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The Challenges of Resident Training in Complex Hepatic, Pancreatic, and Biliary Procedures

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Abstract Operations on the liver and pancreas have fallen within the domain of the general surgeon and have been part of general surgery training. The more complex procedures involving these organs are limited in number in most general surgery residencies and do not afford an opportunity for vast experience. Moreover, fellowship programs in hepato-bilio-pancreatic (HPB) surgery and the development of laparoscopic techniques may have further limited the familiarity of general surgery residents with these operations. To determine the experience accrued by finishing general surgery residents, we accessed, through the Residency Review Committee of the Accreditation Council for Graduate Medical Education, the Resident Case Log System used by general surgery residents throughout their training to document operative cases. The number of operations on the gallbladder, bile ducts, pancreas, and liver was examined over the past 16 years (there were missing data for 3 years). Reference years 1995 and 2005 were compared to detect trends. Experience with laparoscopic cholecystectomy has steadily increased and averaged more than 100 cases in 2006. Experience in liver resection, distal pancreatectomy, and partial (Whipple) pancreatectomy has statistically improved from 1995 to 2005, but the numbers of cases are low, generally less than five per finishing resident. Experience in open common bile duct and choledocho-enteric anastomoses has statistically declined from 1995 to 2005, averaging less than four cases per finishing resident. The mode (most frequently performed number) for liver and pancreas resections was either 0 or 1. It is doubtful this experience in HPB surgery engenders confidence in many finishing residents. Attention should be focused on augmenting training in HPB surgery for general surgery residents perhaps through a combination of programmatic initiatives, ex vivo experiences, and minifellowships. Institutional initiatives might consist of defined HPB services with appropriate expertise, infrastructure, process, and outcome measures in which a resident-oriented, competency-based curriculum could be developed.

Keywords Hepatobiliary surgery · Pancreatic surgery · Graduate medical · Education

Introduction

> We need a system, and we shall surely have it, which will produce not only surgeons, but surgeons of the highest type, men who will stimulate the first youths of our country to study surgery and to devote their energies and their lives to raising the standard of surgical science—William Stewart Halsted, MD

William Halsted, in his treatise, *The Training of the Surgeon*, published in the *Bulletin of the Johns Hopkins Hospital* in 1904, advocated long hours and long years of apprenticeship for surgeons in training to encounter "any emergency that may arise and to perform any operation known to surgery..." Regarding the arduous nature of the residency period, Dr. Halsted commented "These positions are not for those who so soon weary of the study of their profession." Today, we have not the luxury of leisurely training surgeons until they are judged ready to practice their craft. Constraints of time, both in years and hours, even as the complexity of surgery has increased, have

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forced us to concentrate our efforts and provide fundamental skills to equip young surgeons for the multitude of patients and diseases they may see. If not the actual experience, we must teach the framework in which this can happen. However, in all our developing regulations, we must still strive to produce the system and achieve the standard Dr. Halsted advocated.

In essence, the goal today of a general surgical residency is to produce competent and compassionate surgeons. Competency is no longer judged at the whim of attending surgeons. The Accreditation Council for Graduate Medical Education (ACGME) has defined competency in terms of six categories to be addressed during the course of 5 years of training. Today's evolving educational paradigm includes proficiency in medical knowledge, patient care skills, self-reflection and assessment, interpersonal skills and communication, professionalism, and an ability to practice in the wide scope of health care systems. Still fundamental in these competencies for the general surgeon, just as in Dr. Halsted's day, is an ability to select the proper patient, operate skillfully, and render expert postoperative care. It is widely understood among surgeons that good outcomes, a recognized measure of quality, require these components.

For this reason, operative experience remains central to surgical training. There is no substitute for hands-on exposure to surgical anatomy and surgical disease and no substitute for conducting operations from start to finish, albeit with careful, graded supervision. A finishing surgical resident might, within days or weeks, be faced with complex procedures without the reassuring presence of a seasoned mentor. He or she must be prepared. For the most part, even with work hours limitations, the so-called "bread-and-butter" cases, such as laparoscopic cholecystectomy, breast excisions, appendectomies, and thyroidectomies, seem to be done in abundance. Proficiency should accompany such experiences.

