Long-Term Forecasting of Anesthesia Workload in Operating Rooms from Changes in a Hospital's Local Population Can Be Inaccurate

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BACKGROUND: Anesthesia department planning depends on forecasting future demand for perioperative services. Little is known about long-range forecasting of anesthesia workload.

METHODS: We studied operating room (OR) times at Hospital A over 16 yr (1991–2006), anesthesia times at Hospital B over 26 yr (1981–2006), and cases at Hospital C over 13 yr (1994–2006). Each hospital is >100 yr old and is located in a US city with other hospitals that are >50 yr old. Hospitals A and B are the sole University hospitals in their metropolitan statistical areas (and many counties beyond). Hospital C is the sole tertiary hospital for >375 km.

RESULTS: Each hospital's choice of a measure of anesthesia work to be analyzed was likely unimportant, as the annual hours of anesthesia correlated highly both with annual numbers of cases ($r = 0.98$) and with American Society of Anesthesiologist's Relative Value Guide units of work ($r = 0.99$). Despite a 2% decline in the local population, the hours of OR time at Hospital A increased overall (Pearson $r = -0.87$, $P < 0.001$) and for children ($r = -0.84$). At Hospital B, there was a strong positive correlation between population and hours of anesthesia ($r = 0.97$, $P < 0.001$), but not between annual increases in population and workload ($r = -0.18$). At Hospital C, despite a linear increase in population, the annual numbers of cases increased, declined with opening of two outpatient surgery facilities, and then stabilized. The predictive value of local personal income was low. In contrast, the annual increases in the hours of OR time and anesthesia could be modeled using simple time series methods.

CONCLUSIONS: Although growth of the elderly population is a simple justification for building more ORs, managers should be cautious in arguing for strategic changes in capacity at individual hospitals based on future changes in the national age-adjusted population. Local population can provide little value in forecasting future anesthesia workloads at individual hospitals. In addition, anesthesia groups and hospital administrators should not focus on quarterly changes in workload, because workload can vary widely, despite consistent patterns over decades. To facilitate long-range planning, anesthesia groups and hospitals should save their billing and OR time data, display it graphically over years, and supplement with corresponding forecasting methods (e.g., staff an additional OR when an upper prediction bound of workload per OR exceeds a threshold).

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Anesthesia department planning depends on forecasting future demand for perioperative services, over quarters of years, years, and many years.

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Forecasting workload from one quarter to the next has been studied in detail. For example, at one hospital, the total hours of operating room (OR) time for each specialty over a 4-wk period were forecasted 4 wk ahead from the data of the preceding 48 wk.[1,2] At another hospital, the hours of staffing required for each specialty on a day of the week were forecasted several weeks ahead from data of the preceding 36 wk.[2–4] Seasonal variation is usually absent,[1,2,4] and when present is typically very slight.[5,6] These forecasts are useful for staff scheduling, and can guide staff hiring.

Forecasting workload from 1 yr to the next can guide the allocation of additional OR block time. State and federal data can be used to evaluate whether a hospital is performing as many cases as expected of each specialty.[7–9] Results can be combined with hospital and group financial data for use in making annual budgetary decisions.[9–11]

Forecasting anesthesia group workload over many years is not well-developed. For regional and national planning, age-adjusted population has been used. Examples include reports of overall[12] and pediatric[13] per capita anesthetic rates and forecasts of workloads for pediatric, oncological, and general surgery from current per capita age-adjusted surgery rates.[14–17] "Per capita" refers to the amount of anesthesia delivered, divided by the population size. Population size alone is insufficient to predict the annual number of surgical procedures in a country or state. For example:

- Eastern Africa and Pakistan have lower per capita surgical rates than the wealthier United States of America (US) and Western Europe, not the same per capita rates.[18,19]
- National projections of US federal and private healthcare spending are based heavily on total national disposable personal income.[20]
- From 1929 to 2000, the number of active physicians in the US increased in proportion to the nation's gross domestic product (Pearson r = 0.97).[21]
- The number of physicians practicing in each US state correlates with the state's total personal income.[21]
- The annual increase in healthcare expenditure per capita of many US states is correlated with the increase in the gross domestic product per capita of the state.[22]
- The annual increase in the number of physicians per capita nationwide correlates with the annual increase in the gross domestic product per capita 5 yr previously and more strongly with the increase 10 yr previously.[23]

The lags of 5–10 yr are important for predicting workload.[24] Many years before an anesthesiologist cares for a patient, the community invested in bigger hospitals, investors developed surgery centers, and politicians expanded federal and state healthcare programs.

Not only is there a discrepancy between the use of current age-adjusted population-based statistical data[12–17] for long-term national[25] and regional forecasts despite the economic findings,[18,19,20–24] but also in the use of the age-adjusted population data for local decision-making. In our recent Internet search, there were hundreds of press releases by facilities explaining (justifying) their decisions to build "new operating rooms" on the basis of the "aging population" or "growing population." Thus, managers appear to be making decisions on the basis of what superficially seems reasonable, but which has not been shown to be valid scientifically. Our goal is to help anesthesia groups and administrators at surgical facilities make the best decisions possible.

