



The Value of Surgical Graduate Medical Education (GME) Programs Within An Integrated Health Care System

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OBJECTIVE: Surgical graduate medical education (GME) programs add both significant cost and complexity to the mission of teaching hospitals. While expenses tied directly to surgical training programs are well tracked, overall cost-benefit accounting has not been performed. In this study, we attempt to better define the costs and benefits of maintaining surgical GME programs within a large integrated health system.

DESIGN: We examined the costs, in 2018 US dollars, associated with the surgical training programs within a single health system. Total health system expenses were calculated using actual and estimated direct GME expenses (salary, benefits, supplies, overhead, and teaching expenses) as well as indirect medical education (IME) expenses. IME expenses for each training program were estimated by using both Medicare percentages and the Medicare Payment Advisor Commission study. The projected cost to replace surgical trainees with advanced practitioners or hospitalists was obtained through interviews with program directors and administrators and was validated by our system's business office.

SETTING: A physician lead, integrated, rural health system consisting of 8 hospitals, a medical school and a health insurance company.

PARTICIPANTS: GME surgical training programs within a single health system's department of surgery.

RESULTS: Our health system's department of surgery supports 8 surgical GME programs (2 general surgery residencies along with residencies in otolaryngology, ophthalmology, oral-maxillofacial surgery, urology, pediatric dentistry, and vascular surgery), encompassing 89

trainees. Trainees work an average of 64.4 hours per week. Total health system cost per resident ranged from \$249,657 to \$516,783 based on specialty as well as method of calculating IME expenses. After averaging program costs and excluding IME and overhead expenses, we estimated the average annual cost per trainee to be \$84,171. We projected that replacing our surgical trainees would require hiring 145 additional advanced practitioners at a cost of \$166,500 each per year, or 97 hospitalists at a cost of \$346,500 each per year. Excluding overhead, teaching and IME expenses, these replacements would cost the health system an estimated additional \$16,651,281 or \$26,119,281 per year, respectively.

CONCLUSIONS: Surgical education is an integral part of our health system and ending surgical GME programs would require large expansion of human resources and significant additional fiscal capital. (J Surg Ed 76: e173–e181. © 2019 Association of Program Directors in Surgery. Published by Elsevier Inc. All rights reserved.)

KEY WORDS: Surgical education, Cost of graduate medical education, Systems based practice, Professionalism, Resident salary, Health system costs

COMPETENCIES: Practice-Based Learning and Improvement

INTRODUCTION

In the setting of rising health care costs, there is greater scrutiny of the expenses involved in maintaining Graduate Medical Education (GME) programs.^{1,2} As pressure to control such expenses increase, we have seen GME programs become targets of cost reduction strategies.^{3,4} In the face of these potential cuts to educational funding, we believe it is important to closely analyze the

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relationship between these programs and the health systems they serve. While such accounting efforts as these have been attempted before, we believe that a more current estimate is needed.^{5,6,7} Additionally, past attempts at estimating the cost of having GME training programs have not looked specifically at surgical learners. We feel this is problematic as these learners often spend greater hours in the hospital and advance to a level of practice significantly beyond an alternative provider by the end of their training.

Surgical learner salaries are determined largely by national funding through GME. With the establishment of Medicare in 1965, the government acknowledged the need for GME, and included support for residents as part of the reasonable expenses for teaching hospitals.⁸ At that point in time, there were few limits on funding and correspondingly, the number of residency positions increased without federal restriction.⁸ Medicare currently reimburses teaching hospitals for what they estimate to be their share of the cost for training residents with direct and indirect GME (DGME and IGME) payments. DGME payments are made on a per-resident basis to cover direct educational costs, specifically resident salary and benefits, as well as inpatient days of teaching faculty.^{8,9} In the 1980s, policy makers acknowledged the increased costs associated with teaching hospitals that are difficult to quantify, such as treating the critically ill and uninsured, access to highly specialized care, inherent inefficiencies associated with teaching (resulting from time spent teaching, residents ordering additional tests, etc.). Teaching hospitals also need to maintain a productive research environment, higher staffing levels, as well as offer the newest and most advanced technology. These higher costs prompted the development of IGME payments as an attempt to reimburse for the increased costs of operating teaching facilities.^{8,10} While the DGME costs such as salary are easy to account for through concrete costs like salary, IGME expenses are estimated statistically, and paid based on predetermined Medicare percentages based on actual costs.¹¹

