The Increased Financial Burden of Further Proposed Orthopaedic Resident Work-Hour Reductions

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Topics in Training

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Background: Increased funding for graduate medical education was not provided during implementation of the eighty-hour work week. Many teaching hospitals responded to decreased work hours by hiring physician extenders to maintain continuity of care. Recent proposals have included a further decrease in work hours to a total of fifty-six hours. The goal of this study was to determine the direct cost related to a further reduction in orthopaedic-resident work hours.

Methods: A survey was delivered to 152 residency programs to determine the number of full-time equivalent (FTE) physician extenders hired after implementation of the eighty-hour work-week restriction. Thirty-six programs responded (twenty-nine university-based programs and seven community-based programs), encompassing 1021 residents. Previous published data were used to determine the change in resident work hours with implementation of the eighty-hour regulation. A ratio between change in full-time equivalent staff per resident and number of reduced hours was used to determine the cost of the proposed further decrease.

Results: After implementation of the eighty-hour work week, the average reduction among orthopaedic residents was approximately five work hours per week. One hundred and forty-three physician extenders (equal to 142 full-time equivalent units) were hired to meet compliance at a frequency-weighted average cost of $96,000 per full-time equivalent unit. A further reduction to fifty-six hours would increase the cost by $64,000 per resident. With approximately 3200 orthopaedic residents nationwide, sensitivity analyses (based on models of eighty and seventy-three-hour work weeks) demonstrate that the increased cost would be between $147 million and $208 million per fiscal year. For each hourly decrease in weekly work hours, the cost is $8 million to $12 million over the course of a fiscal year.

Conclusions: Mandated reductions in resident work hours are a costly proposition, without a clear decrease in adverse events. The federal government should consider these data prior to initiating unfunded work-hour mandates, as further reductions in resident work hours may make resident education financially unsustainable.

The landscape of the orthopaedic workforce is changing. An aging population, rising obesity rates, greater lifestyle expectations, and technologic advances are increasing the demand for musculoskeletal services. At the same time, teaching institutions are under strain amidst resident work-hour regulations and the need to balance patient care and education. These goals collide in today's economic climate. As lawmakers, patient advocates, and academic centers consider implementation of further resident work-hour restrictions, the fiscal viability of these proposals remains unknown.

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In 2003, the Accreditation Council for Graduate Medical Education (ACGME) reduced resident duty hours to no more than eighty hours per week, averaged over a four-week period[1]. The ACGME implemented these limits out of concern that resident fatigue endangered patients and the residents themselves. The regulations were rooted in the 2001 New York State mandate, Code 405[2,3]. A growing body of literature underscores the benefits and shortfalls of reduced resident work hours on patient safety[4-6], resident morale, quality of life[2,5,7-10], and education and operative experience[4,11-20]. One factor not often discussed is the financial impact of the reduced hours—to our knowledge, no study has evaluated the economic impact of reduced hours in orthopaedic resident education.

Early research on the duty limits shows resident fatigue is still a major problem[6]. This prompted the Institute of Medicine in December 2008 to suggest further work-hour modification[21], while other discussions of resident work hours have included reductions to as low as fifty-six hours[21]. Furthermore, some state legislators have discussed criminalizing duty-hour violators[22]. Residents in other countries, such as the United Kingdom, Denmark, New Zealand, and France, work between thirty-seven and seventy-two hours per week. However, physician labor-supply shortages and insufficient training are a problem in these countries[21].

In light of these calls for additional duty limits, we examined the economic implications of a fifty-six-hour work-week regulation for orthopaedic training programs. Through the use of pilot-survey data, we undertook a cost-sensitivity analysis. Our hypothesis, based on workforce data after the eighty-hour work-week restrictions, was that the economic impact of furthered reduced hours, especially if not funded by the government, may make the orthopaedic resident workforce unsustainable.