We explore the relationship between changes in population and perioperative workloads at two US university hospitals and one US community hospital. Each hospital has an uncommon characteristic making it useful scientifically.

- Hospital A has OR information system data for a 16-yr period during which its regional population, including that of children and elderly, declined. We can therefore directly test the validity of forecasting perioperative workload from current (i.e., fixed) per capita age-adjusted surgery rates[14–17] and changes in local population.
- Hospital B has 26 yr of anesthesia billing data. With such a long time series (i.e., sequential list of annual workloads), its annual change in population can practically be compared with its annual change in workload. Having anesthesia data, different measures of workload can be compared (i.e., hours of anesthesia, American Society of Anesthesiologists' Relative Value Guide (ASA RVG) units of work, and numbers of cases).
- Hospital C is the only tertiary hospital within a 4 h drive (>375 km). The impact of other facilities[17] on the relationship between local population and caseload can be studied. The local population increased linearly over the 13-yr period studied. Two outpatient surgery centers opened in Hospital C's town during those years.

METHODS

Hospital A has continuous OR data from November 1990 through early 2007. This yielded complete information for the 16-yr period from 1991 to 2006. All data were electronically checked for consistency as soon as they were entered. Data from the hospital's anesthesia group was not stored from before 2001, and so were not used for our study. However, the dates at which each anesthesiologist started and stopped working were known. Studied annual counts of anesthesiologists were the number employed on October 1st of each year, ranging from 15 to 34 anesthesiologists. The hospital did not have nurse anesthetists.

Hospital B has continuous computerized anesthesia billing from December 1980 though early 2007. This yielded complete information for the 26-yr period from 1981 to 2006. We limited our study to anesthetics performed in the main and ambulatory ORs of the hospital. Data analyzed were the time of continuous anesthesia presence and the sum of the ASA RVG base and time units. The base units are measures of intensity of effort. Each time unit is 15 min of anesthesia.

Hospital C has recorded its numbers of cases in its sole surgical suite from June 1994 through May 2006.

To relate changes in hours of OR and anesthesia time to changes in population, the US Census Bureau's population estimates for years between decennial censuses were used. The local population of each hospital was considered that of its metropolitan statistical area.

For Hospital A, this was the hospital's county plus two of its coincident counties. For Hospital B, this was the hospital's county plus one of its coincident counties. For Hospital C, this was just the hospital's county. The US Office of Management and Budget sets the counties that contribute to each metropolitan statistical area.[27] By definition, "metropolitan Statistical Areas have at least one urbanized area of 50,000 or more population, plus adjacent [counties] that [have] a high degree of social and economic integration with the core as measured by commuting ties."[27] Hospitals A and B are the sole university hospitals in their area. They are both more than 100-yr-old, as are their cities' other hospitals. Hospital C is the sole tertiary hospital in its area. It is more than 100-yr-old. Its city's other private hospital is more than 50-yr-old.

The P values for the Pearson and Spearman correlation coefficients relating increases in population and workload were calculated by Monte-Carlo simulation to an accuracy ≤ 0.0001 (StatXact-7, Cytel Software Corporation, Cambridge, MA). One-sided P values were used because only positive correlation is relevant to the corresponding managerial decision-making. The Pearson correlation measures linear, or constant, change over time with normally distributed deviation from the trend line. The Spearman correlation measures nonlinear, but monotonic, change with nonnormally distributed deviation from the trend line.

We quantify pediatric surgery at Hospital A, because during the period studied, Hospital A started a successful fundraising campaign for a virtual pediatric hospital located within the current hospital, like the one at Hospital B for more than 50 yr. We considered patients to be "children" if they were $\leq$17 yr old and "elderly" if $\geq$65 yr old. We chose these age categories, because they correspond to the categories of the US Community Survey. Between 1990 and 2005, the percentages of the population that were children declined 0.6% and 0.7% in the counties of Hospitals A and B, respectively. The percentages of elderly increased 0.6% and 1.4%, respectively. These changes were sufficiently small that we limited our reported results to study of the changes in the overall population and pediatric population.

Over the study period, there has been an increase in the US national per capita rate of surgery.[28] We tested whether anesthesia groups and administrators can reasonably apply annual percentage changes in national surgical rates to forecast their local rates of change in workload. The ratio of annual hours of OR or anesthesia time to local population equals a rate that varies across years for Hospitals A and B, respectively. If a common annual percentage increase in the rate can be applied to both hospitals, then the logarithms of Hospitals A's and B's annual rates would have different intercepts but close to a common slope. The F-test was used to test whether the log of the per capita rates for the two hospitals were parallel over the 16 yr.[29] In other words, we tested for a difference in the least squares regression slopes while estimating different intercepts.[29] This analysis was performed using Systat 12 (SYSTAT Software, Inc., San Jose, CA).