In 1997, further evaluation of health care expenses and a projected excess of physicians led to the passage of a cap on the number of Medicare funded residency positions in existing teaching hospitals.¹² More recent evaluations project a dearth of surgeons going forward, and while positions in medical school have expanded, growth of physicians remains relatively at a standstill after failure to pass the Resident Physician Shortage Act in 2009.^{13,14}

With the real possibility of diminished funding in the coming years, many teaching hospitals have chosen to hire more APs rather than fund additional residency positions despite the need, due to presumed associated costs of resident.¹² Replacement costs, or the amount of money it would take to replace residents with APs, is not typically considered when calculating institutional expenses

of GME. When these calculations have been performed, it was found that that APs worked fewer hours for more money and did not result in cost reduction.^{12,15} The 2016-2017 national average stipend for PGY1-PGY7 residents across all specialties ranged from \$54,256 to \$68,604 respectively.¹⁶ Data on duty hour restrictions to date suggest that greater than 60% of surgery residents surpass 80 hour work week restrictions on a weekly or monthly basis, and that their contribution to patient care is somewhat underestimated as well as underreported by residents.^{17,15} In comparison, the 2017 median base salary for hospital employed physician assistants (PAs) was \$105,000.¹⁸ This is significantly greater than the salary of a surgical trainee, and APs usually work closer to 40-50 hours per week in 8-12 hour shifts.¹²

As mentioned above, GME reimbursement has always assumed that residents increase the cost of care due to their inexperience and learning curve, but recent analyses have suggested that this increase is minimal to negligible.^{19,20} In addition, comparisons on the quality of care between residents and APs have found no significant difference in patient outcomes based on provider type.²¹ The objective of this investigation is to examine a single health system's known cost of hiring surgical GME trainees and compare that to the cost of replacing these learners with advanced practitioners or hospitalists.

METHODS

This study was approved by the Institutional Review Board of Geisinger Health System. The goal of our analysis was to characterize the costs associated with having and replacing surgical GME programs within an integrated health care system. Work hours for surgical trainees were obtained from our health system electronic self-reported Med Hub (Minneapolis, MN) database and were averaged to include all surgical trainees. Microsoft (Microsoft Corporation, Redmond, WA) Excel was used to project and calculate personnel requirements (full-time employee or FTE) and costs (salaries plus fringe benefits) related to the hypothetical elimination of surgical GME programs within a single health system.

COST ANALYSIS

To perform our cost analysis, we estimated that on average, APs work 40 hours per work, hospitalists work 60 hours per week and surgical trainees work 64.4 hours per week. Based on these hourly work weeks, our model estimated that we would have to hire an additional 145 APs or an additional 97 hospitalists to replace the surgical trainee work force. To calculate total costs, we

included both salary and fringe benefits for all providers. We did not perform any calculations based upon a 1:1 replacement of trainees with APs or hospitalists. Monetary estimates regarding salary and benefits were obtained from our health systems business office, though divisional and departmental records and through interviews with executive leadership.

The total health system expense of surgical GME was calculated using our health systems DGME expenses (DGME), including salary, benefits, overhead of program management, and teaching expenses, as well as the IGME expenses (IGME) expressed in 2018 US dollars.