Materials and Methods

A brief survey was delivered electronically to 152 residency programs to determine the number of full-time equivalent (FTE) physician extenders hired after the eighty-hour restrictions were implemented (see Appendix). After an initial review by our institutional review board, it was determined that the study met eligibility criteria for institutional review-board review exemption authorized by 45 CFR 46.101, category 2. Data were collected over a six-month period. Survey results were collected anonymously through an online, secure server. From the data collected, we extrapolated the increased cost of further work-hour reductions. This included sensitivity analyses with a range of changes in cost resulting from the potential policy adjustments and data from previously published work[2].

In addition, a systematic review of the literature was conducted to determine the impact of the eighty-hour work week in terms of mortality in orthopaedic patients. Medline and EMBASE were used as the search engines to conduct the systematic review. The key words "resident" and "duty hour(s)" or "work hour(s)" and "mortality" and "orthop(a)edic" were used to guide the search. Following the search, three articles met the following inclusion criteria: (1) in English language; (2) Level I, II, or III study design according to *The Journal of Bone and Joint Surgery* criteria (because the majority of studies examining work hours were cohort studies, with cohorts of post-work-hour regulations compared with the cohorts of pre-work-hour regulations as controls); (3) a minimum of 100 patients per group in the series; (4) two resident groups: pre-work-hour restriction and post-work-hour restriction; (5) data regarding patient mortality that were extractable in a form that was usable for statistical analysis; (6) thirty-day mortality data; and (7) presence of orthopaedic patients. Studies were excluded if (1) they did not meet the inclusion criteria, (2) the data were not in a form available for extracting mortality data, and/or (3) there was a lack of original data (e.g., reviews or expert opinion were excluded).

The percentage of deaths was compared between resident groups with regard to pre-work-hour and post-work-hour regulations. In addition, odds ratios were generated under the random effects model (DerSimonian and Laird weighting technique[23]). Meta-analytic statistics[24,25] were calculated with MIX statistical software, version 1.7 (Kitasato Clinical Research Center, Sagamihara, Kanagawa, Japan). To generate a cost-benefit analysis, the percentage of deaths in each group was considered, and the results were translated to "deaths per 10,000 patients."

Results

Thirty-six (24%) of 152 teaching programs, encompassing 1021 residents, responded to the survey. All survey data were collected by May 2010. There were twenty-nine university-based and seven community-based programs. All questions were answered by the thirty-six respondents.

There was variation in the timing of implementation of work-hour rules: thirty-one programs initiated changes in 2003, three programs met the regulations in 2004, and one program each met the regulations in 2002 and 2009, respectively. The resident demographics of individual program respondents are represented in a table in the Appendix. Thirteen (36%) of thirty-six programs increased the number of residents (range, two to twenty new residents per program) from the time of pre-work-hour regulations to April 2009, for a total of 107 new residents added across the thirty-six surveyed programs. Eighty-six percent of programs experienced a change in the number of operating attending surgeons on staff between 2002 and April 2009 (see Appendix). Five university-based programs saw a decrease in the number of operating attending surgeons (range, two to six fewer attending surgeons per program) at the time of survey, while one community-based program decreased its attending staff by two surgeons. Twenty-five programs increased the number of attending surgeons (range, one to thirty-six additional staff). A table in the Appendix presents moonlighting and night-float systems changes between the time of pre-work-hour regulations and post-work-hour regulations. Twenty-five (69%) programs adjusted their position on allowing senior residents to moonlight (all moonlighting policy changes were in favor of allowing moonlighting): at the time of survey, thirty-two programs (89%) allowed moonlighting, while four programs did not have moonlighting options. No programs had a night-float system in place prior to the work-hour rules; after implementation of work-hour rules, fourteen (39%) of thirty-six programs changed their rotations to include a night-float system.

Prior to work-hour rules, the number of FTE physician-extender staff hired per program ranged from zero to nine ancillary staff members (Table I). Post-work-hour rules hiring patterns, including number, date, and FTE values per extender hired, are reflected in Table I. The average salary and benefits for physician extenders were $101,000 for nurse-practitioner FTE staff, $87,000 for physician-assistant FTE staff, and $110,000 for registered-nurse first-assistant FTE staff.

