The Increasing Workload of General Surgery

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Background: With the aging of the baby boomers, individuals aged 65 years and older make up the fastest-growing segment of the US population. This aging of the population will lead to new challenges for the US health care system because older individuals are the largest consumers of health care.

Hypothesis: The general surgery workload will increase dramatically by 2020 as a result of the aging population.


Setting: A nationally representative random sample of inpatient and outpatient general surgical operations performed in 1996 in the United States.

Methods: Age- and procedure-specific rates of general surgery were obtained from the National Hospital Discharge Survey and National Survey of Ambulatory Surgery. Population projections were derived from the census bureau. We used relative-value units as a proxy for surgical work. By linking these 3 data sources, we predicted the future general surgery workload by analyzing the rates of surgery and modeling both the aging and expansion of the population.

Results: General surgery operations (n=63) were classified into 5 procedure categories. Whereas the population will grow by 18% between 2000 and 2020, the workload of general surgeons will increase by 31.5%. The amount of growth (19.9%-40.3%) varies among different categories of operations.

Conclusions: To our knowledge, this is one of the only studies to analyze the future workload of general surgery. We project a dramatic increase in workload in the next 20 years, largely as a result of the aging US population. Our baseline assumptions are relatively conservative, so this forecast may be an underestimation. Hence, the challenge for general surgeons is to develop strategies to address this problem while maintaining quality of care for our patients.

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based on our hypothesis that the general surgery workload will increase dramatically by 2020. In this study, we address 3 specific issues. First, we quantify the magnitude of the workload increase. Second, we characterize the procedures that will constitute the largest portion of general surgical work. Finally, we analyze the effect of changes in the number of general surgeons on the projected workload in the context of historical and future trends in the general surgery workforce.

**METHODS**

**DATA SOURCES**

We obtained the incidence rates of general surgical procedures from the NHDS and the National Survey of Ambulatory Surgery (NSAS). Both the NHDS and NSAS are nationally representative random samples of acute care hospitals and ambulatory surgery facilities in the United States. The 1996 NHDS and NSAS were chosen for this analysis because they are the most recent nationally representative surveys that included outpatient surgery.

The NHDS uses a stratified technique to randomly sample 300,000 patient discharges from US hospitals each year. The sampling frame includes all nonfederal acute care hospitals in the United States but excludes federal, military, Veterans Administration, and institutional (e.g., prison) hospitals as well as all hospitals with fewer than 6 beds. The NSAS sampling frame includes both hospital-based and freestanding ambulatory surgery centers. Facilities that specialize in dentistry, podiatry, abortion, family planning, or birthing were excluded. The NSAS uses sampling methods similar to the NHDS to accumulate 125,000 patients. The data obtained from these surveys are weighted to produce national estimates. The data from both the NHDS and NSAS have been published previously.

Historical and projected population data were obtained from the US Census Bureau. The technique for these projections uses a detailed model of the existing population and accounts for major demographic changes such as births, deaths, and migration. The assumptions and methods of the census model are described elsewhere.

**MEASUREMENT OF PROCEDURES**

Procedures from the NHDS and NSAS were coded according to the *International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9)*. The number of times an operation was performed in the survey sample was grouped by procedure (ICD-9 code) and patient age group (<15 years, 15-44 years, 45-64 years, or ≥65 years). The NHDS and NSAS maintain strict standards for accuracy. All procedures with a reliably measured rate were evaluated. Surgical rates could not be accurately calculated for certain operations with a low-sampled frequency (e.g., esophageal resection); therefore, these operations were excluded from the analysis. In total, 63 general surgery operations were included and were grouped into 5 separate categories for analysis (Table 1): breast or soft tissue, gastrointestinal (GI), hepatobiliary, hernia, and other abdominal procedures.

**DETERMINING THE TOTAL AMOUNT OF WORK**

We used procedure-specific, resource-based relative-value units (RVUs) as an estimate of the amount of work required to perform each procedure. These RVUs have 3 principal components: physician work, practice (overhead), and malpractice. For this analysis, the physician work component was used because it most directly estimates the work performed by the surgeon. The use of the RVU as a scalar allows for work comparisons that adjust for variations in complexity.

