

# Predicting Future Staffing Needs at Teaching Hospitals

## *Use of an Analytical Program With Multiple Variables*

Christine C. Mitchell, MS; Stanley W. Ashley, MD; Michael J. Zinner, MD; Francis D. Moore, Jr, MD

**Objective:** To develop a model to predict future staffing for the surgery service at a teaching hospital.

**Setting:** Tertiary hospital.

**Interventions:** A computer model with potential future variables was constructed. Some of the variables were distribution of resident staff, fellows, and physician extenders; salary/wages; work hours; educational value of rotations; work units, inpatient wards, and clinics; future volume growth; and efficiency savings.

**Outcomes:** Number of staff to be hired, staffing expense, and educational impact.

**Results:** On a busy general surgery service, we estimated the impact of changes in resident work hours, service growth, and workflow efficiency in the next 5 years. Projecting a reduction in resident duty hours to 60 hours

per week will require the hiring of 10 physician assistants at a cost of \$1 134 000, a cost that is increased by \$441 000 when hiring hospitalists instead. Implementing a day of didactic and simulator time (10 hours) will further increase the costs by \$568 000. A 10% improvement in the efficiency of floor care, as might be gained by advanced information technology capability or by regionalization of patients, can mitigate these expenses by as much as 21%. On the other hand, a modest annual growth of 2% will increase the costs by \$715 000 to \$2 417 000.

**Conclusions:** To simply replace residents with alternative providers requires large amounts of human and fiscal capital. The potential for simple efficiencies to mitigate some of this expense suggests that traditional patterns of care in teaching hospitals will have to change in response to educational mandates.

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**R**EPLACING RESIDENTS OR restructuring hospital care incurs substantial costs that are not specifically funded in conjunction with the duty hour and educational mandates of the past several years. This article attempts to estimate the large magnitude of these expenses. Teaching hospitals have relied heavily on their resident staff to meet their service needs. Nowhere has this been more prominent than in surgery, where trainees are traditionally expected to have a significant service responsibility in exchange for the privilege of participating in the operating room (OR), in effect, a contract to exchange service for training. Recently, however, various forces have altered this contract. The most dramatic has been the impact of work hour reduction for residents. After legislatively mandated duty hour restrictions in New York,<sup>1</sup> the Accreditation Council for Graduate Medical Education (ACGME) adopted national requirements for resident duty hours

that went into effect in July 2003.<sup>2</sup> This change forced many teaching institutions to restructure their staffing, most often by adding physician extenders to replace service hours formerly supplied by resident staff. There is every reason to believe that work hours will be further reduced, and it seems likely that the relatively modest current restrictions on work hours will be increased.

In addition, other forces are driving changes in both the nature and structure of surgical residencies.<sup>3</sup> Among these are the explosion of knowledge in all surgical fields, new technologies for teaching and assessing surgical skills and for performing surgery, evolution toward multidisciplinary collaborations in patient care, progressive and earlier subspecialization, concern for quality and safety of patient care, emphasis on professionalism and competency, and higher expectations of patients. These trends prioritize educational activities over service needs. Implementation of these educational ac-

**Author Affiliations:**  
Department of Surgery, Brigham and Women's Hospital, Harvard Medical School, Boston, Mass.

tivities will mean that teaching hospitals need strategies to replace other traditional resident service functions.

For most institutions, planning for such change presents a practical dilemma. While there is a general consensus on what the future holds, resources are limited and criteria for prioritization are not immediately obvious. To help us rationalize components of this change, we developed a relatively simple computerized model to permit fiscal planning and the prediction of future staffing needs.

## METHODS

### OVERVIEW

A Microsoft (Microsoft Corporation, Redmond, Wash) Excel-based model projected personnel requirement (full-time employee or FTE) and costs (salaries plus fringe benefits) related to changes in work hours, service growth, and workflow in the next 5 years. The model included 7 major factors: number and work hours for each level of resident and fellow, moonlighter, and physician extender; wages, fringe benefits, and inflation rates; staffing type preference; volume and anticipated service growth; workflow efficiency savings; option to eliminate moonlighters; and option to use adjusted staffing ratios to project staffing needs.