The simplest time series model for the annual hours of OR or anesthesia time assumes that annual increases in workload follow a normal distribution and that each year's increase is not correlated to the increase of the year before (1-yr lag), 2 yr before (2-yr lag), and so forth. Such correlations within a time series are called autocorrelations. If present (contrary to our hypothesis), they would measure change in a cyclical pattern. The two-sided P values for the autocorrelations were calculated asymptotically (Systat 12). To make the annual increases in hours easier to interpret, they were divided by 250. Because most surgery is elective and there are approximately 250 workdays per year, a value of 8 h gives a rough estimate for the workload of one additional anesthesia provider (e.g., nurse anesthetist at Hospital B).

The increase in personal income of Hospital A's and B's metropolitan statistical area was correlated with the hospital's change in hours of OR or anesthesia time. Personal income was defined as the income received by persons from all sources, mostly wages (salaries), but also proprietors' income, personal dividend and interest income, etc.[30] We expected income to affect workload 7 yr later, based on the results of Refs. 23 and 24 (see Introduction). Personal incomes were adjusted for inflation using the US regional annual consumer price indices.

RESULTS

The particular measure of work that was used to forecast the long-term trend in anesthesia workload at each hospital can be unimportant based on our findings of concurrent validity. Although the data at Hospital A were annual hours of OR time, there was a strong correlation with the numbers of anesthesiologists working in ORs (Pearson $r = 0.88$, $P < 0.001$). At Hospital B, the annual hours of anesthesia were strongly correlated with the annual numbers of cases (Pearson $r = 0.98$, $P < 0.001$) and with ASA RVG units (Pearson $r = 0.99$, $P < 0.001$) (Fig. 1). Although there was a statistically significant decline in the average number of base units per case (Pearson $r = -0.86$, $P < 0.001$; Spearman $r = -0.73$, $P < 0.001$), the magnitude of the decline over the 26 yr was small (average 7.9 U in the first 3 yr vs 6.2 U in the last 3 yr). Likewise, although there was a statistically significant increase in the average hours of anesthesia per case (Pearson $r = 0.59$, $P = 0.003$; Spearman $r = 0.54$, $P = 0.003$), the magnitude of the increase over the 26 yr was also small (average 2.5 h in the first 3 yr vs 2.8 h in the last 3 yr).

There was no value in predicting anesthesia workload at the three hospitals using the model of a constant per capita surgical rate multiplied by a changing local population. At Hospital A, this would

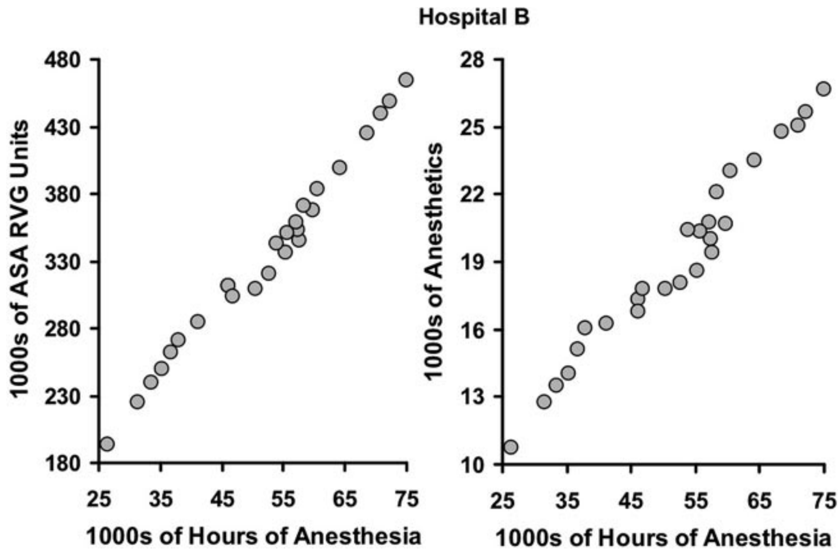

Figure 1. Strong positive correlation between different measures of anesthesia workload at Hospital B over the 26 yr from 1981 to 2006. The annual hours of anesthesia time are related to the annual American Society of Anesthesiologists' Relative Value Guide (ASA RVG) units of work (left) (Pearson r = 0.99) and numbers of cases (right) (Pearson r = 0.98) (both $P < 0.001$).