TABLE I Pre-Work-Hour Regulation (WHR) and Post-WHR Hiring Patterns*

			Post-WHR		
Program Identifier	Program Type	No. of FTE Pre-WHR	Type (No.) of PE Hired	Total FTE Value	Dates of Hire
1	UB	1	PA (3)	3	2004 to 2008
2	CB	0	PA (1)	1	2006
3	UB	0	0	0	
4	UB	3	PA (2)	1†	2005, 2008
5	UB	0	0	0	
6	UB	9	0	0	
7	CB	4	0	0	
8	CB	0	0	0	
9	CB	5	NP (4), PA (4)	8	2004 to 2006
10	UB	5	NP (1), PA (3), RNFA (1)	5	2003 to 2006
11	UB	6	NP (2), PA (1)	3	2004
12	UB	2	NP (2), PA (1)	3	2003, 2004
13	UB	1	PA (4), RNFA (1)	5	2004 to 2006
14	UB	0	NP (2), PA (1), RNFA (1)	4	2003, 2004
15	UB	0	PA (2)	2	2004
16	UB	2	NP (6)	6	2004 to 2006
17	UB	1	NP (1), PA (2)	3	2005
18	UB	3	PA (4), RNFA (2)	6	2004 to 2006
19	UB	0	NP (2), PA (2)	4	2004 to 2006
20	UB	0	NP (1), PA (2)	3	2003 to 2005
21	UB	3	NP (4), PA (2), RNFA (2)	8	2004 to 2007
22	UB	2	NP (3), PA (1)	4	2004 to 2007
23	UB	4	NP (2), PA (3), RNFA (3)	8	2003 to 2007
24	UB	1	NP (3), PA (4), RNFA (1)	8	2004 to 2008
25	UB	0	NP (1), PA (2)	3	2003 to 2006
26	UB	8	NP (3), PA (3), RNFA (2)	8	2004 to 2007
27	UB	0	NP (2), PA (1)	3	2004, 2005
28	UB	0	NP (3), PA (1)	4	2004, 2005
29	UB	4	NP (1), PA (3), RNFA (3)	7	2003, 2004
30	UB	2	NP (1), PA (2)	3	2004, 2005
31	UB	7	NP (2), PA (3), RNFA (3)	8	2005 to 2008
32	CB	0	NP (1), PA (2), RNFA (1)	4	2007, 2008
33	UB	0	NP (1), PA (2), RNFA (1)	4	2006, 2008
34	UB	0	NP (2), PA (3), RNFA (1)	6	2004, 2006
35	CB	0	PA (3)	3	2006, 2007
36	CB	0	NP (3), PA (1)	4	2004 to 2008

*WHR = work-hour regulations, UB = university-based program, PA = physician assistant, CB = community-based program, NP = nurse practitioner, and RNFA = registered nurse first assistant.†Value equals 0.5 full-time equivalent (FTE) units per physician extender (PE) hired.

Sensitivity Analysis

Two hypothetical work-hour models were created in order to analyze the survey data (Fig. 1). The first model (Model A) assumed that the present eighty-hour work week would be reduced to fifty-six hours. This model assumes that residents truly work an average of eighty hours per week, that there exists an even distribution of residents across postgraduate years two through five, and that there is a linear relationship between resident hours and FTE hours. The model assumes an eighty-hour average work week per resident, acknowledging the

TABLE II Benefit of Work-Hour Regulations (WHR) for Orthopaedic Patients

Study	Patient Population	Odds of Death *(Pre-WHR vs. Post-WHR)* (95% Confidence Interval)	Percent of Deaths Pre-WHR	Percent of Deaths Post-WHR	Difference	Benefit in Deaths per 10,000 Patients*
Volpp et al.[29]	All orthopaedic cases	1.12 (1.11 to 1.14)	2.46%	2.19%	0.27%	27
Volpp et al.[28]	All orthopaedic cases	1.26 (1.12 to 1.42)	1.87%	1.49%	0.38%	38
Browne et al.[5]	Hip fracture cases	1.11 (0.93 to 1.34)	2.78%	2.45%	0.33%	33
Weighted average†	NA	1.16*† (1.07 to 1.25)	NA	NA	0.31%	31