The level of current staffing and work hours were gathered from divisional records and interviews. The volume for each service was determined by departmental records of operative relative value units, average hospital census and length of stay, and clinic visit data. The distribution of work effort—OR vs floor vs clinic—varied by service and by seniority in the residency and fellowship programs and was estimated based on polling of the faculty. The residents' poll was used to estimate the educational value of each rotation. With the exception of nonoperating rotations, the residents' estimate of educational value correlated linearly with the attending physicians' estimates of the amount of time residents spent in the OR. Salaries for residents, fellows, and physician extenders were based on historical trends.

The model, initially based on staffing patterns of the Surgery Services at the Brigham and Women's Hospital, can project staffing needs for any resident-covered hospital service.

### DETAILED CALCULATIONS, DATA SOURCES, AND ASSUMPTIONS

The model projected future staffing needs and costs based on current staffing ratios for ORs, inpatient wards, and clinics. Staffing ratios are the quotient of clinical volume and staff hours. Any changes affecting the volume or staff hours would result in a shortage or surplus in workforce.

Current volume for the 3 locations, as measured in relative value units, patient days, and visits, was gathered from internal clinical and billing information systems. Only activities billed under faculty physicians were included. Staffing shortage owing to service growth were calculated based on multiyear planning projections and current staffing ratios.

Annual staff hours for each location are the product of the number of providers, their work hours over 48 weeks, and the percentage of their time spent at each location ("distribution"). Staff hours included those of residents, ACGME fellows, and substitute providers such as moonlighters, non-ACGME fellows, physician assistants (PAs), nurse practitioners (NPs), and registered nurses (RNs). Current work hour assumptions are 80 hours for residents and fellows, 50 hours for PAs, and 40 hours for NPs and RNs per week. Work hours are

adjustable each year hereafter. Current staff distribution, also adjustable each year hereafter, was gathered from faculty, administrators, and team leaders. For our general surgical services, the distribution is as follows: depending on their postgraduate year and the rotation, residents spend 18% to 82% of their time in the OR and most of the remainder of their time in the inpatient wards; fellows spend 80% of their time in the OR and 20% in the inpatient wards; PA distribution varies widely by subspecialty across all 3 locations, while NPs and RNs are mostly in the clinic.

In addition to service growth, work hour, and distribution changes, the model also allows for 2 primary adjustments to the current staffing ratios. First is the modification of current staff hours by the amount perceived to be critically understaffed or overstaffed to generate preferred staffing ratios. The adjustment option is turned on or off in the model by using 1 or 0 as the multiplier. If the option were selected ("1"), the model first would hire or dismiss staff to achieve the preferred staffing level before using the preferred staffing ratios to project future staffing needs. To gauge actual staffing need, the model assumed that managers could recruit, dismiss, or relocate staff to achieve preferred staffing levels.

Another available adjustment to the current staffing ratios is the efficiency factor. Whether used alone or with the preferred staffing adjustment, the efficiency factor reflected the percentage of savings in staff hours anticipated via workflow improvements. Although the efficiency factor can be applied in any given year, we chose fiscal year 2009 for scenario 3 in the "Results" section, because shortly before that a new clinical space will become available at Brigham and Women's Hospital, providing us with an opportunity to decompress and reorganize services to enhance workflow. Similar to the preferred staffing adjustment, the on/off feature is used to juxtapose 2 hypothetical scenarios with or without efficiency improvements.