The same may not hold true for hepatic, pancreatic, and complex biliary (HPB) surgery. How prepared are finishing general surgery residents to treat diseases of the liver, biliary system, and pancreas? We have sought to answer this question through examination of the operative experiences of general surgery residents in major hepatic, complex biliary, and major pancreatic resections using data submitted by residents to the ACGME Resident Case Log System database.

Materials and Methods

The ACGME Resident Case Log System for operative log reporting (operative log) is an Internet-based case log system using Current Procedural Terminology and International Classification of Diseases 9 codes to track operative experience during the years of residency training. The individual resident is responsible for entering procedures that accurately reflect their participation. The operative logs of finishing general surgery residents filed with the ACGME from 1990 to 2006 were examined for experience in the following procedures: distal pancreatectomy (DP), partial pancreatico-duodenectomy (Whipple-type pancreatectomy; PPD), total pancreatectomy (TP), laparoscopic cholecystectomy, open cholecystectomy, open and laparoscopic common bile duct exploration (CBDE), choledocho-enteric anastomoses, and major liver resections, including hemihepatectomy and segmentectomy but not wedge excisions. Values for each year in these categories were expressed as mean+ standard deviation (SD) or reflecting 95% confidence intervals around the mean and mode. The mode was defined as the most frequent number of cases performed. The total number of cases performed as operating surgeon was chosen. Those as surgeon assistant were excluded. There were 3 years, 1993, 1994, and 1999, for which data were not available through the ACGME. The reference years 1995 and 2005 were chosen to represent a 10-year span for trending purposes. The average number of cases in all HPB categories in 1995 and 2005 were compared for statistically significant variation in resident experience. All pairwise comparisons were done using Student's t test. p values were provided to allow the reader to assess significance. Significance was determined at $p<0.05$.

Results

In retrieving ACGME operative logs for HPB procedures, there were 3 missing years, 1993, 1994 (partial), and 1999. There has been a decline in the number of open cholecystectomies performed since 1990 with an eventual corresponding appearance and progressive increase in the numbers of laparoscopic cholecystectomies (Fig. 1). When comparing the number of laparoscopic cholecystectomies from reference years 1995 and 2005 (10-year span), there has been a statistically significant increase in the number of procedures in which the surgical residents were listed as the operating surgeon (52.7±28, 1995 vs 100.6±41, 2005, $p<0.001$). There has been a progressive decline in the numbers of open CBDE, achieving statistical significance from 1995 to 2005 (5.1±4, 1995 vs 1.7±2, 2005, $p<0.001$; Fig. 2). Corresponding to this, there has been a modest but statistically significant increase in the number of laparoscopic CBDEs performed during the 10-year span (0.6±2, 1995 vs 0.7±1.4, 2005, $p=0.025$). Lastly, for biliary procedures, there was a statistically significant decline in the number of choledocho-enteric anastomoses during the 10-year span (3.7±3, 1995 vs 2.6±2.6, 2005, $p<0.001$).

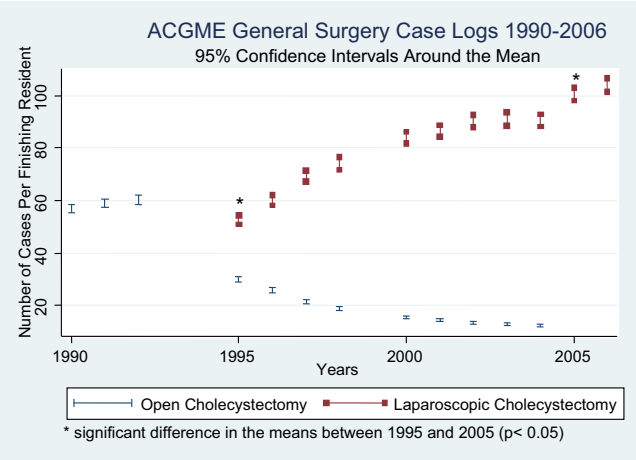

Figure 1 Experience with open and laparoscopic cholecystectomy from 1990 to 2006. In the reference period 1995 and 2005, there has been a statistically significant increase in the number of laparoscopic cholecystectomies done by finishing residents.