Medicare considers overhead to be a part of DGME, and it is reimbursed for on a per resident basis. As overhead costs to a health system will remain with or without surgical training programs, calculations regarding the average cost of each surgical trainee were performed with IME and overhead expenses removed. Teaching expenses, including physician salary and benefits were estimated by 2 different measures. Our first method used the reported percentage of time spent on teaching provided to CMS. If a physician attests to spending 10% of their time teaching or overseeing the program, then 10% of their salaries and benefits are computed as teaching costs. The second method used was our health systems business office internal estimate of relative value units (RVUs) lost rather than the reported time spent teaching. The RVU FTE basis was applied to the same salary and benefit budgeted for that year. In our health system, physicians are paid at the same rate to perform administrative and teaching duties as they are paid for clinical duties. As it is impossible to estimate the true amount of time spent teaching, these methods were used to create high and low ranges based on both percentage salary paid toward teaching and lost RVUs spent on teaching.

Direct, indirect, and total cost estimates of the surgical education programs included in this analysis were obtained from internal financial statements and Medicare cost reports and payroll reports. Cost estimates were also based upon resident salary and recorded hours worked when compared to the hours and wages worked by APs and hospitalists. We estimated IGME expenses using both reported Medicare percentages and the Medicare Payment Advisory Commission (MedPAC) study to provide high- and low-end cost estimates. Medicare percentages, as discussed above, are predetermined reimbursement rates intended to compensate hospitals for difficult to quantify costs such as having critically ill and uninsured patients, inefficiencies of teaching and research.²² CMS currently estimates that inpatient operating cost per case increases approximately 5.5% with each 10% increase in the number of interns and residents per hospital bed. In other words, a 100-bed hospital that adds 10 residents would incur a 5.5% increase in indirect costs. These

Medicare percentages are used to make IGME payment to hospitals, and were used as the high range of our calculation.^{11,23} The recently published study by the MedPAC estimates that this inpatient operating cost increase is closer to 1.88% with every 10% increase in the number of interns and residents per bed.²³ This number was utilized to obtain a low range for our calculations.

We also calculated the average work hours for each level of resident, fellow, AP, and hospitalist along with wages and fringe benefits. The level of current staffing, work hours, and framework used to determine costs of replacing residents with alternative providers was gathered from divisional and departmental records and interviews with leadership. Work hours for surgical trainees were obtained from our health systems electronic self-reported Med Hub (Minneapolis, MN) database and were averaged to include all surgical trainees. Microsoft (Microsoft Corporation, Redmond, WA) Excel was used to project and calculate personnel requirements (FTE) and costs (salaries plus fringe benefits) related to the hypothetical elimination of all surgical GME programs within a single health system. Based on hours worked, filling resident roles would require hiring significantly more alternative providers compared to residents.

RESULTS

Our health system is a physician lead, integrated, and rural health system consisting of 8 hospitals, a medical school and a health insurance company that includes 8 surgical GME programs encompassing 89 surgical trainees. Internal health system business documents estimate identical overhead costs for all GME trainees regardless of specialty. Specifically, overhead expenses include the salaries of interns, residents, teaching, and program administration along with the costs associated with hospital operation, maintenance, and repairs. In total, overhead expenses are estimated to be \$63,651 per full time GME trainee. Further details regarding calculation of overhead costs are outlined in [Table 1](#).

Our 89 surgical trainees report working an average of 64.6 hours per week, ranging from 40 hours per week for pediatric dentistry residents to 75 hours per week for vascular surgery fellows ([Table 2](#)). These duty hour values, while self-reported, were comparable to the work hours estimates obtained from interviews with the program directors and program administrators of the respective surgical training programs ([Table 2](#) and [5](#)).

Direct expenses of surgical GME programs include salary, benefits, travel, continuing medical education along with teaching and overhead expenses. These cost estimates varied depending on the specialty, the length of the training program, as well as the number of surgical

TABLE 1. Overhead Cost Per Full Time Employee (FTE) for All Graduate Medical Education (GME) Trainees

Category	Interns and Residents	Teaching	Other Administrative	Total
Building	125,328		294,025	419,353
Employee benefits	131,983	154,148	3382	289,513
Administration and general	10,843,702	10,076,793	549,599	21,470,094
Maintenance and repairs	6919		407	7326
Operation of plant	178,620		419,053	597,673
Total	\$11,286,552	\$ 10,230,941	\$1,266,466	\$22,783,959
Total GME FTE	358	358	358	358
Amount per GME FTE	\$ 31,530.97	\$28,581.94	\$3,538.10	\$63,651.00

