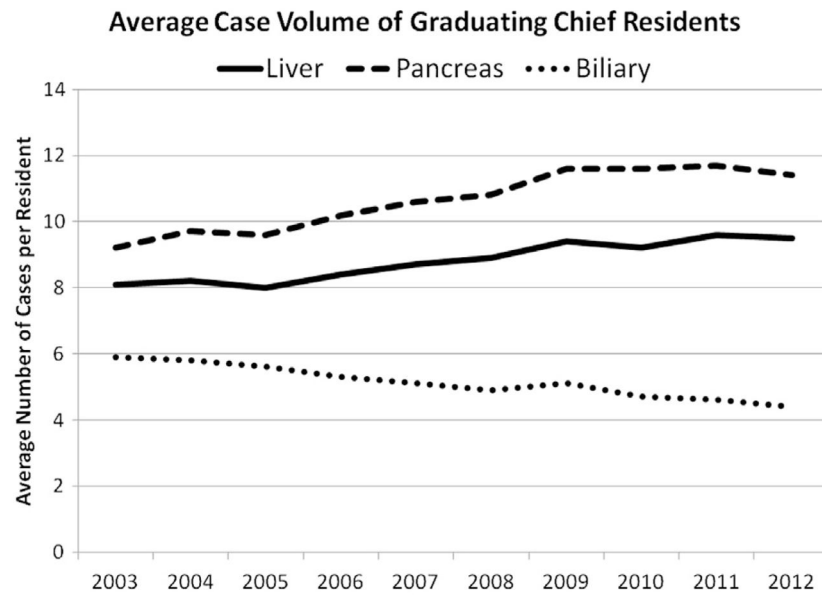


Fig 2. The mean number of HPB cases performed over 5 years of training by graduating chief residents (2003–2012).

