Clinical Science

Changing relationship of pediatric surgical workforce to patient demographics

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Pediatric surgical workforce; Pediatric patient demographics; Complex index operations

Abstract

BACKGROUND: Physician workforce studies indicate that more specialists contribute to higher average costs. The closely monitored pediatric surgery specialty may reflect what is occurring in other specialties.

METHODS: This report reviews the number of complex operations performed on infants and children in 1970, with <225 trained US pediatric surgeons, and in 2010, when there were 1,130. The number of births remained consistent during this 40-year period.

RESULTS: In 2010, approximately 10,710 complex index operations were performed on children in the United States by certified pediatric surgeons, resulting in 9.5 per surgeon annually. Data from the University of California, Los Angeles, and the Vanderbilt Children’s Hospital confirm these observations.

CONCLUSIONS: The progressive disparity in the number of pediatric surgeons trained and the number of complex index operations performed annually may increase costs and calls into question the ability of individual pediatric surgeons to maintain optimal competence. Consideration might be given to performing index operations at centers of excellence.

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A series of longitudinal analyses of the pediatric surgical workforce have been performed over the past 40 years, but they have not been related to workload, surgeon competence, or issues of health policy such as cost. The purpose of this study was to present data relating the numbers of pediatric surgeons (PS) to close estimates of complex pediatric surgical caseload during this time. We chose to define workload as the index case list originally published by Ravitch and Barton1 to standardize the longitudinal comparison from multiple studies in the literature and because these unique cases constitute a major reason for graduate education in the field. Although we refer to the additional types of cases PS perform today, we focused on the types of newborn and unique complex cases that require special expertise as well as expensive dedicated facilities and teams of specialists. It is possible from these data to infer certain conclusions, supported by verified studies in the literature, related to maintenance of competence, duplication of facilities, and cost. Additional in-depth studies of cost and outcomes may be indicated but are beyond the scope of this study.

The escalating cost of medical care in the United States is frequently described as unsustainable.2 Many persons,
including physicians and economists, believe that the US health care system is dysfunctional, is very expensive, is wasteful, and denies equal access. In 2012, US spending on health care reached $2.8 trillion, or about 18% of total spending on all goods and services. By 2016, this figure is projected to reach $4.2 trillion. In 1960, the United States spent only 5.2% of its gross domestic product on health care, whereas in 2005, costs had increased to >16%. The current per capita annual spending of $>$7,500 makes the United States the most costly health care country in the world.

The Centers for Medicare and Medicaid Services estimated in 2006 that physician and clinical services accounted for 21% of health care spending. Total spending in the United States on health services continues to grow at a rate of approximately 6% annually and currently outpaces spending in all other sectors in the US economy. Payments to physicians in the US are considerably higher than in all other industrialized countries. Physician workforce studies make a case that more physicians, specifically more specialists, contribute to higher average costs. At a time when the United States national debt of >$16 trillion is about equal to our gross domestic product, the pressure to reduce spending is now severe enough to bring about change.

Observations from the very closely monitored pediatric surgery specialty may be somewhat reflective of what may be occurring to varying degrees in other subspecialty areas of surgical and medical care. In this report, we review the demographics regarding the number of major complex operations performed on infants and children in 1970, when there were <225 PS in the United States who were trained in accredited pediatric surgery programs, and in 2010, when there were 1,130 PS (Schwartz M.Z., personal communication, July 2011). The number of births in the United States remained remarkably consistent during this 40-year period.

Background

Surgical specialization was initiated during the early 20th century and further expanded into several subspecialties in the second half of the century. Although several children’s hospitals in the United States have been in existence for over a century, by 1930, only a handful of surgeons concentrated their efforts on the surgical management of infants and children. By the 1940s, many children’s hospitals had identified a small number of surgeons who devoted much of their practice to pediatric surgery. Many general hospitals had ≥1 adult surgeon who had some special interest in operating on children with no specific training in this age group. By the 1950s, a few PS developed training programs at children’s hospitals, often within university hospital complexes, which were monitored by the Surgical Section of the American Academy of Pediatrics. In 1975, pediatric surgery was approved as a subspecialty by the American Board of Surgery. Training programs were subsequently approved and monitored by the Residency Review Committee.