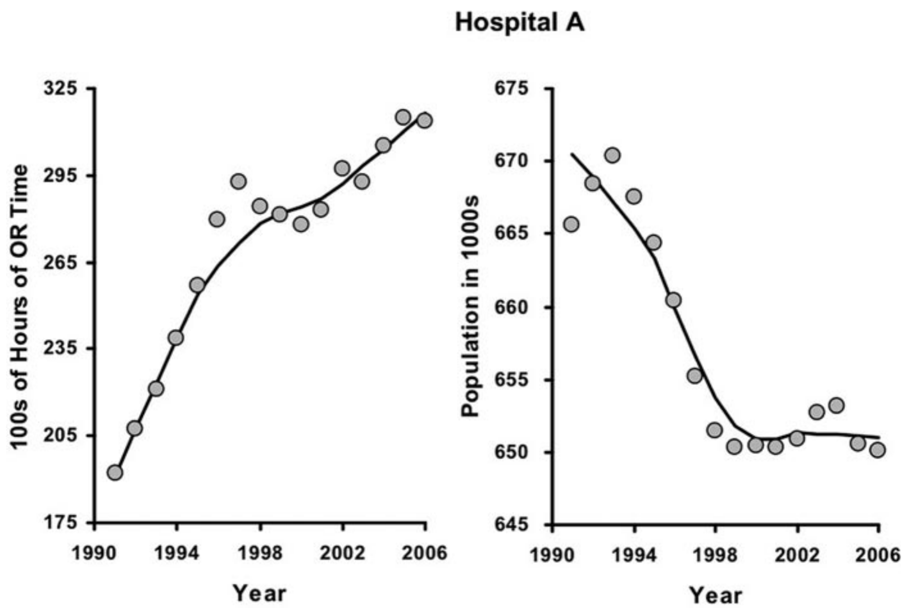

Figure 2. Inverse relationship between the local population and the hours of operating room (OR) time at Hospital A over the 16 yr from 1991 to 2006. Despite a 2% decline in population, there was an increase in the hours of OR time (Pearson $r = -0.87$, $P < 0.001$; Spearman $r = -0.68$, $P = 0.002$). The LOWESS lines in the figure were drawn with tensions of 0.6 (Systat 12).

be true even including lags of several years, since there was an inverse correlation between the local population and hours of OR time (Figs. 2 and 3). Despite a 2% decline in the population, there was an increase in both overall OR time (Pearson $r = -0.87$, $P < 0.001$; Spearman $r = -0.68$, $P = 0.002$) and pediatric OR time (Pearson $r = -0.84$, $P < 0.001$; Spearman $r = -0.96$, $P < 0.001$). Regardless of how time-invariant per capita surgical rates were calculated, forecasts from the first 10 yr would predict declines in the hours of OR time proportional to the curves on the right in Figures 2 and 3, unlike the actual increases on the left, because the age distributions of the population hardly changed during the studied years. At Hospital B, there was a positive correlation between the local population and the total anesthesia time (Pearson $r = 0.97$, $P < 0.001$; Spearman $r = 0.97$, $P < 0.001$) (Fig. 4). However, this relationship was not of incremental predictive value versus a linear trend (i.e., was probably not causal), since the annual increase in workload was correlated neither with the year (Pearson $r = -0.10$) nor with the annual increase in population (Pearson $r = -0.18$) (Fig. 5). At Hospital C, the annual numbers of cases increased, declined with opening of two outpatient surgery facilities, and then stabilized, despite a linear increasing trend in population (Fig. 6).

Although trends in national per capita surgical rates[28] are available to anesthesia groups and administrators, their application to forecasting local changes in anesthesia group workload can cause much error. Because Hospital A's local population declined and yet its hours of OR time increased, there was a progressive increase in its ratio of hours of OR time to local population (i.e., in its per capita perioperative workload). Over 16 yr, Hospital A's per capita hours of OR time increased 180% whereas Hospital B's per capita hours of anesthesia increased 25% ($F(2,28)$ =