The total amount of work was derived using a multistep approach. To project the number of operations for each age group, the age-specific incidence rate of a procedure was multiplied by the number of individuals in that age group. The total number of projected operations was obtained by aggregating the estimates across all age groups (<15 years, 15-44 years, 45-64 years, and ≥65 years). Work for a particular operation was determined by multiplying the total number of operations by its corresponding RVU.

Total general surgery work was obtained by adding the work for all operations. Workload changes were then analyzed for all of general surgery and by operative category. Projections are expressed as a percentage increase relative to workload in 2000.

**SENSITIVITY ANALYSIS**

Our baseline projection assumed that the general surgery workforce would remain constant. To specifically examine the feasibility and effect of expanding the size of the general surgery workforce, we performed a sensitivity analysis by increasing the number of general surgeons at a constant rate across time. Recent estimates of the numbers of practicing general surgeons and incoming (graduating) general surgery residents were used. Each year, approximately 1000 residents complete their general surgery training. This number has remained remarkably constant in the last 20 years. Of these, approximately 600 (60%) practice general surgery exclusively, whereas 400 continue on to fellowships for further specialization (e.g., vascular, plastic, or transplant surgery). The current workforce is composed of approximately 20,000 full-time general surgeons (mean estimate, 20159; range, 17289-23502). For our analysis, general surgeons include colorectal surgeons and surgical oncologists.

At baseline, the rates of attrition and retirement were assumed to be constant and approximately equal to the number of surgery residents entering the practice of general surgery. We analyzed the effects of a net increase of 100 or 200 surgeons annually until 2020. This simulates an active policy of expanding the general surgical workforce by either increasing the number of residency graduates or decreasing the rates of retirement and attrition.

**RESULTS**

**POPULATION GROWTH**

Between 2000 and 2020, the US population is projected to rise from 275 million to 325 million, an 18.0% increase. During this period, the numbers of individuals...
younger than 15 years and aged 15 to 44 years will increase by 10.2% and 4.1%, respectively. However, the numbers of persons aged 45 to 64 years and 65 years and older will grow by 32.3% and 54.2%, respectively. For individuals 65 years and older, this represents an increase of 18.9 million, from 34.8 million to 53.7 million (Table 2). Persons 65 years and older make up the most rapidly expanding segment of the population; their growth contributes nearly 40% of the overall population increase (18.9 million of 49.6 million).

RATES OF GENERAL SURGERY

Overall, rates of general surgery increased with age and were highest for the oldest age group, those 65 years and older. Rates of surgery in this age group were 3 times higher than those among individuals aged 15 to 44 years and 1.6 times higher than rates among persons aged 45 to 64 years. This trend was consistent across all categories of operations. Rates of operations involving the GI tract were 5-fold and 3.2-fold higher among individuals 65 years and older compared with those aged 15 to 44 years and 45 to 64 years, respectively. Similarly, the rates of surgery for breast and soft tissue procedures and hernia repairs were 4-fold higher among persons 65 years and older compared with persons aged 15 to 44 years and were 1.2 and 1.5 times those of individuals aged 45 to 64 years, respectively. Hepatobiliary operations were 3 times more common in individuals aged 15 to 44 years and 1.3 times more common in those aged 45 to 64 years. The rates of other abdominal surgical procedures were only 1.3-fold and 1.7-fold higher among persons 65 years and older compared with those aged 15 to 44 years and 45 to 64 years, respectively.

GENERAL SURGERY WORKLOAD

Overall, the general surgery workload will increase 31.5% by 2020, significantly higher than the 18.0% population growth during the same period. When examining the 5 categories of general surgery operations, the workload for each group increases more rapidly than the population. The growth is highest for the operative categories with a large proportion of individuals 65 years and older. Increases in workload for the 5 operative categories range from 19.9% to 40.3%, with the largest growth in GI surgery (Table 3). Significant increases are also forecasted for breast or soft tissue, hernia, and hepatobiliary procedures. The “other abdominal” category is forecasted to grow only slightly faster than the population.