Pediatric surgery training in the 1950s and 1960s included an extensive experience in all aspects of infant and children’s surgical care, including what have now become subspecialties. During the 1960s, the number of training programs increased from 8 in the United States and 1 in Canada to the current number of 44 in the United States and 8 in Canada. At least 3 additional applications for new training programs are being considered for approval in the near future, which would further increase the number of PS certified annually. By 1970, there were <225 fellowship-trained PS in the United States, whereas in 2010, the number had increased to 1,130, although the number from each period in full-time practice is not available (Schwartz M.Z., personal communication, July 2011). Certification in pediatric surgery commonly requires ≥9 years of training after medical school (7 years of general surgery and surgical research followed by 2 years of fellowship training). In recent years, pediatric surgery has become 1 of the most popular surgical specialties for students to pursue as a career choice.

The number of babies born in the United States in 1970 was 3,731,386, whereas there were 3,999,386 births in 2010, including immigration estimates, with the numbers varying only slightly during the intervening years. The number of births has decreased further during the current persistent economic recession, and it is unlikely that there will be a significant increase in the birth rate for several years. The overall US population increased from 203,392,031 in 1970 to 308,745,538 in 2010.

Ravitch and Barton were the earliest to suggest that numbers of 9 key index cases might be indicators of what individual PS need to ensure competence. We sought to examine the estimated number of Ravitch index cases being performed annually in the context of the significantly expanded pool of PS. We further investigated the volume of pediatric surgical index cases being performed at 2 major university medical centers, for which reliable data exist. These data were compiled to provide a context to share our opinions regarding current trends in the pediatric surgical workforce.

Methods

The numbers of certified PS in 1970 and 2010 were obtained from the American Board of Surgery records. We chose to investigate the 9 key Ravitch index cases shown in Table 1. National incidence was compiled from data published in specific book chapters in the 2012 edition of Pediatric Surgery by Coran et al., in which the frequency of patients with each condition requiring operation is indicated in numbers per thousand births. These numbers were validated against those recorded for the same International Classification of Diseases, Ninth Revision, Clinical Modification codes in the National Inpatient Kids Inpatient Database for 2009. These data are believed to be within a 5% to 10% margin of error. The numbers of births in 1970 and 2010 were obtained from US census data.
Aggregate numbers of index cases performed at the Monroe Carell Jr Children’s Hospital at Vanderbilt University from 2003 to 2012 were obtained from division service records. The numbers of individual cases performed at the University of California, Los Angeles, in 1970 and 2010 were obtained from service and billing records. Redo operations were excluded.

**Results**

The total number of key complex “index cases” requiring the expertise of board-certified PS in the United States is directly related to the number of births and increased only very slightly from 1970 to 2010. There are currently >5 times the number of certified PS in clinical practice compared with 1970. In 2010, approximately 10,710 complex Ravitch index operations were performed on infants and children in the United States. Another 8,800 major operations on children (gastroesophageal fundoplication, intussusception, intestinal malrotation, congenital cystic adenomatoid malformation and pulmonary anomalies, meconium ileus, biliary atresia, teratomas, germ cell, and ovarian, liver, and other tumors) were performed in 2010. In view of the difficulty in identifying the number of complications and redo operations after primary repairs, these were not included, nor were minor operations in the present compilation of surgical procedures. With >1,130 board-certified PS in the United States, this averages to approximately 9.5 index operations per surgeon each year, or <1 every month, and 8 other major nonindex operations on children annually, with some surgeons likely to perform more while others perform fewer. Additionally, approximately 183,000 children up to 18 years of age with noncomplex disorders are estimated to undergo operations annually. This category might add approximately 162 operations each year for each PS, although general surgeons have continued to operate on many of these patients, including those with appendicitis, hernias, and pyloric stenosis. In many hospitals nationwide, trauma in children is often managed by adult trauma teams with PS as consultants and having little actual operative experience.