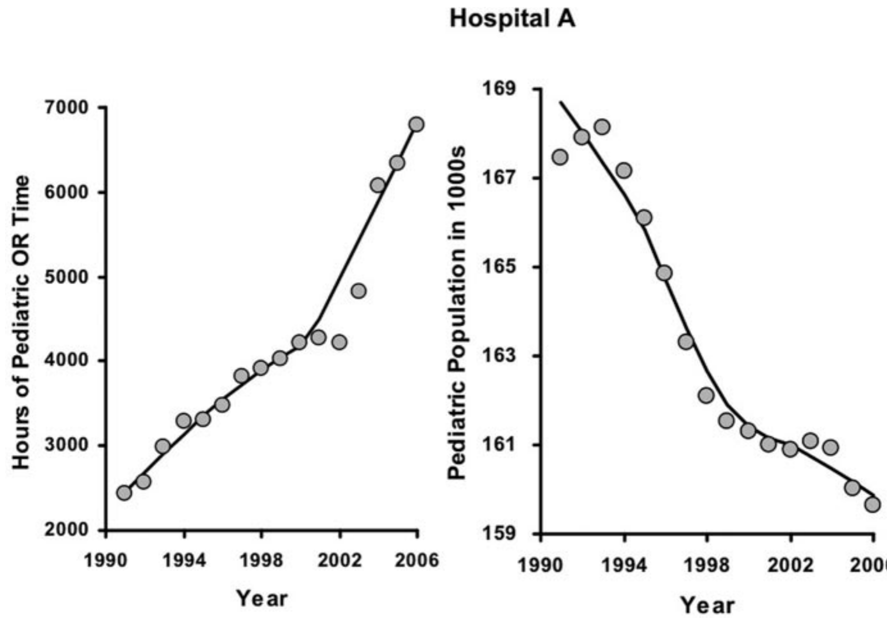

Figure 3. Inverse relationship between the numbers of children (≤17 yr) in the metropolitan statistical area (right panel) and the hours of operating room time (left panel) at Hospital A from 1991 to 2006. The Pearson $r = -0.84$ and Spearman $r = -0.96$ (both $P < 0.001$). The LOWESS lines were drawn with tensions of 0.6 (Systat 12).

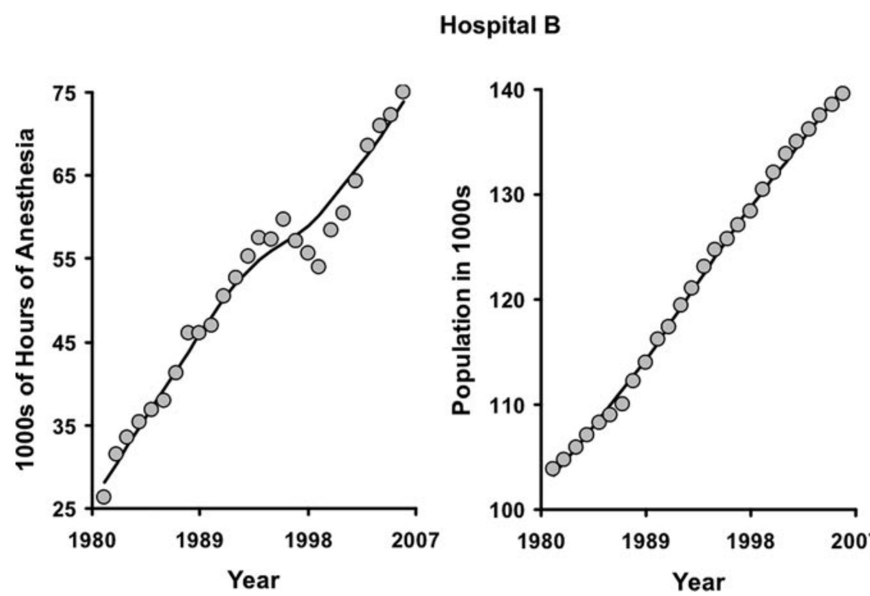

Figure 4. Strong positive correlation between the local population and the hours of anesthesia at Hospital B over the 26 yr from 1981 through 2006. The Pearson $r = 0.97$ ($P < 0.001$) and Spearman $r = 0.97$ ($P < 0.001$). The LOWESS lines were drawn with tensions of 0.6 (Systat 12). Despite a progressive increase in the numbers of elderly (≥65 yr) in the region around Hospital B, the percentage of residents who are elderly increased by only 1% from 1990 to 2005. Thus, separate figures are not presented for the elderly, because the results were virtually identical to those shown in this figure.

42.3, $P < 0.001$). Furthermore, results for Hospital C show that growth both in per capita surgical rates and in local population does not assure growth in anesthesia workload, because of the simultaneous decisions of other facilities (Fig. 6).

The predictive value of local personal income was low. There were strong positive correlations between local personal income 7 yr previously and Hospital A's OR time (Pearson $r = 0.95$, $P < 0.001$; Spearman $r = 0.94$, $P < 0.001$) (Fig. 7) and Hospital B's anesthesia time (Pearson $r = 0.93$, $P < 0.001$; Spearman $r = 0.97$, $P < 0.001$). There was also a statistically significant, albeit weak, positive correlation between annual increases in personal income 7 yr previously and increases in Hospital A's OR time (Pearson $r = 0.57$, $P = 0.012$; Spearman $r = 0.51$, $P = 0.026$) (Fig. 7). However, this association was not evident for Hospital B (Pearson $r = 0.13$, $P > 0.27$; Spearman $r = 0.16$, $P > 0.21$). The 7-yr lag was the most predictive lag studied (i.e., there were lower correlations for the five other choices between the 5- and 10-yr lags mentioned in the Introduction).

The hospitals' historical data were more useful for long-term forecasting of their workloads. For Hospitals A and B, there was a close to constant annual increase in the hours of OR and anesthesia time, respectively (Figs. 2 and 4). In addition, the deviations from a straight line were close to normally distributed (Lilliefors' test for normal distribution: $P = 0.13$ for Hospital A and $P = 0.44$ for Hospital B; autocorrelations: Hospital A's $r = 0.37$ for 1-yr lag and $r \leq 0.29$ for 2–10 yr lags, all $P > 0.17$; Hospital B's $r = 0.20$ for 1-yr lag and $r \leq 0.22$ for 2–10 yr lags, all $P > 0.26$). For Hospital C, the decline in caseload progressively stabilized (Fig. 6).