As a percentage of total work in 2020, GI and hepatobiliary operations account for 27% and 26%, respectively. Breast or soft tissue operations will account for 18% of the work, whereas other abdominal and hernia operations will account for 15% and 14%, respectively. These percentages are similar between 2000 and 2020 (Figure 1).

When examining specific procedures, large increases are projected in the absolute number of operations performed. Laparoscopic cholecystectomies will increase by 26.0%, from 662000 in 2000 to 833000 in 2020.

Table 2. US Population Projections, 2000-2020*

<table>
<thead>
<tr>
<th>Age Group, y</th>
<th>2000 Population</th>
<th>2010 Population</th>
<th>Increase, †%</th>
<th>2020 Population</th>
<th>Increase, †%</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;15</td>
<td>58 554</td>
<td>59 445</td>
<td>1.5</td>
<td>64 500</td>
<td>10.2</td>
</tr>
<tr>
<td>15-44</td>
<td>120 750</td>
<td>121 113</td>
<td>0.3</td>
<td>125 749</td>
<td>4.1</td>
</tr>
<tr>
<td>45-64</td>
<td>61 167</td>
<td>79 590</td>
<td>30.1</td>
<td>80 946</td>
<td>32.3</td>
</tr>
<tr>
<td>≥65</td>
<td>34 837</td>
<td>39 715</td>
<td>14.0</td>
<td>53 734</td>
<td>54.2</td>
</tr>
<tr>
<td>Total</td>
<td>275 308</td>
<td>299 863</td>
<td>8.9</td>
<td>324 929</td>
<td>18.0</td>
</tr>
</tbody>
</table>

*Source: US Census Bureau. †Increase relative to 2000.
Likewise, colon resections will increase from 236,426 in 2000 to 336,200 in 2020, a growth of 42.0%. Inguinal hernia repairs and breast excisions will increase by 26.0% and 28.0%, respectively. Appendectomies will increase by 13.0% (Table 4). As a percentage of total work in 2020, laparoscopic cholecystectomy accounts for the largest portion, 17.9%. Colon resection accounts for the second-largest portion of work, 13.7%. These (top) 5 operations will constitute 50.0% of the operative work in 2020, slightly decreased compared with 56.0% of operative work in 2000 (Table 5).

WORKFORCE ANALYSIS

The effect of changes in the workforce on the projected workload per surgeon is shown in Figure 2. In the baseline scenario with a stable workforce size, the general surgery workload is projected to increase 14.7% by 2010 and 31.5% by 2020. If the total number of general surgeons increases by 100 each year, the workload per surgeon is projected to increase 28.6% by 2020. Similarly, if the total number of general surgeons increases by 200 each year, the workload per surgeon is projected to increase 26.0% by 2020. When examining the interim effects at the year 2010, there is almost no difference between the 3 scenarios (baseline, +100 surgeons annually, and +200 surgeons annually). Overall, increasing the number of general surgeons by 100 or 200 annually during the period of analysis (2000-2020) does not significantly alter the per surgeon workload projection.

In the next 20 years, the general surgery workload will increase at a rate that significantly exceeds population growth. Although the population will grow by 18.0% between 2000 and 2020, the workload of general surgeons will increase by 31.5%. The dramatic growth in the surgical workload is due to the aging of the population, a phenomenon that increases the amount of work above and beyond increases in population. The explanation for this is clear: older individuals are the primary consumers of general surgical care, and the number of older individuals is increasing much more rapidly than the overall population. Consequently, the general surgery workload will increase faster than population growth.

The large range (19.9%-40.3%) in workload increases among the 5 categories of operations illustrates the importance of demographic changes on the surgery workload. Operation categories in which rates of surgery for older individuals are higher than those of younger counterparts have the most rapid increases in workload. For example, the rate of GI surgery in persons 65 years and older is 5-fold higher than in those aged 15 to 44 years and 3-fold higher than in persons aged 45 to 64 years. As a result, the GI surgery workload is forecasted to increase 40% by 2020, faster than any other group of general surgical operations.