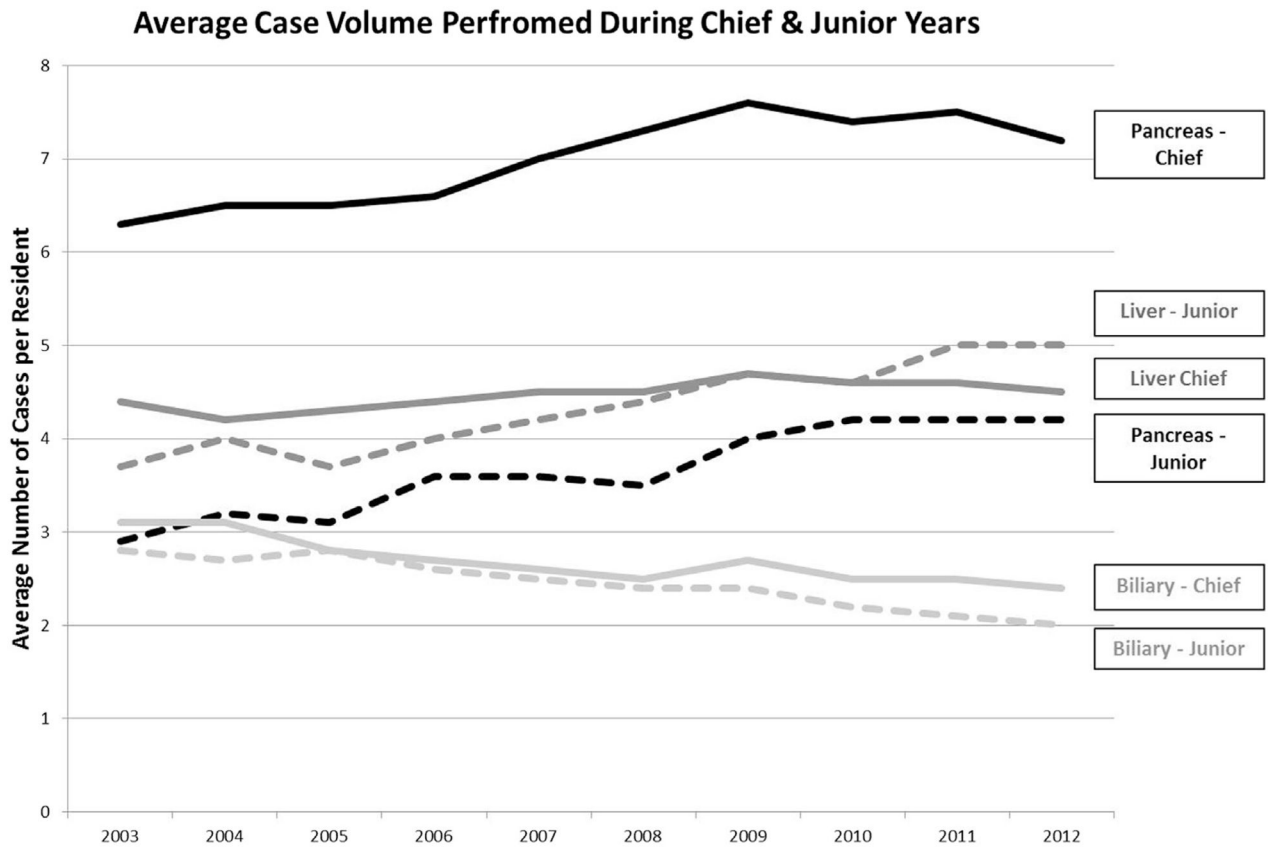


Fig 3. The mean number of HPB cases performed by GCRs during their chief (*solid line*) and junior (*dotted line*) years (2003–2012).

Table 1

Mean and total number of cases performed during the Chief (PGY-5) and Junior (PGY 1-4) years of residency in each category of complex hepatopancreatobiliary surgery

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Total	Overall mean
Mean												
Liver (Chief)	4.4	4.2	4.3	4.4	4.5	4.5	4.7	4.6	4.6	4.5	44.7	4.5
Anatomic	2.4	2.5	2.5	2.5	2.7	2.8	3.0	2.9	2.8	2.8	26.9	2.7
Wedge	1.4	1.3	1.3	1.4	1.3	1.2	1.2	1.1	1.0	0.9	12.1	1.2
Other	0.6	0.4	0.5	0.5	0.5	0.5	0.5	0.6	0.8	0.8	5.7	0.6
Liver (Junior)	3.7	4.0	3.7	4.0	4.2	4.4	4.7	4.6	5.0	5.0	43.3	4.3
Anatomic	1.3	1.5	1.4	1.6	1.8	1.9	2.2	2.2	2.3	2.4	18.6	1.9
Wedge	1.8	1.9	1.7	1.8	1.7	1.8	1.8	1.6	1.7	1.4	17.2	1.7
Other	0.6	0.6	0.6	0.6	0.7	0.7	0.7	0.8	1.0	1.2	7.5	0.8
Pancreas (Chief)	6.3	6.5	6.5	6.6	7.0	7.3	7.6	7.4	7.5	7.2	69.9	7.0
Pancreatoduodenectomy	2.9	3.1	3.2	3.4	3.6	3.8	4.0	3.6	3.7	3.7	35.0	3.5
Distal	1.4	1.4	1.6	1.7	1.8	2.0	2.1	2.1	2.0	2.0	18.1	1.8
Other	2.0	2.0	1.7	1.5	1.8	1.5	1.5	1.7	1.8	1.5	17.0	1.7
Pancreas (Junior)	2.9	3.2	3.1	3.6	3.6	3.5	4.0	4.2	4.2	4.2	36.5	3.7
Pancreatoduodenectomy	0.9	1.1	1.0	1.4	1.4	1.4	1.6	1.6	1.6	1.6	13.6	1.4
Distal	0.6	0.7	0.7	0.9	0.9	0.9	1.1	1.1	1.2	1.2	9.3	0.9
Other	1.4	1.4	1.4	1.3	1.3	1.2	1.3	1.5	1.4	1.4	13.6	1.4
Biliary (Chief)	2.8	2.7	2.8	2.6	2.5	2.4	2.4	2.2	2.1	2.0	24.5	2.5
CBDE	1.1	1.1	0.9	0.9	0.9	0.9	0.9	0.8	0.8	0.7	9.0	0.9
CDE	1.6	1.5	1.6	1.4	1.3	1.2	1.2	1.1	1.0	1.0	12.9	1.3
Other	0.1	0.1	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	2.6	0.3
Biliary (Junior)	3.1	3.1	2.8	2.7	2.6	2.5	2.7	2.5	2.5	2.4	26.9	2.7
CBDE	1.9	1.8	1.5	1.4	1.3	1.2	1.3	1.2	1.2	1.2	14.0	1.4
CDE	1.1	1.1	1.0	1.0	1.0	1.0	1.0	0.9	0.9	0.9	9.9	1.0
Other	0.1	0.2	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.3	3.0	0.3
Subtotal	23.2	23.7	23.2	23.9	24.4	24.6	26.1	25.5	25.9	25.3	245.8	24.6
Total												