Staffing shortage resulting from all aforementioned changes was then totaled for all locations. Before converting staffing needs from hours to FTEs and calculating salaries plus fringe benefits, the model required input on staffing preference for each location. Staffing types included hospitalists, fellows, PAs, NPs, and RNs. For example, a manager might prefer to fill vacancies in the inpatient ward with 50% PAs and 50% hospitalists because of limited PA availability in the hiring market. According to the staffing preference, the model then estimated the impact of hypothetical changes based on the following 2006 new hire compensation and work hour assumptions: salaries of residents and fellows ranging from \$47 000 to \$61 507, PAs at \$90 000, RNs at \$110 000, NPs at \$125 000, and hospitalists at \$150 000. These amounts can be adjusted as needed. Annual compensation increased 3% per year and fringe benefits were estimated at 28% of the compensation. In addition to work hours mentioned before, the model assumed a 60-hour work week for hospitalists.

## RESULTS

For a general surgical service with 20 residents and 4 ACGME fellows that is in compliance with the ACGME standards for resident education, we used the model to estimate the financial impact of 4 hypothetical types of future change, "scenarios 1 to 4." The model also predicted how many, what type, and when additional personnel would need to be hired, based on local conditions of salaries and work hours (data not presented). With the exception of scenario 3, all changes would take effect in year 1. In each case, the expenses reflect a total of 5 years of change.

**Table 1. Scenario 1: Effect of Increasing Resident Didactic Activities on Personnel Expense\***

Didactic Activity, h/wk	Clinical Work, h/wk	Efficiency Factor, %	Volume Growth, %	Expense if Replaced by PAs, \$	Expense if Replaced by NPs, \$	Expense if Replaced by Hospitalists, \$
2	78	0	0	113 000	197 000	158 000
5	75	0	0	284 000	492 000	394 000
10	70	0	0	567 000	985 000	788 000
15	65	0	0	851 000	1 477 000	1 182 000
20	60	0	0	1 134 000	1 969 000	1 575 000

Abbreviations: NP, nurse practitioner; PA, physician assistant.

\*Total expenses in 5 years.

**Table 2. Scenario 2: Effect of Reducing Resident Work Hours on Personnel Expense\***

Didactic Activity, h/wk	Clinical Work, h/wk	Efficiency Factor, %	Annual Volume Growth, %	Expense if Replaced by PAs, \$	Expense if Replaced by NPs, \$	Expense if Replaced by Hospitalists, \$
10	70	0	0	567 000	985 000	788 000
10	65	0	0	851 000	1 477 000	1 182 000
10	60	0	0	1 134 000	1 969 000	1 575 000
10	55	0	0	1 418 000	2 462 000	1 969 000
10	50	0	0	1 702 000	2 954 000	2 363 000

Abbreviations: NP, nurse practitioner; PA, physician assistant.

\*Total expenses in 5 years.

In scenario 1, the 80-hour work week is maintained, but 2 to 20 hours of mandatory didactic time away from inpatient clinical care is subtracted from the 80 hours of patient care. The estimated 5-year cost for the introduction of didactic time and replacement of care hours ranges from \$113 000 for 2 hours for PAs to \$1 969 000 for 20 hours for NPs (**Table 1**). In each case, PAs were the least expensive workforce, followed by hospitalists, and then by NPs (work hours constrained by union contracts). The overall cost greatly increases when one adds other resident surgery services into this analysis such as neurosurgery, cardiac surgery, and thoracic surgery, which results in department-wide estimates that we have not attempted for this article.

In scenario 2, in addition to 10 hours of didactic time, overall work hours are decreased from 75 to 60 hours per week. The estimated 5-year cost to the team of 20 residents and 4 fellows ranges from \$851 000 for replacement of lost care hours because of a 75-hour week with PAs to \$2 954 000 for replacement of lost care hours because of a 60-hour week with NPs (**Table 2**).

In scenario 3, the lost clinical work hours because of a 60-hour work week are ameliorated by increasing the efficiency of clinical work in the third year of analysis. A 10% improvement in efficiency of care reduces the costs of replacing resident clinical care with NPs to \$2 349 000, a savings of \$700 000 (**Table 3**). Such an efficiency improvement saves \$350 000 when resident work is replaced by PAs and \$350 000 when residents are replaced by hospitalists.