Although the total hours of OR time increased linearly over time at Hospital A (Fig. 2), the workload for each specialty did not (Fig. 8). Short-term forecasts

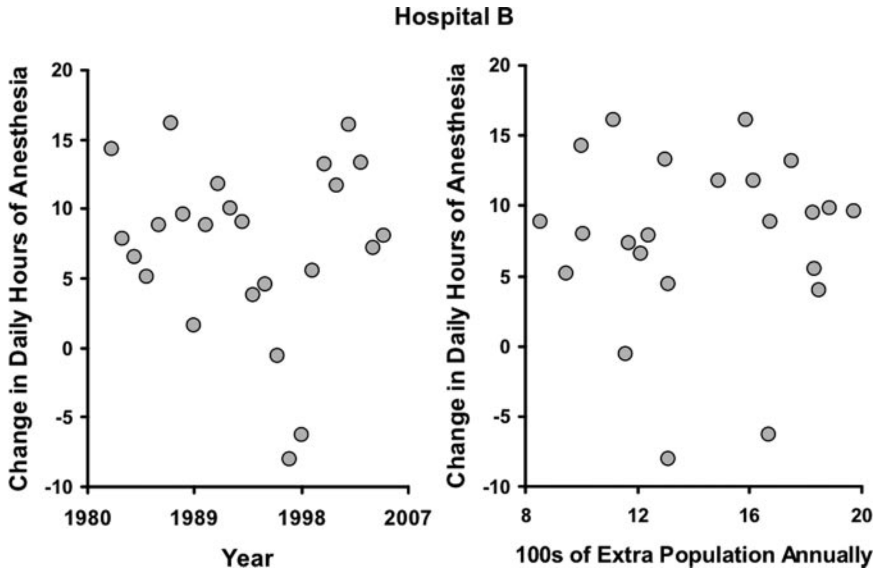

Figure 5. Lack of correlation between annual increase in hours of anesthesia time at Hospital B and year (left) or increase in local population (right). Comparison of these results with those shown in Figure 4 highlights that the hospital's anesthesia group and hospital administrators should not make decisions based on the assumption that growth in local population is correlated with growth in perioperative workload, and *vice versa*. Overlaps of the plotted data were reduced by slightly jittering those in the left and right panes vertically and horizontally, respectively. Although the Pearson correlations ($r = 0.10$, left; $r = 0.18$, right) were calculated using sequential differences to match the time series analysis (if linear, then change is constant), the values plotted are the second-order accurate estimates of the derivatives. To make the annual increases in hours easier to interpret, the difference of each year's total hours from that of its preceding year was calculated and then divided by 250. Because most surgery is elective and there are approximately 250 workdays per year, a value of 8 h gives a rough estimate for the workload of one additional anesthesia provider (e.g., nurse anesthetist at Hospital B). The 50th percentile of the annual increase was 8 h, roughly the workload of one additional anesthesia provider per day. However, the spread (80th percentile) was from no increase to nearly two additional providers per day, highlighting the importance of not over-interpreting results for any 1 yr.

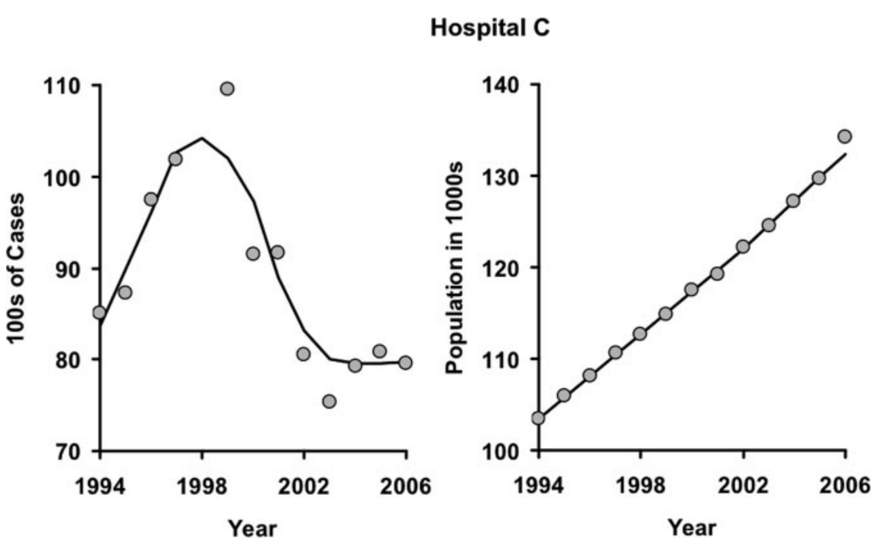

Figure 6. Non-monotonic relationship between the local population and the annual numbers of cases at Hospital C over the 13 yr from 1994 to 2006. The LOWESS lines in the figure were drawn with tensions of 0.6 (Systat 12). Suppose that a time invariant per capita surgical rate was calculated, whether with national data, local data, or some weighted combination. Then, from the panel on the right, the forecast of caseload over time would be linearly increasing. However, reality was that on the left, presumably caused by the outpatient surgery centers.