TABLE 2. Baseline Characteristics of Surgical Educational Programs Included in Cost Analysis

Specialty	Gen Surg	Vasc Surg	ENT	Ophtho.	GU	Peds Dental	Oral Surgery
Length of Program (y)	5	2	5	1	5	6	3
Minimal prior training (y)	0	5	0	1	0	0	0
Trainees per program	55	4	8	6	5	5	6
% of IMG in program	20	10	5	5	0	20	0
Average week duty hours	73	77	65	55	70	40	60

IMG, international medical graduates.

trainees. Direct expenses were highest for the largest group of trainees, the 5-year general surgery residency, which included 55 residents at a cost of \$7,154,617 per year. In comparison, direct expenses were lowest for our smallest training program, a traditional 2-year vascular surgery fellowship with 4 fellows and cost of \$536,107 per year. The health system's cost associated with teaching expenses was estimated using both hours allocated to teaching in addition to lost RVU production. When estimated based on hours allocated, the estimate of teaching expenses was highest (Table 3). Similarly, yearly indirect medical expenses (IME) varied based upon the method used in the calculation. Yearly IME cost per surgical trainee was estimated at \$26,889 when performed using Medicare percentages and at \$9191 when using the methodology outlined in the MedPAC study (Table 3). These variations were then used to calculate both high and low expense estimates for each surgical GME program and ranged from \$14,298,816 for our most expensive program to \$844,740 for our least. When evaluating total annual expense per trainee, we again found variability. Expense per trainee varied between the different PGY year residents per program, as well as departmental overhead cost. To minimize these discrepancies, and because overhead costs to a health system will remain with or without surgical training programs, calculations regarding the average cost of each surgical trainee was performed with IME and overhead expenses removed. Moreover, we felt comfortable removing these expenses from our calculations as we

believe that these expenses would continue for the health system regardless of the staff type performing patient care duties. Averaged over all surgical GME programs, the annual expense per trainee (minus IME and overhead expenses) was \$84,168. In total, the cost to the health system was \$7,490,955 per year for 89 surgical GME trainees. Additional specifics regarding the calculation of total expenses for surgical GME training programs is detailed in Table 3.

To determine the costs associated with eliminating the surgical GME training programs within our health system, we proposed replacing surgical trainees with alternate providers such as APs or hospitalists. Within our health system, APs include both nurse practitioners (NPs) and PAs as both can perform similar roles and function relatively interchangeably. Per internal business office documents, the average salary for an AP at our institution was \$130,000 per year, with an additional \$36,500 per year in benefits. This came to a total estimated expense per AP per year of \$166,500 (Table 4). In comparison, hospitalists in our health system had an average annual salary of \$268,000, in addition to an average \$41,000 per year in incentives and \$387,000 per year in benefits. The total estimated cost per year totaled \$346,500 per year per hospitalist (Table 4). In contrast, salaries of surgical residents and fellows within our health system ranged from \$58,036 for PGY1 residents to \$74,926 for PGY7 residents for the 2018-2019 academic year.

Assuming a 40-hour work week for APs and a 60-hour work week for hospitalists, in comparison to an average