In scenario 4, no efficiencies could be achieved. Hospital surgical volume also increased. In this case, even modest increases in surgical volume greatly magnified the expense of replacing resident clinical care with other

providers, reaching as high as \$6 000 000 for the 5-year period (**Table 4**).

#### COMMENT

The advent of work hour restrictions was widely criticized by surgeons and surgical educators for its potential negative effect on trainee caseload and contact with the full diversity of surgical issues. Residents have also been voicing the same concern, and we are now witnessing further increases in applications to postgraduate fellowships, augmenting an already established trend. Hospitals for the most part have provided the necessary resources. However, with the projected changes, hospitals may begin to balk as the costs for caring for surgical patients soar with additional staffing requirements. In addition, the implicit contract between residents and hospitals will be broken, raising the possibility of tuition payments for training in surgery. For instance, in scenario 1, a surgery service of moderate size will cost its institution an additional \$1.6 million over 5 years to maintain a constant level of care if anticipated educational mandates were implemented. In scenario 4, the worst-case scenario, with educational mandates, work hour reductions, volume increases, and administrative inefficiencies, our model predicts that these costs could soar to \$5 million, depending on the type of staff hired to replace the residents. In every scenario, PAs provide the least expensive solution and NPs the most expensive, because of Boston salary and work hour standards.

In addition to the aforementioned 4 scenarios, the model can accommodate virtually any local conditions

**Table 3. Scenario 3: Effect of Improved Service Efficiency on Personnel Expense\***

Didactic Activity, h/wk	Clinical Work, h/wk	Efficiency Factor, %	Annual Volume Growth, %	Expense if Replaced by PAs, \$	Expense if Replaced by NPs, \$	Expense if Replaced by Hospitalists, \$
10	50	0	0	1 702 000	2 954 000	2 363 000
10	50	5	0	1 527 000	2 652 000	2 121 000
10	50	10	0	1 353 000	2 349 000	1 879 000
10	50	15	0	1 179 000	2 046 000	1 637 000
10	50	20	0	1 004 000	1 744 000	1 395 000

Abbreviations: NP, nurse practitioner; PA, physician assistant.  
\*Total expenses in 5 years. Improved efficiency starts in year 3.

**Table 4. Scenario 4: Effect of Volume Increase and Work Hour Reduction on Personnel Expense\***

Didactic Activity, h/wk	Clinical Work, h/wk	Efficiency Factor, %	Annual Volume Growth, %	Expense if Replaced by PAs, \$	Expense if Replaced by NPs, \$	Expense if Replaced by Hospitalists, \$
10	50	0	0	1 702 000	2 954 000	2 363 000
10	50	0	1	2 052 000	3 563 000	2 850 000
10	50	0	2	2 417 000	4 196 000	3 357 000
10	50	0	3	2 797 000	4 856 000	3 885 000
10	50	0	5	3 604 000	6 257 000	5 006 000

Abbreviations: NP, nurse practitioner; PA, physician assistant.  
\*Total expenses in 5 years.

or projections with any combination of current and future staffing types, work hours, location distribution, salary, productivity measurement, efficiency savings, and service growth. As variables are adjusted to reflect unique aspects of programs or market trends, the model shows the impact of the changes immediately on the same screen numerically and graphically. The model provides an annual and a 5-year cumulative view; the latter is preferred when the timing of changes is uncertain or when services have different thresholds for hiring a 0.5 FTE or 1 FTE. Taking it 1 step further, hospital leaders can also use this model to compare current service staffing ratios and to determine whether a service is overstaffed or understaffed relative to other services in the same department. Also, the model can generate departmental staffing ratios based on an average of service staffing ratios and project a different staffing need for all services. These new estimates provide a useful comparison to staffing projections that are based on historical practices.