The number of major liver resections (hemihepatectomies and segmentectomies) performed by general surgery residents has risen over the 10-year span, achieving statistical significance (1.9±3, 1995 vs 3.9±4, 2005, $p<0.001$; Fig. 3). The maximum number of liver resections for any given program for 2005 was recorded as 38. Likewise, the number of pancreatectomies—PPDs and DPs—have increased over the 10-year span (PPD=2.1±3, 1995 vs 4.2±4.1, 2005, $p<0.001$; DP=1.4±2, 1995 vs 2.3±2.2, 2005, $p<0.001$; Fig. 4). The maximum number of PPDs for any given program for 2005 was recorded as 31. There have been a minimal number of TPs performed throughout the survey period and no appreciable increase in numbers during the reference period 1995–2005. Table 1 summarizes comparative HPB cases for the sentinel years 1995 and 2005.

The mode (most frequent number of cases) for all HPB procedures is listed in Table 2. There were 5 years in which complete information on the mode were not available, 1993, 1994, 1999, 2005, and 2006. While adequate numbers are recorded for both open and laparoscopic cholecystectomies, the mode for other hepatic, biliary, and pancreatic cases ranges from 0 to 3. In particular, the mode for major liver resection is most commonly zero or one case per finishing resident and for PPD and DP, most often one case per finishing resident.

Discussion

General surgery resident experience, as recorded in the ACGME operative case log system, has shown an approximate doubling in average number of liver and pancreas cases (liver resection, PD, DP) performed over the 16 years surveyed, from roughly two to four. For the reference years 1995 and 2005, the increase attained statistical significance. This may represent an actual enhancement of HPB experience or may simply reflect a better reporting system of operative cases developed over the years by the ACGME. However, many residents still report a meager experience, as judged by the mode, one or no cases, during their training. Even an average number of four PDs and major liver resections are of questionable value in preparing surgical residents for these procedures in practice. Both PD and major liver resections are complex procedures requiring not only familiarity with anatomy but also familiarity with the nuances of exposure, mobilization, and use of assistants during surgery. Our findings are reminiscent of those reported by Ong et al.[1] who concluded that surgical chief residents "have a widely variable experience in liver and pancreatic surgery." As well, our findings also are in agreement with the institutional experience from the University of Louisville furnished by Cheadle et al.[2] who indicated that their finishing residents had, on average, done less than five PDs and approximately five major liver resections. With a standard deviation for liver resections of approximately three and for PPDs from three to four and assuming a normal distribution, we can gather that about 68% of finishing residents (in 2005) have done from zero to eight liver resections and from zero to five PPDs. To look at it another way, about one half of finishing residents have done less than four liver resections and less than three PPDs.

We have also demonstrated a steady decline in the number of open CBDEs and a scanty experience with laparoscopic CBDE. In general, residents did less than half

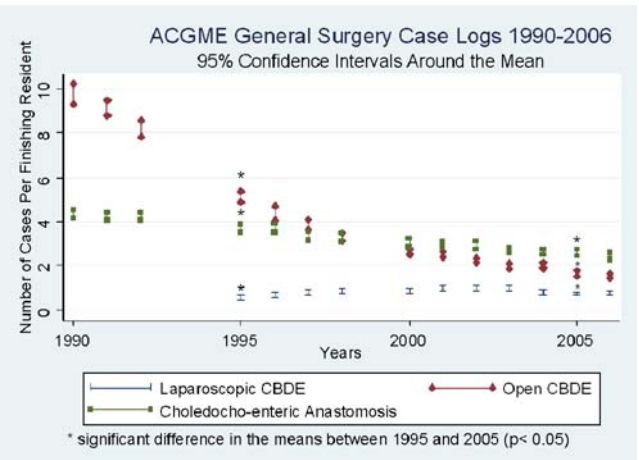

Figure 2 Experience of finishing general surgery residents in open and laparoscopic common bile duct explorations (*CBDE*) and in choledocho-enteric anastomoses. There has been a statistically significant decline in the number of open CBDE and the number of choledocho-enteric anastomoses performed in the reference period 1995 and 2005. There has been a significant, albeit unimpressive, increase in the number of laparoscopic CBDE during this same period.