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Total	Overall mean
Liver (Chief)	4,915	4,876	4,947	4,889	4,660	4,571	4,473	4,354	4,387	4,248	46,320	4,632
Anatomic	3,058	2,968	3,033	3,104	2,847	2,741	2,570	2,529	2,573	2,387	27,810	2,781
Wedge	983	1,060	1,190	1,286	1,272	1,323	1,374	1,345	1,364	1,338	12,535	1,254
Other	874	848	724	499	541	507	529	480	450	523	5,975	598
Liver (Junior)	5,460	5,300	4,818	4,861	4,484	4,265	4,150	3,854	4,060	3,573	44,825	4,483
Anatomic	2,621	2,438	2,320	2,298	1,940	1,804	1,660	1,443	1,557	1,241	19,322	1,932
Wedge	1,529	1,802	1,690	1,841	1,844	1,755	1,849	1,784	1,910	1,775	17,779	1,778
Other	1,310	1,060	808	722	700	706	641	627	593	557	7,724	772
Pancreas (Chief)	7,862	7,950	7,737	7,963	7,339	7,028	6,741	6,652	6,651	6,089	72,012	7,201
Pancreatoduodenectomy	4,040	3,922	3,776	4,149	3,826	3,627	3,409	3,286	3,122	2,836	35,993	3,599
Distal	2,184	2,120	2,156	2,163	1,989	1,761	1,732	1,619	1,466	1,335	18,525	1,853
Other	1,638	1,908	1,805	1,651	1,524	1,640	1,600	1,747	2,063	1,918	17,494	1,749
Pancreas (Junior)	4,586	4,452	4,269	4,185	3,656	3,523	3,495	3,178	3,289	2,832	37,465	3,747
Pancreatoduodenectomy	1,747	1,696	1,680	1,690	1,467	1,361	1,361	1,045	1,103	837	13,987	1,399
Distal	1,310	1,272	1,113	1,113	957	923	857	738	732	604	9,619	962
Other	1,529	1,484	1,476	1,382	1,232	1,239	1,277	1,395	1,454	1,391	13,859	1,386
Biliary (Chief)	2,184	2,226	2,272	2,425	2,439	2,467	2,613	2,873	2,843	2,842	25,184	2,518
CBDE	764	848	783	901	933	887	897	958	1,095	1,110	9,176	918
CDE	1,092	1,060	1,188	1,242	1,228	1,302	1,393	1,593	1,569	1,591	13,258	1,326
Other	328	318	301	282	278	278	323	322	179	141	2,750	275
Biliary (Junior)	2,621	2,650	2,532	2,754	2,511	2,575	2,781	2,817	2,996	2,934	27,171	2,717
CBDE	1,310	1,272	1,259	1,361	1,249	1,303	1,418	1,481	1,781	1,789	14,223	1,422
CDE	983	954	940	1,054	974	993	1,020	1,047	1,093	1,046	10,104	1,010
Other	328	424	333	339	288	279	343	289	122	99	2,844	284
Subtotal	27,628	27,454	26,575	27,077	25,089	24,429	24,253	23,728	24,226	22,518	252,977	25,298

Anatomic, Lobectomy or segmentectomy; CBDE, common bile duct exploration; CDE, choledochostomy; Chief, case volume performed during the fifth year of surgical residency; Junior, case volume performed over years 1–4; Other, other major.

Table II

Total number and percentages of complex hepatopancreatobiliary cases logged by graduating chief residents, 2003–2012

Procedure	n	%
Liver resection		
Anatomic	47,132	51.7
Wedge	30,314	33.3
Other	13,699	15.0
Subtotal	91,145	36.0
Pancreatectomy		
Pancreatoduodenectomy	49,980	45.7
Distal	28,144	25.7
Other	31,353	28.6
Subtotal	109,477	43.3
Biliary		
CBDE	23,399	44.7
CDE	23,362	44.6
Other	5,594	10.7
Subtotal	52,355	20.7
Total	252,977	

CBDE, Common bile duct exploration; *CDE*, choledochenterostomy.

Table III

Median and 90th percentile of cases performed by graduating chief residents in the role of teaching assistant, 2003–2012

	Year										
	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	
50th percentile											
Liver	0	0	0	0	0	0	0	0	0	0	0
Pancreas	0	0	0	0	0	0	0	0	0	0	0
Biliary*	3	4	3	3	3	3	3	4	4	4	4
90th percentile											
Liver	0	0	0	0	0	0	0	0	0	0	0
Pancreas	0	0	1	0	0	1	2	1	0	1	1
Biliary*	14	12	11	11	11	19	19	12	13	15	15

* Includes laparoscopic and open cholecystectomy.