Costs and FTEs aside, the model underscores a number of difficult decisions facing administrators in teaching hospitals. To use this model effectively as a decision-making tool, hospital leaders need to first reach a consensus on the ideal distribution of existing residents among programs and patient care locations. This consensus must be driven more by their institution's education mission and less by its service needs, because regulatory bodies may force teaching hospitals to make a seismic, and costly, shift from the existing immersion model of residency to a case-based model in which residents only attend to as many cases as needed to attain competency.<sup>4</sup> From a staffing perspective, hospital leaders may have to view interns and residents as students rather than as an economical source of labor in a difficult reimbursement environment.

Instead of simply shifting all noneducational tasks to other providers hired for this purpose, hospital leaders would benefit by evaluating provider workflow first. Comparing scenario 2 with scenario 3, our model predicts that a modest improvement in efficiency will save \$1 000 000 in a 5-year period. For instance, in our hospital, one major efficiency would be the regionalization of inpatients for general surgical services within the facility, so that resident teams have patients on only 1 floor and with 1 group of nurses. This is not possible currently because very high occupancy rates make it difficult for the admitting office to regionalize patients. Other efficiencies could be gained from improved, portable information technology and stratification of patient care based on detailed knowledge of the patient's condition. Additional efficiencies could be achieved by eliminating the redundancies in finding, gathering, documenting, and communicating patient data and assessment. Our technological needs are similar to those studied and reported elsewhere: computerized, prepopulated templates for generating patient lists, sign-outs, progress notes, and discharge summaries; increased electronic capturing of vital signs and fluid balance; single electronic care plans updated and used by different types of providers; integration of disparate clinical information systems with a single user interface; and increased availability of mobile devices such as personal digital assistants with the ability to download patient information.<sup>5-7</sup> Although the model does not include costs associated with physical or technological infrastructure changes, it indicates the financial benefit to making these efficiency improvements.

Once resident distribution is decided and workflow improvements planned, there remain 2 key questions: how to substitute for residents with other types of providers

and which types of provider best serve the hospital's needs. The exact conversion is difficult to ascertain because of intraprovider and interprovider differences in efficiency, aptitude, ability to provide off-hour coverage and to ensure continuity of care, and willingness to perform various tasks. Although the model translates residents to other types of staffing hour for hour, any other less costly conversion ratio can be selected based on experience. One program incorporated PAs into their surgical teams at the level of postgraduate year 1 or 2 and observed a 1:1 ratio of resident work hour reduced to PA work hour added.<sup>8</sup> The American Academy of Physician Assistants also noted that some found the replacement ratio to be closer to 1:1 in practice, instead of the 3 PAs per resident position initially predicted by some researchers.<sup>9</sup> Hospitalists, or any other faculty-level providers, are more costly substitutes. However, studies of the hospitalist programs at the University of California at San Francisco and Brigham and Women's Hospital show benefits that are not included in this model, such as reduced length of stay, improved patient communication, and increased resident education satisfaction, among others.<sup>10,11</sup>

The model does not account for other effects of resident work hour reduction such as loss of faculty productivity and retention owing to increased workload, decrements in medical student education provided by resident staff, and detriment to continuity of care with attendant patient safety concerns. The effect on faculty is potentially the most concerning, because many programs report increased faculty responsibilities and/or work hours in the wake of the 2003 duty hour requirement changes.<sup>12,13</sup> Faculty members already need to increase clinical activity to ensure continued financial viability in the face of declining reimbursement. To handle increased patient care responsibility as a result of resident work hour reductions, faculty may require additional resources to maintain current levels of involvement as educators and researchers. We are unable to project the magnitude of these expenses and have not accounted for them in our model.

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**Correspondence:** Francis D. Moore, Jr, MD, Department of Surgery, Brigham and Women's Hospital, 75 Francis St, Boston, MA 02115.