Despite the large increase in the amount of work, the overall profile of operations does not appear to change. The 5 operative categories will constitute approximately the same proportion of work in 2020 as in 2000. Similarly, the same top 5 operations represent most of the work in 2000 and 2020. However, small changes are noted in the individual contributions of each of the 5 operations (laparoscopic cholecystectomy, colon resection, appendectomy, inguinal hernia repair, and breast excision) and in the total (down from 56.0% in 2000 to 50.0% in 2020). Colon resection, which in individuals 65 years and older has a rate that is 17-fold higher than in those aged 15 to 44 years and 4-fold higher than in those aged 45 to 64 years, is the most rapidly increasing of the top 5 operations.

The aging of the population is not the only trend that will affect the workload of general surgeons. The major limitation of our study is the assumption that rates

Table 4. Forecasted Number of Operations

<table>
<thead>
<tr>
<th>Operation</th>
<th>2000</th>
<th>2020</th>
<th>Increase, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laparoscopic cholecystectomy</td>
<td>662,782</td>
<td>833,600</td>
<td>26.0</td>
</tr>
<tr>
<td>Colon resection</td>
<td>236,426</td>
<td>336,200</td>
<td>42.0</td>
</tr>
<tr>
<td>Appendectomy</td>
<td>289,742</td>
<td>328,000</td>
<td>13.0</td>
</tr>
<tr>
<td>Inguinal hernia</td>
<td>319,060</td>
<td>403,600</td>
<td>26.0</td>
</tr>
<tr>
<td>Breast excision</td>
<td>387,387</td>
<td>495,300</td>
<td>28.0</td>
</tr>
</tbody>
</table>

Figure 2. Sensitivity analysis showing the increase (percentage) in general surgery workload per surgeon relative to 2000. Solid line indicates baseline; dotted line, projected workload increases per surgeon if the workforce increases by 100 surgeons annually; and line of triangles, projected workload increases per surgeon if the workforce increases by 200 surgeons annually.

Table 5. Percentage of Total Work for the Top 5 Procedures

<table>
<thead>
<tr>
<th>Operation</th>
<th>2000</th>
<th>2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laparoscopic cholecystectomy</td>
<td>20.6</td>
<td>17.9</td>
</tr>
<tr>
<td>Colon resection</td>
<td>13.9</td>
<td>13.7</td>
</tr>
<tr>
<td>Appendectomy</td>
<td>8.1</td>
<td>6.4</td>
</tr>
<tr>
<td>Inguinal hernia</td>
<td>6.8</td>
<td>5.9</td>
</tr>
<tr>
<td>Breast excision</td>
<td>6.6</td>
<td>5.8</td>
</tr>
<tr>
<td>Total</td>
<td>56.0</td>
<td>50.0</td>
</tr>
</tbody>
</table>
of surgery will remain constant across time. Although a recent study by Shoemaker\textsuperscript{14} indicates a declining volume of procedures performed by general surgeons during the last decade, it examined only operations on patients older than 65 years. Its findings differ from those of similar studies showing that the workload per surgeon either remained the same or increased across time.\textsuperscript{15,16} Furthermore, rates of surgery have historically increased with time; this is especially true after the introduction of new technology that either expands the indications or lowers the threshold for surgery.\textsuperscript{17-22} When we analyzed California inpatient discharge data between 1990 and 2000, we found that the volume of cardiothoracic, vascular, and general surgery increased across time.\textsuperscript{21} Despite our assumption of stable rates of surgery, we believe that our baseline projection based on established patterns of utilization accurately forecasts growth in the general surgical workload. If rates of surgery change significantly, our projections may prove inaccurate. However, if rates of surgery increase with time as they have historically, our projections may actually be an underestimation.

