Increased rate of complications on a neurological surgery service after implementation of the Accreditation Council for Graduate Medical Education work-hour restriction

Clinical article

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Object. The Accreditation Council for Graduate Medical Education instituted mandatory 80-hour work-week limitations in July 2003. The work-hour restriction was met with skepticism among the academic neurosurgery community and is thought to represent a barrier to teaching, ultimately compromising patient care. The authors hypothesize that the introduction of the mandatory resident work-hour restriction corresponds with an overall increase in morbidity rate.

Methods. This study compares the morbidity and mortality rates on an academic neurological surgery service before and after institution of the work-hour restriction. Complications are individually assessed at a monthly divisional conference by neurological faculty and residents. A prospective database was commenced in July 2000 recording all complications, complications that were deemed to be potentially avoidable (“possibly preventable”), and complications that were deemed unavoidable. The incidence of morbidity and mortality from July 2000 to June 2003 is compared with the incidence from July 2003 to June 2006.

Results. The overall rate of morbidity and mortality increased from 103 to 114 per 1000 patients treated after institution of the work-hour restriction, although this increase was not statistically significant ($\chi^2_{1,N=8546} = 2.6, p = 0.106$). The morbidity rate increased from 70 to 89 per 1000 patients treated after institution of the work-hour restriction ($\chi^2_{1,N=8546} = 10, p = 0.001$). The overall mortality rate was diminished from 32 to 27 per 1000 patients treated after institution of the work-hour restriction ($\chi^2_{1,N=8546} = 3.2, p = 0.075$). Morbidities considered avoidable or possibly preventable were seen to increase from 56 to 66 per 1000 patients treated ($\chi^2_{1,N=8546} = 5.7, p = 0.017$). Avoidable or possibly preventable mortalities numbered 3 per 1000 patients treated, and this rate did not change after introduction of the work-hour restriction ($\chi^2_{1,N=8546} = 0.08, p = 0.777$).

Conclusions. The morbidity rate on a neurological surgery service is increased after implementation of the work-hour restriction. Mortality rates remain unchanged. (DOI: 10.3171/2011.9.JNS116)

Key words • complications • work-hour restriction • Accreditation Council for Graduate Medical Education • neurosurgery

Mandatory work-hour restrictions for residents were initiated in July 2003. This change was mandated by the ACGME to reduce resident fatigue, citing “... public opinion that long duty hours compromise patient safety.” The introduction of duty-hour restrictions in the neurological surgery training community was met with skepticism. This sentiment is captured in a national survey published in 2005, with a majority of responding residents and program directors noting that work-hour restriction had a negative impact on their respective training programs. In this same survey, a majority of residents felt the work-hour restriction might enable more time for research and study. Unfortunately, this hope has not been borne out. Instead, there was a reduction in the mean American Board of Neurological Surgery test scores among residents taking the examination for self-assessment and the number of abstract presentations at the American Association of Neurological Surgeons annual meetings after the mandatory introduction of the resident work-hour restriction. The results of a separate survey distributed to program directors and chief neurosurgery residents in 2007 showed that an overwhelming majority of respondents believed the ACGME work-hour restriction not only diminished the quality of neurosurgical training but also compromised patient care.

The perception of diminished quality of education can be measured with board scores and, to a lesser degree, numbers of presentations and publications. However, the perception of compromised patient care among members of the neurosurgical community is more difficult to measure. The authors hypothesize that the mandatory introduction of the resident work-hour restriction
corresponds with an overall increase in the morbidity rate. We evaluated the morbidity and mortality rates prospectively tracked at our institution on an academic neurosurgery service in the years preceding and following the ACGME-mandated resident work-hour restriction.

**Methods**

This study compares the incidence of morbidity and mortality on an academic neurological surgery service before and after institution of the work-hour restriction in July 2003. A prospective database was commenced in July 2000 recording all complications experienced by patients who were treated by the neurosurgical service. This database includes inpatient and periprocedural outpatient complications. The complications database is prospectively maintained by the neurosurgery resident and attending team. Each complication is individually assessed at a monthly divisional conference by the neurosurgical faculty and residents. A consensus opinion on the nature of complications, including causality, is determined by this same neurosurgery team that maintains the database. Individual complications are adjudicated, with respect to causality, as potentially avoidable (either “avoidable” or “possibly preventable”) or unavoidable. This practice was continued until 2008, after which date a new complications-adjudicating vernacular was instituted, limiting comparison of complication causality between patients treated before and after 2008. For the purpose of this study, complications are further dichotomized into deaths (mortality) and nondeath complications (morbidity). Overall morbidity and mortality rates from July 2000 to June 2003 are compared with morbidity and mortality rates from July 2003 to June 2006 and from July 2006 to June 2009. Causality of complications is compared for 2 epochs with data available (July 2000–June 2003 and July 2003–June 2006).

Data were analyzed with SAS 9.2 (SAS Institute, Inc.) and GraphPad Prism 5.0 (GraphPad Software, Inc.). Using a 2-tailed Pearson chi-square test, the risk of each complication was assessed for the cohorts of patients treated before and after institution of the work-hour restriction. Individual statistics with p values < 0.05 were deemed statistically significant.