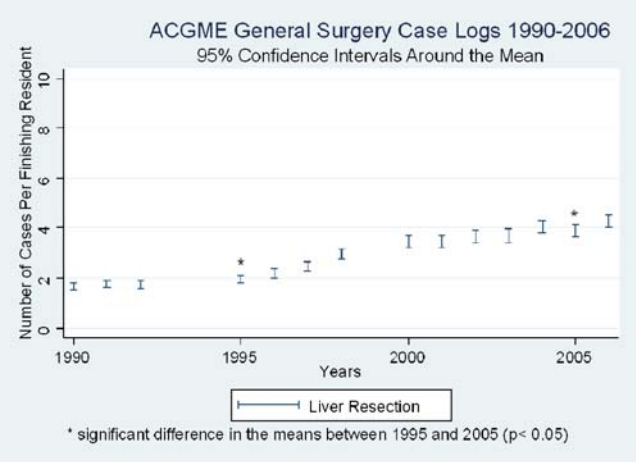

Figure 3 Experience in major liver resections reported by finishing residents in general surgery. There has been a statistically significant increase in the number of cases performed in the reference period 1995 and 2005.

the number of open CBDE in 2005 compared to 1995. Open CBDE has traditionally been an opportunity for surgical residents to become acquainted with the anatomy and operative exposure of the extrahepatic biliary tree and hilum of the liver. Principles involved in exposure of the common bile duct could be used for other, more emergent, situations such as trauma to the liver. No doubt, much of this decline has been due to the enhanced ability to remove choledochal stones with less invasive procedures namely, endoscopic retrograde cholangiopancreatography. Furthermore, the report by Livingston and Rege[3] described an increase in complications associated with open CBDE, which they linked to a dwindling surgeon experience. The introduction of laparoscopic CBDE has not seemed to compensate. While the numbers of laparoscopic CBDE have statistically increased from reference years 1995 to 2005, the average number of cases barely reaches one per finishing resident. Furthermore, the number of choledocho-enteric anastomoses has also statistically declined from 1995 to 2005 with residents, on average, doing only two or three of these procedures during their training, again reflecting diminishing opportunities to acquaint general surgery residents with extrahepatic biliary anatomy.

What implications does this have for the future of HPB surgical training—particularly for programs (perhaps half) in which there are relatively few HPB cases available? Is regionalization the answer so that HPB cases would be concentrated at designated centers? While there is some evidence to support attempts at regionalization,[4] it is doubtful that the relatively few high-volume centers could accommodate all patients in need of HPB surgery, even if they were willing to go. For example, Fong et al.,[5] using National Medicare databases, collected 3,734 patients who had hepatectomies and 2,592 patients who underwent pancreatectomies within a 2-year period. High volume was rather arbitrarily assigned as more than 25 such cases performed per institution per year. Using this definition, there were 10 of 1,101 (9%) surveyed hospitals classified as high volume. These hospitals cared for 291 of 2,592 patients (11%) who had a pancreatectomy. Similarly, for hepatic resection, 12 of 1,284 hospitals (9%) were classified as high-volume hospitals operating on 474 of the 3,734 patients (13%) who underwent an hepatectomy during the study period. Moreover, it is doubtful that there would be equal access to high-volume centers for all ethnic and socioeconomic strata. There has already been the observation that more Medicaid and uninsured patients go to low-volume hospitals.[6]