The issue facing general surgeons is not simply workload but also the ratio of workload to workforce. We analyzed the effect of changes in the number of practicing general surgeons (including colorectal surgeons and surgical oncologists) on the growth in surgical work. Our sensitivity analysis showed that increasing the number of general surgeons only slightly blunts the projected increase in operative work per surgeon. Our baseline scenario projects a 31.5\% increase in general surgical work by 2020. A net increase of 100 general surgeons annually for the next 20 years, equivalent to a 10\% increase in the total size of the workforce across 20 years, would decrease this projection to 28.6\%. A net increase of 200 general surgeons annually for the next 20 years, equivalent to a 20\% increase in the total size of the workforce across 20 years, would decrease the projection to 26.2\%. On the basis of this analysis, increasing the number of general surgeons may not be the most effective solution.

Despite the forecasted increase in general surgery workload, there is good reason to believe that the effective size of the general surgery workforce will decrease in the future. First, recent articles have cited a crisis in general surgery training precipitated by a declining medical student interest in surgery.\textsuperscript{24-28} Although the open positions are eventually filled with foreign medical graduates, it is unclear whether this will translate into additional practicing surgeons. Longitudinal studies examining surgery residents have found that foreign medical graduates have an attrition rate 3 times that of US graduates.\textsuperscript{27} Second, the inability of general surgery to attract and retain individuals may not be limited to medical students. Boyarsky et al\textsuperscript{23} found that general surgery chief residents continue to seek subspecialization despite the perception that there is no longer a surplus of general surgeons. This finding concurs with other studies investigating the career paths of general surgery residents that indicate an increasing number of general surgery graduates seeking fellowship training.\textsuperscript{13} It appears that general surgery needs to become more attractive not only to medical students but also to its own graduates. Third, the number of women in surgery has been steadily increasing.\textsuperscript{28,29} Whereas the increasing number of women in surgery leads to improved diversity and versatility in the workforce, women tend to perform approximately 25\% fewer procedures than men.\textsuperscript{13} Given these reasons, it may be difficult for the general surgery workforce to meet workload demands by increasing the number of residency graduates or by working harder or longer.

In the next 20 years, methods to meet the increasing amount of general surgical work will be needed. One potential solution to address a surgeon shortage is the increased use of nonphysician clinicians (eg, physician assistants or nurse practitioners). The numbers of these health professionals have increased dramatically in the last 10 years, and they are commonly used in primary care roles.\textsuperscript{30} However, they are less commonly used in surgical specialties, and their role in surgical care is poorly defined. Research in this area may eventually lead to synergistic, cost-effective relationships between nonphysician health professionals and surgeons in the delivery of surgical care.

Two additional pertinent issues will affect general surgery in the near future. First, it is unknown what proportion of general surgery work is performed on an urgent or emergent basis. As the population ages, this proportion will certainly increase. How will general surgeons provide the necessary emergency coverage? It is important that the general surgical workforce be sufficient to meet the demands for elective services and still provide coverage for urgent conditions. If the network of professionals who provide general surgical care becomes stretched too thin, the result may be a public health problem. Second, although the 80-hour workweek is targeted primarily at postgraduate medical education, the potential for regulation of work hours for practicing surgeons is obvious. How this change would affect the ability of the surgical workforce to meet either current or future demands is unknown and merits further investigation.

In summary, this study specifically analyzes the future workload of general surgeons. We believe that our estimates accurately reflect an impending increase in general surgery workload. Because our baseline assumptions are relatively conservative, this forecast may in fact be an underestimation. Clearly, there will be a dramatic increase in workload in the next 20 years, largely a result of the aging US population. At the same time, the field of general surgery, poised to undergo a potentially significant reduction, is ill equipped to handle these demands. The challenge for general surgeons is to develop strategies to address this problem while maintaining the quality of care for our patients.

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REFERENCES


Correction

In the article titled “Seattle’s Harborview Medical Center, 1877-2003,” published in the January issue of the ARCHIVES (2004;139:14-15), there was a reference to a cover image that was incorrect. The article referred to an image of Harborview’s mobile intensive care unit, nicknamed “Moby Pig,” which was not pictured in the cover photograph. The journal regrets the error.