*Not enough information based on the studies available to attribute benefits to work-hour reductions.†Significant at the <0.001 level.‡NA = not applicable.

possibility that certain residents—perhaps postgraduate-year-two (PGY2) residents—may log more hours than senior-level residents do. For example, a PGY2 resident may work eighty-five hours, whereas a PGY5 resident may work seventy-five hours; between the two residents, there are eighty hours of work done per resident, on average. In this first model, the number of average hours that would be reduced per week, per resident, would be twenty-four hours (i.e., eighty hours minus fifty-six hours).

The second model (Model B) applies workforce data from the 2005 study by Zuckerman et al.[2]. Analysis from this study demonstrates a de facto work week of seventy-three hours, averaged across all resident training levels. This second scenario creates a seventeen-hour work-hour differential (i.e., seventy-three hours minus fifty-six hours). Using two models in this sensitivity analysis allows for an estimated range of possible cost increases. Furthermore, the two calculated scenarios account for the variability in the number of hours of resident labor that new FTE staff would be displacing, as well as the theoretical baseline number of hours from which a hospital shifts to the new fifty-six hours.

After implementation of the eighty-hour work week, the average reduction in work hours was approximately five hours per week. One hundred and forty-three physician extenders (142 FTE staff) were hired to meet compliance, at a frequency-weighted average cost of $96,000 per FTE staff. A further reduction to fifty-six hours would increase the cost by $64,000 per resident. With approximately 3200 orthopaedic residents nationwide (3259 residents, according to recent ACGME data[1]), the increased cost would be $208 million per fiscal year (Model A). For each hourly decrease in work hours, the cost is $8 million to $12 million over the course of a fiscal year. Based on more conservative "real-world" data from previous studies (applied to Model B), the reduction in work hours performed per resident translates into an increased cost of $147 million per fiscal year.

To control for increases in the number of attending staff potentially confounding the number of corresponding FTE staff hired, a subgroup analysis was performed for the eleven programs that saw a decrease or no change in the number of hired attending surgeons after implementation of work-hour rules. These eleven programs (seven university-based programs and four community-based programs) encompassed 226 residents. Thirty-two FTE staff were added across these programs, with a frequency-weighted average cost of $88,600 for each physician extender hired. Two of these programs allowed

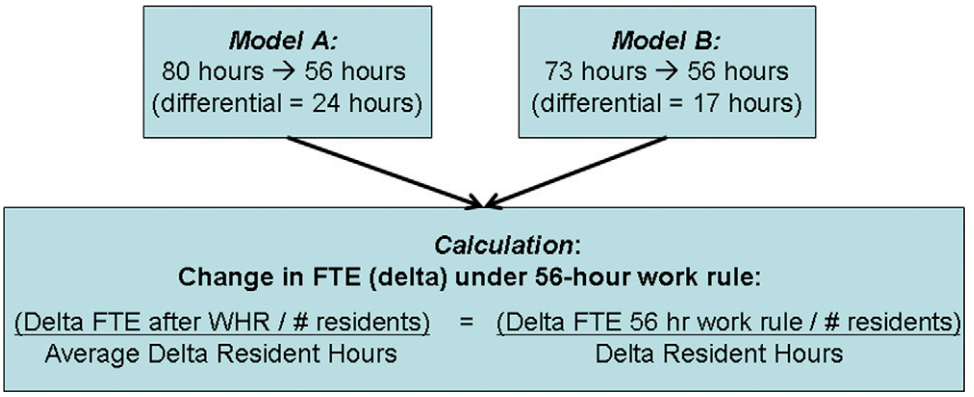

Fig. 1

Cost-sensitivity modeling based on proposed further reductions in work-hour restrictions. FTE = full-time equivalent, and WHR = work-hour regulations.