are made by specialty,[1,3,4,7–9] but longer term forecasts are affected by technological change. For example, the hours of OR time for cardiothoracic surgery progressively increased during the 1990s and then progressively declined. As the cardiac surgery workload declined, the number of cardiothoracic surgeons at the hospital declined. However, the workload of other specialties increased, resulting in an overall smooth increase in workload over time (Fig. 2). Hospital A, like others, has a highly diversified OR workload, resulting in lack of sensitivity to seasonal variation or trends in any one subspecialty.[2,31] In the absence of the introduction of another facility (Fig. 6), estimation of total anesthesia requirements may be straightforward (Figs. 2–5), but not estimation of the capacity requirements for any particular specialty.

DISCUSSION

Many administrators and anesthesia groups rely at least qualitatively on forecasts of local population to predict long-term changes in OR workload. We

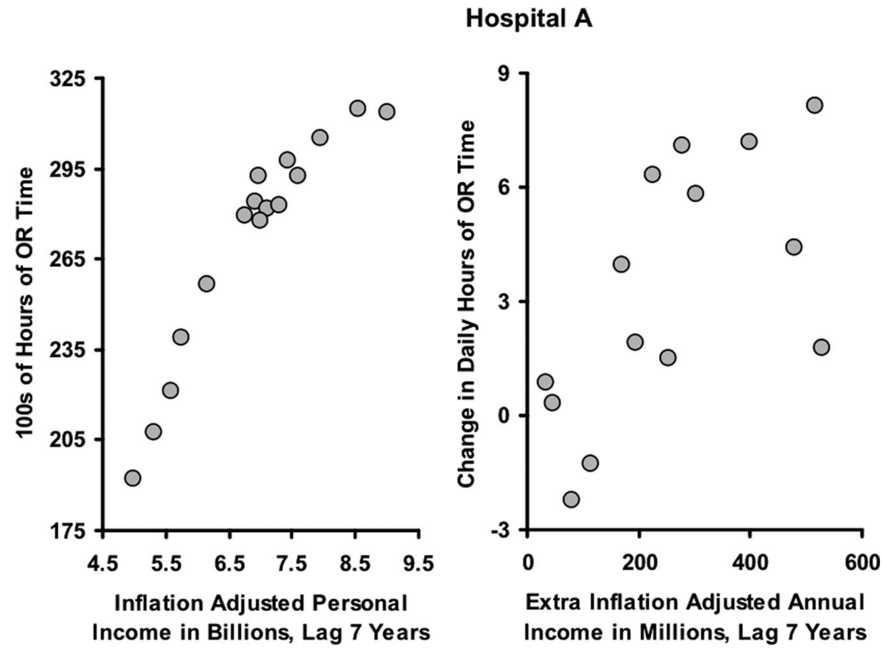

Figure 7. Strong positive correlations between local personal incomes 7 yr previously and hours of operating room (OR) time at Hospital A (left), but weak though statistically significant correlation between the annual increases in personal incomes and OR time (right). To the left, Pearson $r = 0.95$ ($P < 0.001$) and Spearman $r = 0.94$ ($P < 0.001$). To the right, Pearson $r = 0.57$ ($P = 0.012$) and Spearman $r = 0.51$ ($P = 0.026$). The value of −$30 million in 2001 was deleted from the graph to the right. The data in the left pane were jittered slightly horizontally to reduce overlaps of plotted data. Although the correlations were calculated with sequential differences to match the time series analysis, the values plotted in the right pane are the second-order accurate estimates of the derivatives.

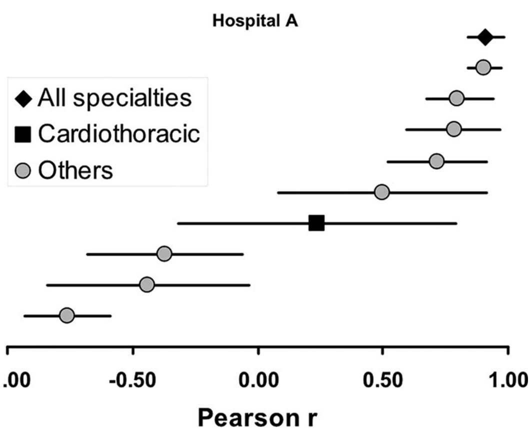

Figure 8. Although total hours of operating room (OR) time increased close to linearly over the 16 yr studied at Hospital A, the workload for each specialty did not. The Pearson correlation coefficients (r) for the hours of OR time and year are shown with their asymptotic confidence intervals (StatXact-7). The "All specialties" are the data shown in Figure 2. The hours of OR time for cardiothoracic surgery progressively increased during the 1990s and then progressively declined, but by 2006 had a workload exceeding that of 1991, resulting in a positively valued correlation coefficient ($r = 0.23$). The 10 specialties plotted in the figure were the specialties with averages of at least 250 h of OR time used per year.

showed that such methods were highly inaccurate at three hospitals. Each hospital should consider, instead, plotting its trend in past workload to predict its future workload.