TABLE 3. Detailed Expense Calculations Per Program

Specialty	General Surgery	Vascular Surgery	ENT	Ophtho.	Urology	Peds Dentistry	Oral Surgery
Direct Expenses							
Salaries	\$3,329,415	\$236,445	\$538,408	\$410,586	\$250,276	\$319,989	\$456,948
Benefits	\$895,287	\$59,336	\$150,975	\$116,547	\$66,840	\$94,617	\$76,093
Other direct expenses (travel, CME, books, periodicals, etc.)	\$234,962	\$35,007	\$59,924	\$40,954	\$33,838	\$28,202	\$56,306
Overhead expense	\$1,610,831	\$113,084	\$274,787	\$187,837	\$133,396	\$173,616	\$225,105
Teaching overhead	\$1,084,122	\$92,165	\$223,956	\$153,090	\$133,936	\$141,501	\$183,465
Total direct expense	\$7,154,617	\$536,037	\$1,248,050	\$909,014	\$618,286	\$757,925	\$997,761
Teaching expense (TE)							
TE based on hours	\$2,229,304	\$384,724	\$1,249,984	\$383,327	\$343,464	\$939,113	\$42,716
TE based on budgeted RVU's	\$1,198,922	\$200,407	\$376,934	\$230,831	\$257,712	\$982,031	\$115,133
Average teaching expenses	\$1,714,113	\$292,566	\$813,459	\$307,079	\$300,588	\$78,925	\$332,644
Indirect GME expenses (IME)							
IME based on medicare percentages	\$7,677,184	\$853,006	\$2,072,757	\$1,416,879	\$1,010,296	\$5,500,579	\$1,309,612
IME based on Med PAC study	\$2,624,175	\$291,570	\$708,499	\$484,310	\$345,334	\$1,880,179	\$447,645
Total expenses							
High estimate	\$23,500,797	\$1,681,609	\$4,134,266	\$2,632,972	\$1,929,170	\$2,146,462	\$3,028,557
Low estimate	\$13,839,924	\$1,120,173	\$2,770,008	\$1,700,403	\$1,264,208	\$1,284,494	\$1,910,961
Total no. of residents per program	55	4	8	6	5	5	6
Average hours on duty per week	75	77	65	55	70	40	60
Total annual expense per trainee							
High estimate	\$425,784	\$420,402	\$516,783	\$438,828	\$385,834	\$429,292	\$504,759
Low estimate	\$252,305	\$280,043	\$346,251	\$283,400	\$252,841	\$256,899	\$318,494
Total annual expenses minus fixed overhead							
High estimate	\$21,386,234	\$1,568,525	\$3,859,479	\$2,445,135	\$1,795,774	\$1,972,845	\$2,803,452
Low estimate	\$12,722,825	\$1,007,089	\$2,495,221	\$1,512,566	\$1,130,812	\$1,110,878	\$1,685,856
Total annual expense minus overhead and IME	\$4,459,664	\$330,788	\$749,307	\$568,087	\$350,954	\$1,914,610	442,808

CME, continuing medical education; RVU, relative value units.

of 64.4 hours per week for surgical trainees, our model found that we would have to hire an additional 145 APs or an additional 97 hospitalists to replace the surgical trainee work force. This would cost the health system an additional \$166,500 per AP each year, or an additional \$346,500 per hospitalist per year. Excluding overhead and IME expenses, these replacements would cost the health system an estimated additional \$16,651,545 to \$26,118,545 per year depending on the method used to calculate total expenses (Table 4), and a 320% to 440% increase in cost overall.

To perform our calculations, a number of assumptions had to be made regarding the function and costs of surgical training programs within our health system. To help ensure the validity of these speculations, we administered a standardized questionnaire to the program directors and program administrators responsible for managing these surgical training programs. The pertinent results of these interviews are summarized in Table 5 and were used to influence calculations where necessary. Furthermore, this questionnaire suggests that

residents fill a unique role within our health system that APs and hospitalists would be difficult to, if not impossible, to replace. For multiple groups at our institution, program directors and program administrators did not believe that APs or hospitalists would be qualified or able to help them fill the role of a surgical trainee, and that if the trainees were unavailable, it would require the hiring of additional surgeons further increasing expenses to the health system (Table 5).