With the limited number of complex index disorders requiring operation in infants and children, each of the enlarging number of PS will on average necessarily perform a smaller number of operations on index patients each year unless the birth rate increases considerably, and that is not the trend. Surgeons may thus find it more difficult to develop good judgment with respect to optimal patient management as well as maintaining technical proficiency in the often complex surgical techniques. Many previous reports have indicated that individual surgeon volume is a strong predictor of patient outcomes, hospital length of stay, and cost.13,14 Furthermore, new advances in surgical care are less likely to occur when the number of patients with a specific disorder operated on by a surgeon is low. Many PS have had only limited experience in making major decisions or functioning as the operating surgeon in the care of patients with complex index disorders even during their fellowship training, when they are closely supervised by faculty members. The majority of complex conditions requiring operation are congenital, and although their patterns may have changed somewhat over the years, the overall spectrum of disease is much the same. A few new operations, including gastroesophageal fundoplication, reconstruction for necrotizing enterocolitis, extracorporeal membrane oxygenation care, and placement of dialysis catheters, have been added to the PS’s workload. A few other operations that were formerly performed have been reassigned to the newer subspecialties of pediatric urology, cardiac, head and neck, and transplantation surgery during the past 3 decades.

Data compiled by 1 of the authors (J.A.O.) from the Monroe Carell Jr Children’s Hospital at Vanderbilt University indicate that from 2003 to 2012, there were 1,663 Ravitch index cases operated on by 7 full-time equivalent PS during the 10-year period. The average annual number of index cases for each of the 7 full-time equivalent surgeons was 24. Thus, each surgeon performed only 1 index operation every 2 weeks and, for some of the severe anomalies, <1 per year.

Data compiled from the University of California, Los Angeles, Medical Center indicate that 17 major Ravitch index operations were performed on infants and children by 1 author (E.W.F.) in 1970, in addition to 64 major cardiac operations. During 2010, 4 faculty PS performed 45 Ravitch index operations on infants and children, with an average of 11.3 per surgeon (Table 2). Seven percent of these index operations in 2010 were performed at satellite hospitals that had contracted with the University of California, Los Angeles for surgical care.

**Table 1** Ravitch index operations performed on infants and children in the United States (2010)

<table>
<thead>
<tr>
<th>Malformation</th>
<th>Number of operations</th>
</tr>
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<tbody>
<tr>
<td>Esophageal atresia/tracheoesophageal fistula</td>
<td>1,000</td>
</tr>
<tr>
<td>Congenital diaphragmatic hernia</td>
<td>1,000</td>
</tr>
<tr>
<td>Intestinal atresia (duodenal, jejunoileal, colonic)</td>
<td>2,210</td>
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<tr>
<td>Gastrochisis, omphalocele</td>
<td>2,500</td>
</tr>
<tr>
<td>Imperforate anus</td>
<td>1,500</td>
</tr>
<tr>
<td>Hirschsprung’s disease</td>
<td>800</td>
</tr>
<tr>
<td>Neuroblastoma</td>
<td>700</td>
</tr>
<tr>
<td>Wilms’ tumor</td>
<td>550</td>
</tr>
<tr>
<td>Rhabdomyosarcoma</td>
<td>450</td>
</tr>
<tr>
<td>Total</td>
<td>10,710</td>
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</tbody>
</table>

Comments

With >5 times as many board-certified PS in the face of a stable birth rate from 1970 to 2010, there is a growing
disparity between the nation’s pediatric surgical needs and workforce. We are troubled by this trend and sought to share our perspective, in the hope of reinvigorating a national discussion.

The pediatric surgery workforce has been evaluated almost every 5 years since the American College of Surgeons and American Surgical Association Survey on Surgical Services in the United States was published in 1975. The first analysis of the pediatric surgery workforce, including projected needs, was published in 1976. In an extensive updated survey in 2000 by O’Neill et al., it was noted that pediatric surgery trainee output had increased markedly during the previous 10 years. The pediatric surgery workforce was found to be 50% greater than the forecasted rate of increase in the number of patients in the pediatric age group. These data were within a low margin of error and were believed to be the best data available.

This disparity between the number of newly trained PS added to the workforce and the pediatric population has accelerated during the past decade. The decline in birth rate increased markedly during the previous 10 years. The pediatric surgery workforce was found to be 50% greater than the forecasted rate of increase in the number of patients in the pediatric age group. These data were within a low margin of error and were believed to be the best data available.