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## DISCUSSION

**Robert Quinlan, MD, Worcester, Mass:** Have you thought about the subspecialization that might occur with new American Board of Surgery designs and paradigms of splitting our general surgical workforce off into other specialties after 2 years?

**Dr Moore:** We are able to do that with this model but our best information coming out of the Board is that the proposal has been tabled indefinitely, so we did not do that.

**Mark Callery, MD, Boston, Mass:** If I understood your presentation correctly, the one factor that did not change was the relative size of the 20-resident workforce, correct?

**Dr Moore:** That was the beginning workforce. The expense that we are projecting is almost entirely based on hiring physician replacement FTEs.

**Dr Callery:** If there are to be programs that need to be consolidated because of prohibitive expense, that could increase the number of available residents. If true, would increasing the available resident workforce mitigate against the expense of it all?

**Dr Moore:** We can actually project that. We did not project it, because the ability to actually add residents to the system is severely constrained by the regulatory bodies. However, you could imagine that one method of addressing the shortfall, if you have a residency that is distributed in many hospitals, is to pull your residents out of the outside hospitals. That would be devastating to the outside hospitals potentially. It might help you at the base hospital for your program but overall would be devastating to private, local staff who had been helping you with training for years.

**W. Hardy Hendren, MD, Boston:** Dr Moore, I would like to comment about your last conclusion that we have to get more efficient. In 1958, Dr Edward Churchill decided to hire a con-

sulting firm which had proposed a study to make surgical residents more efficient. He introduced me, as the chief resident, to the consultant, Mr. Richardson, who had a terrible stutter. He would shadow me for 1 week, keeping close watch on all activities, messages received while operating, and so forth. I insisted that if he were to really see how the residents work he had to come in when we did and stay until we went home. You know we were on an every-day and every-other-night program at that time. At the end of the week, poor Mr. Richardson was just exhausted. In a particular day there were nearly 100 "message units" that required an answer or a decision during operation or between cases. He kept a note of all of that in a little black book. He came to the conclusion that there was no way that you could make residents in surgery more efficient. This is not a new subject to be considered but I am sure we are going to learn a lot from what you have just pointed out to us. Thank you.

**Dr Moore:** If it is any comfort to you, the word "consultant" in no place appears in any publication associated with this.

**Murray Brennan, MD, New York, NY:** The thing I do not see, which you have a great opportunity to do, is the efficiency in the OR. We have been reminded by our administration on numerous occasions that the utilization of a physician in the OR who is not the surgeon or the first assistant is a waste of institutional resources. The consequence of that is enormous. If you get rid of every assistant you would have a great way to demonstrate perhaps the negative educational impact but the positive financial impact.

**Dr Moore:** So you are suggesting that we do not have residents assisting us in the cases, Dr Brennan?

**Dr Brennan:** Perhaps.

**Dr Moore:** We polled our residents and the staff on the educational value and the various rotations. The educational value of a rotation in a given year linearly correlated with the amount of OR time spent. In a way that sounds like a self-fulfilling prophecy for a surgery program, but I think that what is really going on is that the OR is the resident's time to be one-to-one with a faculty member. In no other place in medicine does that opportunity really exist, and I really would hate to give that up.

**John Welch, MD, Hartford, Conn:** One of the concerns of patients today is increased fragmentation of care. Does your model look at increased fragmentation as well as at efficiency and cost? How do you propose dealing with this issue?

**Dr Moore:** I think that would come into our analysis as possibly the design of care, as you reduce the number of personnel. I do think that there is some opportunity here for information technology to step up so that everybody on the team is looking at the same piece of information at the same time wherever they are, whether they are at the New England Surgical for the morning or whether they are back in the hospital making rounds. In that sense, I am not sure that we are going to see quite the handoff problems that we have been concerned about in the past. On the other hand, you could imagine systems evolving where we just become surgical technologists, and our contact with our surgical patients is very limited. Thus, efficiency is gained by having surgeons only do what they do best which is to operate. I hope that we can avoid that eventuality.

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