DISCUSSION

As the healthcare landscape becomes more complicated and the focus on cost effectiveness becomes more intense, a health system's decision on how to best support GME programs becomes more challenging. Ultimately, leadership must weigh the costs associated with medical training programs against the benefits that the health system derives from undertaking such educational efforts. We commenced this investigation as we

TABLE 4. Annual Expense of Ending of ACGME Approved Surgical Educational Programs

Variable	US Dollars 2018
Annual total expense per surgical trainee	
High estimate	\$447,577
Low estimate	\$259,659
Annual average overhead expense per trainee	
Overhead expense	\$30,546
Teaching overhead	\$22,607
Total	\$53,153
Annual teaching expenses per trainees	
Teaching expense bases based on hours	\$68,250
Teaching expense based on RVU	\$39,614
Annual IME expense per surgical trainee	
IME based on Medicare percentages	\$242,003
IME based on MedPAC study	\$82,720
Annual average expense per trainee minus overhead, IME and teaching	\$84,171
Total expense for trainees minus overhead, IME and teaching	\$7,491,219
Average AP annual salary	\$130,000
Average AP annual benefits	\$36,500
Average annual expense per AP	\$166,500
No. of AP FTE's to replace 89 trainees	145
Total expense if surgical trainees are replaced by APs	\$24,142,500
Total cost differential if trainees replaced with APs	−\$16,651,281.00
Average hospitalist base annual salary	\$268,000
Average hospitalist annual incentive	\$41,000
Average hospitalist annual benefits	\$37,500
Average annual expense per Hospitalist	\$346,500
No. of hospitalists to replace trainees	97
Total expense if trainee replaced by hospitalist	\$33,610,500
Total cost differential if residents replaced with hospitalists	−\$26,119,281.00

\$16,651,281.00 is the amount of additional cost per year to replace trainees with APs, and \$26,119,281.00 is the amount of additional cost per year needed to replace trainees with hospitalists.

AP, advanced practitioners; FTE, full-time employee; MedPAC, Medicare percentages and the Medicare Payment Advisor Commission; RVU, relative value units.

did not feel that there was sufficient data to properly perform this risk versus benefit analysis, especially regarding surgical GME programs.

The findings of our examination are novel and demonstrate a significant monetary and nonmonetary value to maintaining surgical GME programs. Specifically, within our health system, we found that attempting to replace our 89 surgical trainees with alternative providers would result in an overall increase in cost of 320% to 440%. Astonishingly, our calculations demonstrate that the elimination and replacement of surgical trainees does not

demonstrate monetary savings and in contrast would cost the health system an estimated additional ~16 to 26 million dollars annually. In addition to these large effects on the financial performance of our health system, we also found that our surgical trainees provide significant non-monetary value that is difficult to quantify. By administering a standardized questionnaire to the program directors and administrators responsible for managing trainees, we were able to repeatedly highlight that surgical educators feel that the absence of surgical learners would cause the attrition of high-quality surgeons who are invested in the training program and would require additional expenditures in efforts to replace. Furthermore, our survey found that surgical educators feel that their current trainees provide on-call services that benefit patients, hospital and themselves in addition to favorably affecting attending physician productivity and revenues.

We acknowledge that there are several limitations to our study. First, the findings of our investigation may be unique to our health system and may not be generalizable to other health systems or surgical training programs that have a different organizational structure or operating strategy. Secondly, our study is limited by its primary focus primarily focus on financial variables. We did, however, administer a standardized questionnaire to the program directors and administrators to quantify the nonmonetary value of surgical learners. Despite our best efforts, we found this to be an exceedingly difficult task. Highlights of our questionnaire revealed that the absence of surgical learners would cause the attrition of high-quality surgeons who are invested in the training program and that surgical educators feel that their current trainees provide on-call services that benefit patients, hospital, and themselves in addition to favorably affecting attending physician productivity and revenues. These additional benefits are of great importance and should not be minimized. Thirdly, our analysis is limited by the inclusion of multiple different training programs within our surgical institute. This leads to some variation in the work hours and in our financial calculations. These variations make the broad application of our findings difficult for individual training programs. Lastly, we would like to add that we believe that the inclusion of multiple different categories of surgical training programs makes our study more broadly applicable. Furthermore, we believe that the inclusion of programs with lower duty hours further increases the financial impact of some surgical trainees greater and thus make our findings even more significant.