In the present work, the national incidence of Ravitch index cases was estimated by extrapolating the most recent published data. These were validated against the 2009 National Inpatient Kids Inpatient Database and were not statistically different when taking the limitations of this database into consideration. The recent study by Huang et al. on Hirschprung disease using the National Inpatient Kids Inpatient Database produced similar numbers for primary operations for that disorder. These data are likely to be within a 5% to 10% margin of error and include a few more complex conditions than were used in previous workforce studies, to reflect the increase in complex surgery performed in this age group during the intervening years. Geiger et al. modified the Ravitch index case definition in 2003 to include laparoscopic, thoracoscopic, and extracorporeal membrane oxygenation procedures.

We report the number of certified PS, for which data are available; it is unclear how many remain in active practice. Our compiled national rates of index cases are best estimates on the basis of the most recently published data. They constitute a convenient metric that has been previously described in the literature but may not fully reflect the spectrum of care delivered by PS. Although health care economic considerations in small part motivated this study, our goal was not to attempt an in-depth analysis but rather to provide additional context to share our opinions. Notwithstanding certain limitations to our approach, the current trends regarding the expanding pediatric surgical workforce give us pause for thought and warrant attention.

Several surgical workforce studies have recommended a need to train more surgeons to encourage more to establish surgical practice in rural communities that have few specialists. Realistically, surgeons are unlikely to move to rural communities, where compensation is often lower, on-call requirements are more demanding, complex case-loads are small, and many of the lifestyle amenities available in large cities are missing. This has been the trend over the past 30 years. During the past decade, medical students have increasingly chosen specialty surgery, including pediatric surgery, medical specialties, anesthesiology, pathology, and radiology, while decreasing their interest in family practice, obstetrics and gynecology, and particularly general surgery, medicine, and pediatrics. Previous reports indicated that the market demand for PS is strong, as measured by employment and income, which appear to be based on demand rather than need.

With contemporary restrictions on the number of work hours permitted during residency and fellowship training, it is unlikely that the recent graduates of these programs will look favorably on more extensive call and responsibility when entering their own practice. A large number of newly trained PS join the faculties of existing large children’s hospitals in major cities each year, with a few such hospitals now having >20 surgeons on their staffs. At many large children’s medical centers, the on-call schedules have been

<table>
<thead>
<tr>
<th>Condition/indication</th>
<th>Operations per year</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>1970</td>
</tr>
<tr>
<td>Esophageal atresia/tracheoesophageal fistula</td>
<td>4</td>
</tr>
<tr>
<td>Gastrochisis, omphalocele</td>
<td>3</td>
</tr>
<tr>
<td>Imperforate anus</td>
<td>2</td>
</tr>
<tr>
<td>Intestinal atresia</td>
<td>1</td>
</tr>
<tr>
<td>Congenital diaphragmatic hernia</td>
<td>3</td>
</tr>
<tr>
<td>Hirschsprung’s disease</td>
<td>3</td>
</tr>
<tr>
<td>Rhabdomyosarcoma</td>
<td>0</td>
</tr>
<tr>
<td>Wilms’ tumor</td>
<td>1</td>
</tr>
<tr>
<td>Neuroblastoma</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>18</td>
</tr>
</tbody>
</table>
Ravitch and Barton in 1974, it is often preferable to transport surgical operations is very small, so compensation is often optimal care. Furthermore, the number of complex pediatric surgery, and less special equipment and technology for providing families and pediatricians. There is, however, considerable surgical care has been a convenience for patients and their selection of a community hospital for tertiary pediatric hospitals to contract with PS based at larger centers. The increase in the number of PS by incentivizing affiliated times. These mandates provide a driving force for the increase in the number of PS by incentivizing affiliated hospitals to contract with PS based at larger centers. The selection of a community hospital for tertiary pediatric surgical care has been a convenience for patients and their families and pediatricians. There is, however, considerable increase in cost because of the duplication of necessary resources, less consistent supporting staff including anesthesia, and less special equipment and technology for providing optimal care. Furthermore, the number of complex pediatric surgical operations is very small, so compensation is often based on contracts with large tertiary centers. As noted by Ravitch and Barton in 1974, it is often preferable to transport patients with critical conditions to specialized centers rather than to duplicate such centers over the numerous communities, which would dilute surgeon experience and hinder training, thus diminishing quality. It would be more cost effective and efficient to develop centers of excellence for complex specialty surgery, as in most other industrialized countries, where operative care can be provided in a more optimal environment. Additionally, such centralization of complex cases for care enables research and evaluation of innovative procedures and approaches.