Let us assume, then, that regionalization in HPB surgery cannot and will not occur. How are we to provide adequate training with the number of cases currently being performed in many, if not most, programs? Is mandatory fellowship training in HPB the answer? Intensive training in high-volume centers should provide the exposure and experience necessary for competent HPB surgery. Currently, the International Hepato-Pancreato-Biliary Association recognizes 16 fellowships in HPB surgery in North America, training approximately 18 fellows per year—perhaps enough to staff the relatively few high-volume centers but unlikely enough to satisfy the large number of "low volume" programs. One thousand ten general surgery residents finished their training in 2006. While almost 70% will enter specialty fellowship training, almost one third will not and will presumably begin a practice in general surgery. Many of these practicing surgeons will want or need to operate on liver, biliary, or pancreatic problems. In fact, despite fellowship training, most surgeons who

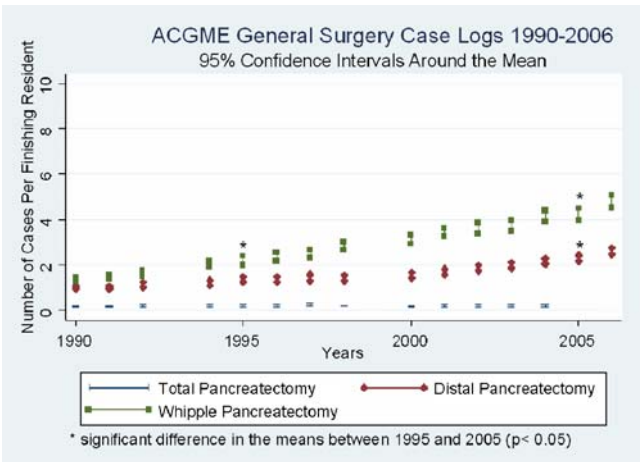

Figure 4 Experience in Whipple-type pancreatectomy, distal pancreatectomy, and total pancreatectomy reported by finishing general surgery residents. There has been a statistically significant increase in the number of Whipple-type and distal pancreatectomies performed during the reference period 1995 and 2005.

Table 1 Mean Number of HPB Procedures Completed in 1995 and 2005 ACGME General Surgery Case Logs

Procedure	1995	2005	*p* value
Major hepatic resection	1.948	3.886	<0.001
Distal pancreatectomy (DP)	1.379	2.291	<0.001
Whipple pancreatectomy (PPD)	2.185	4.238	<0.001
Total pancreatectomy (TP)	0.163	N/A	N/A
CBDE open	5.122	1.659	<0.001
CBDE laparoscopic	0.555	0.727	0.025
Lap cholecystectomy	52.665	100.599	<0.001
Open cholecystectomy	29.953	N/A	N/A
Choledocho-enterostomy	3.706	2.583	<0.001

TP cases were included in PPD cases for 2005; open cholecystectomies were no longer counted in 2005.
CBDE Common bile duct exploration

completed a general surgery residency maintain certification by the American Board of Surgery and conduct a broad general surgery practice.[2] There is currently not the capacity to formally train all of these individuals in HPB surgery, at least not in the conventional sense. How, then, do we teach these surgeons to safely perform major hepatic, biliary, and pancreatic operations? Are we to eventually subscribe to recommendations that general surgery training paradigm be changed into "specialist in general surgery" tracks after a period of core training[7]—so that all HPB cases are funneled to the "generalists" and not surgical "specialists"—or do we channel all of our surgical residents early on into superspecialization—HPB surgery included—much like the Swedish system?[8]

Within existing general surgery residencies, we would submit that programmatic development in HPB surgery, incorporating the pillars of structure, process, and outcomes, is necessary. Such programs require expertise, leadership, and infrastructure. Their primary focus should be excellence in the multidisciplinary care of patients with disorders of the liver and pancreas—much like the "center of excellence" concept. Within such programs residents could learn in a setting of comprehensive care. Components of patient selection, case review, and treatment planning are essential to instruct residents on the place of surgery in the care of these complex problems. Rarely is surgery standalone treatment but most often one element in a multifaceted approach. In fact, when such programs are established, the volume of HPB cases can dramatically increase.[9]