Publications of a similar nature to ours are few. In 1 investigation by DeMarco et al., a university medical center performed a financial analysis examining the replacement of internal medicine residents with NPs, the replacement of anesthesia residents with certified

TABLE 5. Select Responses to Survey of Program Directors and Program Administrators

Question	General Surgery	Vascular Surgery	Ophtho.	Urology	Peds Dentistry	Oral Surgery
Number of hospitals covered by trainees	6	2	1	1	4	2
Estimated duty hours per week	70-75	60-65	60	60	40	50-60
Type of call	In house and home call	Home	Home	Home	Home call	Home
OR days/week staffed by trainees	25	18	2 residents 5 d/wk	15	2-3	3-4
Estimated number of NPs to replace residents	45	8	Residents are irreplaceable in clinic, APs would not fill same role APs not qualified, would need 4 more attendings	6-7	n/a—trainees are dentists	n/a, nurse practitioners not qualified
Estimated number of PAs to replace residents	6	8	APs not qualified, would need 4 more attendings	6-7	n/a—trainees are dentists	n/a not qualified
Estimated number of hospitalists to replace residents	0	6	We would have to hire 4 or more attendings	n/a not qualified	n/a—trainees are dentists	n/a not qualified
Estimated increase or decrease in career satisfaction with loss of trainees	60% decrease	80% decrease	Decreased career satisfaction with loss of educational environment	decrease—upset	100%—no attending wants to be first call at high volume trauma center	100% decrease

NP, nurse practitioners.

registered nurse anesthetists, the elimination of all small residency programs (consisting of > 10 residents in an outpatient specialty) and absorbing patient volume with 5 additional NPs and eliminating small fellowship programs (≤ 3 fellows).¹² The findings of this cost analysis were significant and included that the elimination of trainees in large programs, like internal medicine and anesthesia, did not result in savings, as the replacement costs are higher than the direct costs of the residents. Specifically, replacing 1 internal medical resident with a NP resulted in a loss of ~\$170,000 while replacing 1 anesthesia resident resulted in a loss of ~\$220,000. However, these investigators did find that eliminating small residencies (8 programs consisting of 41 learners) and small fellowships (20 programs with 31 learners) would save teaching and administrative costs that could add up to ~6 million dollars. We believe that this study, while provocative, is flawed. For example, the investigators proposed not replacing 31 fellowship positions with any additional providers and assumed that 41 residency positions could be replaced with 20 NPs or PAs. We feel that these measures are unrealistic and if carried out, would leave for severely compromised patient care. Additionally, DeMarco et al. failed to distinguish any differences between procedural and non-procedural training programs and did not account for other intangibles such as loss of quality faculty, increased faculty recruitment costs and decreased faculty productivity. In a similar study, by Mitchell et al. evaluated the costs associated with reduced surgical trainee manpower due to duty hour restrictions and increased didactic time.²⁴ In this analysis, an estimated 5-year cost to a team of 20 residents and 4 fellows ranged from ~\$850,000 for replacement of lost care hours because of a 75-hour week with PAs to ~\$3,000,000 for replacement of lost care hours because of a 60-hour week with NPs. In a worst-case scenario that included work hour reductions, volume increases, and administrative inefficiencies, these authors estimated the costs associated with a decrease in the surgical trainee workforce could reach \$5 million dollars, depending on the type of staff hired to replace the residents. We believe this analysis to be more realistic and agree with the authors conclusion that to simply replace residents with alternative providers requires a large expenditure of both human capital and monetary resources. Furthermore, we believe that such dramatic changes are likely to be harmful to a health system bottom line and ability to properly care for their patients and providers.

CONCLUSIONS

Surgical education is an integral part of our health system and ending surgical GME programs would require large expansion of human resources and significant additional fiscal capital. While concern for rising health care

costs are valid, attempting to reduce costs through limiting funding toward educating the future physician workforce is shortsighted, and has not been proven to result in cost reduction. Our research shows a number of financial benefits associated with surgical trainees, as well as a number of more difficult to quantify strengths that require further investigation.

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SUPPLEMENTARY INFORMATION

Supplementary material associated with this article can be found in the online version at doi:[10.1016/j.jsurg.2019.08.006](https://doi.org/10.1016/j.jsurg.2019.08.006).