Currently, the health care industry is a leading sector for new employment in the United States, accounting for approximately 12,000 to 15,000 new jobs during each of the past several months. Although in general, PS have taken over the “market” of surgery in infants and children, market forces do not appear to apply in determining the rate of increase in the surgical workforce as long as there is minimal limitation of health care spending. Previous reliable observations have indicated that if there are excessive numbers of surgeons, the cost of care will rise proportionately. Although the majority of PS have between 30% and 60% of their practice compensated by Medicaid, ironically, patterns for reimbursement of PS have steadily increased far beyond those of general pediatricians and many other specialties, largely because of the high hospital revenues generated by neonatal intensive care units and ancillary testing.

Decisions regarding training program approval are currently based on defined educational criteria as determined by the Accreditation Council for Graduate Medical Education and the Residency Review Committee, not on needs or economics, which would be restraint of trade and a federal felony. A recent analysis of the operative experience of pediatric surgical trainees found small numbers of index operations performed, as well as a trend over time toward decreasing modes of total and index cases performed and increasing positive skew of the case distribution among trainees; the authors concluded that this “suggests a possible deficit in overall and index case load at an increasing percentage of programs.”

Solutions to these systemic problems are elusive because most would require regulatory change or realignment of the profit model in our health care system. Although limiting health care costs will be necessary, we are principally concerned in this study with ensuring adequate training and maintenance of competency. Considering the data in this report, we believe that further increases in PS trainee output would not be helpful in moving toward these goals.

The only corrective approach available currently is voluntary, including agreement to establish minimal experience volume requirement for complex cases, willingness to establish single centers of excellence in communities rather than fragmenting via duplication, and agreement to limit trainee output to meet societal need rather than the current trend of meeting hospital-based demand. It would be beneficial to have pediatric surgical leaders and program directors determine the minimum number of index and other complex cases per surgeon annually necessary to achieve optimal outcomes and ensure competence. Another approach might be to designate certain high-volume training programs that produce PS capable of complex surgery. A less extensive training approach might then be developed for those choosing to limit their practice to noncomplex pediatric surgery, in programs in which trainees are currently finishing with relatively few index case operations. One or 2 years of research training and 1 year of specialty training might be deleted for these surgeons, which might further reduce costs of education and health care. All of the above approaches either have barriers or are not considered acceptable for 1 reason or another. One of the best examples of this is the limitation of the residency review committees to assessing only the quality of a particular program and not whether it meets a national need.

A less attractive approach would be regulatory in nature. This would include limiting the number of training programs, requiring minimum case volumes for surgeon certification, establishing centers of excellence on the basis of community need, and offering enhanced reimbursement to accredited centers and their surgeons, much like the current trauma center model now operative in the United States. Many of our colleagues, who are accustomed to relative sovereignty, would likely not welcome such external requirements. Nonetheless, they must at least be considered, if not anticipated, in a climate of heightened attention to health care resource utilization. Combined voluntary and regulatory approaches might also be considered. At present, it would appear that the current dysfunctional economics of our health care system, rather than the
real need for specialty physicians, is the major factor in determining the number of PS trained.

Conclusions

Various hospitals’ demand for a continued increase in the number of new board-certified PS in the United States does not appear to be based on the actual medical needs in terms of the care of complex conditions in infants and children but rather on health care economics and certain market forces. The number of PS has increased >5-fold over the past 4 decades, whereas the total number of complex index operations performed annually on infants and children has increased only minimally. It is our opinion that this progressive disparity may increase the costs for surgical care but, more important, calls into question the ability of individual PS to maintain optimal competence in the surgical management of all complex index disorders in infants and children. Consideration might be given to encouraging complex operations on infants and children to be performed in a few large children’s medical centers of excellence, as well as other possible solutions. Noncomplex operations might also be performed at certain community hospitals with children’s units and appropriate but less extensive facilities and staff. Shortening of the lengthy training program might be considered for PS who do not operate on complex pediatric disorders. These workforce observations may be somewhat reflective of what is likely to be occurring to varying degrees in other subspecialty areas of surgical and medical care.

References