Our results are likely irrelevant to national healthcare policy, but applicable to decision-making of individual anesthesia groups. Managers should consider our results during meetings at which participants are making the tacit, but false, assumption that increases in local population will drive increases in local anesthesia workload, and *vice versa*. Although growth of the elderly population is often used as a simple justification for building more ORs, managers should be extremely cautious in making capacity decisions at individual hospitals based on future national changes in the age-adjusted population. Not only can population and workload be negatively correlated (Figs. 2 and 3), but even for hospitals at which they have been positively correlated, the relationship is not necessarily causal (Figs. 4 and 5). The introduction of facilities nearby can offset the effect of a growth in population (Fig. 6).

Our results emphasize that anesthesia groups should save their billing data and hospitals should save their OR information system data. Because anesthesia groups' financial strength depends on their operational decisions, transactional data (e.g., each case's start and stop times for case duration and specific room for turnover time) are needed for good strategic decision-making. Some hospitals (e.g., Hospitals A and B) may be fortunate and have a nearly constant annual rate of growth (i.e., one year's prediction determining the next year's prediction) and normally distributed variations from the trend line.

Previously described methods for forecasting OR time by specialty were designed for forecasting appropriate staffing several months ahead.[1–4] The techniques were valid and useful despite not incorporating trend, an aspect that we can now explain. Average annual increases in hours of OR time were 3.3% at Hospital A (Figs. 2 and 7) and in hours of anesthesia were 2.7% at Hospital B (Figs. 4 and 5). These changes represent trends in workload of just 0.6% and 0.4%, respectively, every other month. In contrast, there is routinely variability in workload exceeding 6.0% among days of the week. Thus, the trends in workload among studied forecast periods are of irrelevant magnitude when compared with the variability of data within each period.

The 3.3% and 2.7% average annual percentage increases in workload at the two hospitals were not noticeably different from national rates for inpatient and outpatient surgery in the US and France. There was a 2.5% per capita annualized rate of growth of surgical procedures in the US between 1980 and 1995.[28] There was a 4.6% per capita annualized rate of growth of anesthetics in France between 1980 and 1996.[12]

Some anesthesia groups tell us that they forecast their future workload based on the hiring plans of local surgical groups. However, the addition of surgeons does not cause an increase in anesthesia workload unless the lack of surgeons is the bottleneck to growth and there are no other bottlenecks such as full intensive care units.[7–11] Whether forecasting months in advance for staffing decisions,[1,3–6] a yr in advance for block time budgetary decisions,[7–9] or several years in advance for strategic decisions (Figs. 2–4 and 6), study results suggest that hospitals should start its forecasting of future workload by using its historical and current workload. The decision to staff an additional OR can be made by calculating the overall hours of OR and anesthesia time during each of the preceding 12 four-week periods.[1] From the mean and standard deviation of the $N = 12$ values, staff another OR if an upper prediction bound (e.g., 80%) on future workload exceeds some undesirable threshold (e.g., 8 h).[1]

Our study was limited by our lack of understanding of the role that economic policy plays in anesthesia workload (see Introduction). Ironically, a recent study showed a strong correlation between annual increases in healthcare expenditure per capita and gross domestic product per capita in the state where Hospital B is located, but not in the state where Hospital A is located,[22] which is the opposite of the findings of the current study. Our finding of no correlation between changes in local personal income and anesthesia workload for Hospital B highlights that the relationships between personal income and anesthesia workload are complicated and/or multifactorial. The results for Hospital C suggest that the impact of other facilities' managerial decisions and the chance of there being new facilities need to be included in the model.[27] Although in any given year the effect of another facility on a hospital's workload for a specialty can be quantified,[7,27] we are not aware of such methods being modified for longitudinal use. Perhaps the impact of patients' demands for healthcare on the supply of surgery also needs to be included in the model.[25]

In conclusion, our study led to several important findings. First, although monthly, quarterly, or even annual reports can give the impression that growth in OR and anesthesia workloads vary markedly (Fig. 5), they can remain strikingly consistent over longer periods (Fig. 4). Second, even though local population statistics are useful for comparing workloads among hospitals,[7–9] changes in local population can be highly inaccurate in forecasting future anesthesia workloads at individual hospitals (Figs. 2–5). Third, archiving and periodically analyzing anesthesia billing data or OR information system data are simple and useful tools for long-range forecasting of service demand and for facilities planning.

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