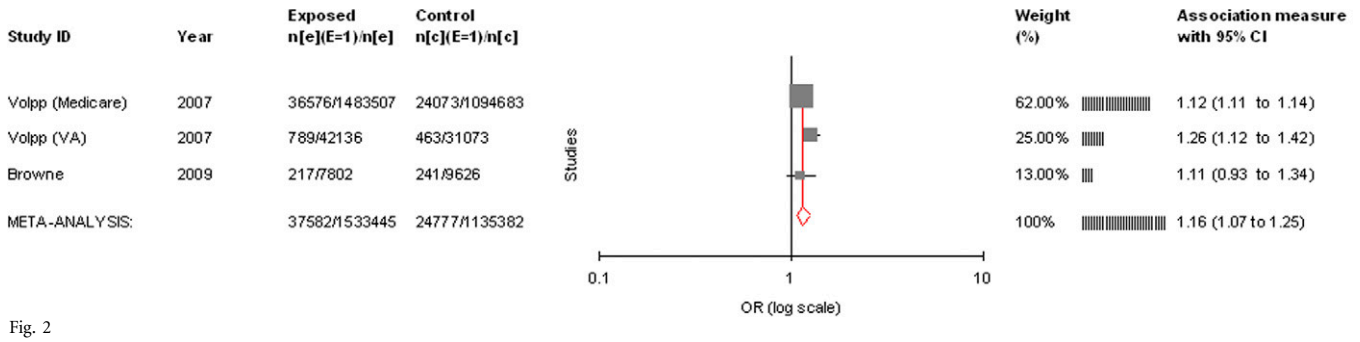

Fig. 2
Meta-analysis for mortality (forest plot) for orthopaedic patients. CI = confidence interval, and OR = odds ratio.

moonlighting prior to work-hour rules; ten allowed moonlighting by the time of survey. Four programs employed a night-float system after the work-hour rules were in place. Based on Models A and B, respectively, the reduction in work hours performed per resident translates into an increased cost of $197 million or $139 million per fiscal year. Likewise, when performing a subgroup analysis on the twenty-three programs (seventeen university-based programs and six community-based programs) that saw no change in the number of residents (a total of 567 residents) before and/or after work-hour rules, the associated increased costs for Models A and B were $145 million and $103 million, respectively, per fiscal year.

Mortality data, adjusted odds ratios, and weighted percentages are presented in Figure 2 and Table II. Based on cost-sensitivity analysis (Model A, reducing work hours from eighty to fifty-six hours) and assuming that the weighted average death rate per 10,000 is true, in order to save one patient in 10,000, the cost to the system is approximately $6.7 million. This is an estimate based on prior assumptions particular to this model, not accounting for the confounding cost factors mentioned before.

Discussion

The ACGME's decision to regulate resident work hours has added considerable costs to teaching hospitals. Our study examined the financial impact on orthopaedic training programs, and it represents the first cost-sensitivity analysis of resident duty limits on orthopaedic training programs. The financial impact of work reductions is immense. The passage of the work-hour restrictions represents one of the largest unfunded mandates in graduate medical education. Implementing the duty-hour reductions across all ACGME programs costs teaching institutions $1.6 billion, according to Nuckols et al.[13]. Academic medical centers filled the void created by resident work-hour reductions through hiring more physician assistants and nurse practitioners; expanding moonlighting programs; implementing night-float systems; and increasing home call[8,15,18]. Teaching hospitals also considered expanding the number of residency positions[13] and/or lengthening residency duration[12,19]. While the ACGME has not directly weighed in on a change in the number of orthopaedic residency positions[20], the practicality of expanding residency programs on an institution-by-institution basis would be based on available Medicare funding. With a limited pool of Medicare funding, adjusting residency spots in one program may necessarily affect the available positions in other programs.

Previous studies have examined the costs of the initial reductions in work hours. For example, Nuckols et al.[13] determined that the 2003 duty limits cost teaching hospitals $3.2 million for substitute providers and $990,000 to $3.5 million for additional residents. The federal government did not provide additional funding to supplement the cost differential caused by the duty-hour limitations of 2003. Thus, teaching hospitals bore these costs as they struggled with decreasing third-party payments and reductions in Medicare reimbursement for services[26]. Despite the considerable costs, most ACGME-accredited orthopaedic programs have been compliant with the duty-hour limits[2,8,19].