However, what about operative skills? Even with a programmatic concept, many residents, by ACGME operative logs, will continue to do only a handful of complex HPB cases. How many HPB cases confer proficiency? We cannot answer for sure but certainly more than one or two. Recent evidence indicates that continued improvement in outcome (blood loss, operative times, length of stay) occurs for individual surgeons even as experience climbs into the hundreds of cases.[10] Can surgical residents absorb and appreciate the complexities of hepatic or pancreatic surgery after only one or two exposures? It is doubtful. How can we augment that? Virtual training may be an option. For open operations, this can be done with ex vivo experiences such as cadaver dissection, preferably using fresh cadavers. Periodic cadaver laboratories, simulating the operating

Table 2 The Mode for HPB Cases Performed by Finishing General Surgery Residents from 1990 to 2006 ACGME General Surgery Case Logs

Year	Maj Hep	TP	DP	PPD	O CBDE	L CBDE	O Chole	L Chole	Chole-En
1990	0	0	0	0	7	N/A		N/A	3
1991	0	0	0	0	8	N/A	47	N/A	3
1992	0	0	0	1	6	N/A	27	N/A	2
1993		Information not available							
1994		1	1	0					
1995	0	0	1	1	5	0	22	39	3
1996	0	0	1	1	2	0	15	32	2
1997	1	0	1	1	3	0	15	43	2
1998	0	0	0	1	1	0	18	34	2
1999		Information not available							
2000	0	0	1	1	2	0	13	56	2
2001	2	0	1	1	1	0	11	76	2
2002	1	0	1	1	1	0	13	63	1
2003	1	0	1	1	1	0	10	73	1
2004	1	0	1	1	1	0	12	59	1
2005		Information not available							
2006		Information not available							

Maj Hep Major hepatic resection, *TP* total pancreatectomy, *DP* distal pancreatectomy, *PPD* partial pancreatico-duodenectomy, *O CBDE* open common bile duct exploration, *L CBDE* laparoscopic common bile duct exploration, *O Chole* open cholecystectomy, *L Chole* laparoscopic cholecystectomy, *Chole-En* choledocho-enterostomy

room, can allow senior-level residents the opportunity to leisurely work through hepatectomies and pancreaticoduodenectomies, with time to identify anatomic landmarks and even perform pancreatic anastomoses. There is some evidence that familiarity with cadaver dissection transfers well to the operating room and has been perceived by residents as a positive educational experience.[11,12]

Are there surrogates for actually performing operations? Is there any value to observing and assisting? Undoubtedly, there is. The use of short, intense visits to high-volume centers affords an opportunity to watch experienced HPB surgeons select and operate on patients. These "minifellowships" are not unknown in surgical practice and are sure to become commonplace in the future. Many bariatric surgeons, for example, have learned laparoscopic techniques through a few to several weeks of observation (apprenticeship) with an established laparoscopic surgeon.[13] In such settings, much information can be gleaned about the selection criteria, preoperative preparation, postoperative care, and adjuvant treatments to develop a quality HPB program. We are reminded, too, that "competence develops over time and is nurtured by reflections on experience"[14]—thus, the importance of outcomes assessment. The end of residency should not be the end of training but the beginning of lifelong learning.

In summary, operative experience for surgery residents in HPB surgery may continue to be highly variable and often meager. Our challenge as educators, then, is to provide a framework for success. Whether high volume or low volume, the resident should approach HPB surgery as a matter of lifelong learning, incorporating their experiences in graduate training with postgraduate education. Residents must view HPB surgery as a multidisciplinary endeavor involving their medical, radiology, and pathology colleagues in a programmatic setting of structure (expertise), process, and assessment of outcomes and not simply as procedures to master. Instrumental in this is the organizational leadership of committed HPB surgeon/educators who can function as mentors, much as in Dr. Halsted's days, to produce capable HPB surgeons for future generations.

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