One survey of orthopaedic program directors[15] found that 76% of orthopaedic departments hired physician extenders in response to the duty limits. Our pilot data found a similar 86% rate of physician-extender hiring. Problems may occur with this strategy: Peabody[15] suggested that few physician extenders have the desire or training to do orthopaedic work, making recruitment difficult. Moreover, the relatively high salaries of physician extenders increase the financial burden of resident duty-hour limits. Over $96,000 was spent per physician-extender FTE, on average, in this study, with costs as high as $150,000 for registered-nurse first-assistant positions.

Restricted duty hours were designed to reduce the morbidity and mortality associated with medical errors. The literature conflicts on the impact of work-hour reforms, despite the high implementation costs. Although several studies show a benefit in mortality in different populations[27-32], others show no change in mortality after work-hour reforms[33-38]. In our review of the literature, there were three studies that supplied orthopaedic-specific information. Each series showed a reduction in mortality among orthopaedic patients[5,28,29]—a benefit of twenty-seven to thirty-eight deaths prevented per 10,000 cases. However, these data must be interpreted with caution: the difference seen in the study by Browne et al.[5] was not significant. In addition, the control group (nonteaching institutions) showed a comparable reduction in mortality over the same time period. This supports the idea that the reduction in mortality could be the result of improvements in technology or some other extraneous factor. After adjusting for factors such

as teaching status, Volpp et al.[28,29] found no difference in mortality in surgical patients. In one of their studies[28], these authors did find a benefit in mortality after adjustment for medical patients; orthopaedic patients were not specifically separated out in their study. Our meta-analytic data were based on the entire sample (raw data), and thus we were not able to adjust for teaching status. Since this is the case, the argument could be made that, because neither the Volpp studies nor the Browne study found a difference after statistical adjustment, the improvement in mortality was due to some other factor occurring in hospitals in the time frame of interest and not solely as a direct result of work-hour regulations. As such, the argument could be made that there was no "benefit" at all to justify the cost.

The significance of this finding, as well as the extrapolation of deaths prevented under proposed further hour restrictions, is an area of debate. In particular, frequent handoffs increase the risk of adverse events[5]. Other conflicting evidence suggests that the mortality in nonteaching groups actually increased in the time period of work-hour restrictions[30]. Since the impact of the work-hours limitations is unclear with respect to decreasing mortality, it is difficult to say if our cost-benefit analysis is applicable to this aspect of the debate. In addition, further limitation of work hours is based on the assumption that the "benefit" would be linear in terms of medical errors and mortality.

Studies indicate that the effects of duty limitations differ among surgery and medical residents[5,37,39]. Orthopaedic programs achieve the goal of adequate surgical and care competencies training through immersive educational models, with repeated operative exposure and simulation[40]. Surgical faculty members have expressed concerns that residents will view themselves as shift workers as a result of work-hour reductions[6,41]. Others have suggested that reduced work hours could discourage residents from entering demanding specialties such as trauma[42]. Furthermore, the greater number of medical versus surgical residents per program also may alleviate the constant need for continuing house-staff coverage in internal-medicine residencies. In this study, 36% of programs increased the number of residents, including both clinical and research positions. From an attending-surgeon perspective, 86% of the programs experienced a change in the number of operating attending surgeons on staff between 2002 and April 2009; data were insufficient to make adequate correlations between type of program, number of residents, and attending-surgeon operating coverage.

A concern has been that surgery residents will not be adequately trained at the time of matriculation. Studies conflict with regard to whether or not this is true. Herndon[12] and Weatherby et al.[16] postulated that operating hours were reduced by 21.5% to 33%. Others[14,17] found no change in operative volume. Peabody[15] suggested that work-hour reductions short-change residents with regard to clinic experiences rather than operative experience. Other barriers to learning include night-float rotations, which tend to be less educational[15]. Moreover, night-float provides less continuity of care: residents often are not able to participate in procedures on patients they evaluated during the previous night's call[6]. Eighty-nine percent of programs allowed moonlighting at the time of the survey, and a substantial 39% of programs added a night-float system to provide additional coverage.

A potential solution for meeting educational goals would be to extend the length of the orthopaedic residency. However, most residents adamantly oppose this idea. Surveyed residents argue that doing so will have little educational benefit and that orthopaedic fellowship training may make up for learning gaps under the reduced work week[19]. This may shift the focus of training to increased subspecialization[12]. Conversely, hospitals may turn to money-generating specialties—even particular subspecialties within orthopaedics—when considering hiring choices. Compounding this is the upward trend of specialization in high-reimbursement fields, such as sports medicine and spine surgery[12]. This creates shortages in orthopaedic trauma and pediatrics; concordantly, the Orthopaedic Trauma Association adamantly opposes further reductions[43]. The American Academy of Orthopaedic Surgeons has suggested several challenges that may make further reductions in residency hours economically nonviable[26]. These challenges include a looming nursing shortage, reduced reimbursement rates, and provision of care for the uninsured. Moreover, a reduction in hours has not been definitely correlated with improvement in patient-centered outcomes.

There are limitations to this study. Not all programs responded to survey requests, and these pilot data are a foundation for larger-scale studies and continued data collection. As with all retrospective survey data, reporting and recall bias exist. With more survey data, we might be able to look further at issues of sex, residency size, number of research positions, and type of program. The models assume that (1) five hours less, on average, were worked by residents per week[2]; (2) the effect of work-hour rules was linear for this decreased five-hours-per-week period; (3) the cost of a change in residency hours would be consistent on a per resident basis regardless of program type; and (4) the additional benefit of reducing mortality is due to work-hour restrictions and not some extraneous confounding factor (e.g., better technology, more integrated care, effects of the additional staff alone). Underestimates of total monetary adjustments, such as the values of FTE benefits, may further increase the cost of hiring physician extenders. We did attempt to control for the potential confounding factor of increased attending staff or increased resident complement leading to increased costs per FTE physician extender hired. Despite representation from university-based and community-based programs, no armed forces programs responded to the survey. There was variation in the implementation of work-hour restrictions after the 2003 ACGME ruling, pointing to potentially appreciable time lags between regulatory statutes and reflections in the data collected. Finally, there is inherent variability in self-reported resident survey work-hour data[8], causing some error in extrapolating data.

In conclusion, ten years ago, the orthopaedic community worried about an oversupply of surgeons[44]. The landscape of the workforce has shifted dramatically. Today, orthopaedists are

grappling with the realities of a workforce shortage. The demand for certain orthopaedic services is expected to rise 23% between 2000 and 2020[45]. Other research shows orthopaedic surgeons make up 2.5% to 3.5% of all physicians but provide 30% to 40% of all musculoskeletal care[46]. Duty limits may ultimately cost society if certain populations, such as those living in rural communities or the underinsured, cannot receive preventative and timely musculoskeletal care[4].

Further work reductions will have important implications for residency training and the structure of funding support. Teaching hospitals may need to conduct job analyses to maximize learning in shorter periods of time. For instance, residents still spend nine to twenty-four hours per week on noneducational tasks that lower-level providers can perform[13]. Such job analyses require time and resources. Questions also remain on whether the next generation of orthopaedic surgeons will be able to maintain as high a level of commitment to their communities as their predecessors, based on intensity and duration of training. Of interest, the FTE orthopaedic surgeon spends an average of 2200 hours annually—an average of 42.3 hours per week—providing direct patient care[44,47].

As the Institute of Medicine and legislators consider further resident duty-hour limits, a number of proposals exist for teaching hospitals to meet the educational and patient safety goals. These include hiring more physician extenders, expanding moonlighting programs, and increasing the number of residency positions. Our pilot study indicates these solutions will cost orthopaedic training programs upwards of $147 million to $208 million per year. Based on our analysis, further work-hour reductions will be costly and potentially unsustainable without supplementary government funding.

Appendix

(eA) The survey and demographic tables are available with the electronic version of this article on our web site at jbjs.org (go to the article citation and click on "Supporting Data").

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