**Results**

In the 9 years encompassed in this study, 12,957 patients were treated. At least 1 complication occurred in 1471 patients (11%). Admissions of 4 attending neurosurgeons present for the entire study period represent 79% of the entire treated population. Patients admitted under the care of 1 of 6 attending neurosurgeons present for portions of the study period represent the other 21% of the population.

Primary comparisons are drawn between the 3 years before and the 3 years after institution of the resident work-hour restriction (July 2000–June 2003 and July 2003–June 2006). The patients treated had comparable primary diagnoses (Table 1), with 3 notable exceptions: 1) the proportion of patients with atraumatic subarachnoid hemorrhage increased from 21 to 28 per 1000 patients treated after the work-hour restriction ($\chi^2, N = 8546 = 4.3, p = 0.038$); 2) neurotrauma ($\chi^2, N = 8546 = 428.6, p < 0.0001$) was treated more frequently in the years prior to the work-hour restriction; and 3) admissions for peripheral nerve surgery increased from 8 to 20 per 1000 patients treated in the years following the work-hour restriction ($\chi^2, N = 8546 = 21, p < 0.001$).

The overall morbidity and mortality rate increased from 103 to 114 per 1000 patients treated after institution of the work-hour restriction, although this increase was not statistically significant ($\chi^2, N = 8546 = 2.6, p = 0.106$). Morbidity rates increased from 70 to 89 per 1000 patients treated after institution of the work-hour restriction ($\chi^2, N = 8546 = 10, p = 0.001$). The overall mortality rate was diminished from 32 to 27 per 1000 patients treated after institution of the work-hour restriction ($\chi^2, N = 8546 = 3.2, p = 0.075$). Figure 1 represents a summary of morbidity and mortality rates in the comparison groups. The incidence of morbidities considered avoidable or possibly preventable increased from 56 to 66 per 1000 patients treated ($\chi^2, N = 8546 = 5.7, p = 0.017$). The rate of avoidable or possibly preventable deaths (3 per 1000 patients treated) did not change after introduction of the work-hour restriction ($\chi^2, N = 8546 = 0.08, p = 0.777$). Figure 2 represents a summary of avoidable or possibly preventable morbidities and mortalities in the comparison groups.

A subgroup analysis of patients presenting with subarachnoid hemorrhage and neurotrauma was performed. The complication rate among subarachnoid hemorrhage patients having morbidities decreased from 45% to 38% following introduction of the work-hour restriction, although this finding was not statistically significant ($\chi^2, N = 8546 = 1.2, p = 0.271$). The complication rate among patients admitted with neurotrauma increased from 8% to 9% after introduction of the work-hour restriction, although this finding was not statistically significant ($\chi^2, N = 8546 = 2.0, p = 0.163$). Of additional note, there was 1 complication (a wound infection) among 125 total patients treated for peripheral nerve maladies. This occurred prior to introduction of the work-hour restriction.

Secondary comparisons are drawn between more recent years (July 2006–June 2009) and the prior epochs (Fig. 1). Rates of morbidity (91 per 1000 patients treated) and mortality (33 per 1000 patients treated) were the highest among all epochs analyzed ($\chi^2, N = 12,957 = 9.0, p = 0.011$). Compared with previous epochs, patients treated in this time frame were more likely to have neurotrauma, peripheral nerve surgery, and atraumatic subarachnoid hemorrhage, but less likely to have spine surgery (summarized in Table 1).

**Discussion**

The results of this study show an increased overall morbidity rate and diminished mortality rate after mandatory introduction of the ACGME-mandated work-hour restriction. At our residency program, the mandatory ACGME work-hour restriction was instituted in July...
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2003. In the years preceding the work-hour restriction, the 1st- and 2nd-year residents on service carried a majority of the daily patient care and overnight call, limiting handoffs. To comply with the ACGME-mandated work-hour restriction, midlevel residents were brought into the call schedule, effectively doubling the number of resident caretakers and patient care handoffs. We hypothesize that diminished familiarity with patients outweighs any potential benefit offered by the work-hour restriction. Incidentally, this schedule modification has resulted in less protected research and study time for 3rd- and 4th-year residents, who traditionally have devoted time to research and electives.

Comparison of treatment groups between 2 epochs is inherently biased, but the 2000–2003 and 2003–2006 treatment groups were similar when stratified by diagnosis (Table 1). Atraumatic subarachnoid hemorrhage was more frequently treated after introduction of the work-hour restriction, which represents a potential confounding factor. Although, complication rates are typically high in such cases, a lower incidence of complications was seen in these patients after introduction of the work-hour restriction. We attribute this change to the evolution of treatment of ruptured aneurysms, which has led to a diminished rate of complications nationally.1 A higher rate of neurotrauma prior to the work-hour restriction represents a relevant source of bias. This primary diagnosis represents roughly 22% of the entire population treated, and the complication rate for patients with neurotrauma (9%) is lower than that of the overall population (11%). This potential confounder is in part offset by an increased percentage of patients with peripheral nerve maladies treated after the work-hour restriction.

A trend toward a reduced mortality rate in the years following introduction of the work-hour restriction is encouraging but deceiving (Fig. 1). The nature of neurosurgical problems includes intracranial pathology frequently resulting in inevitable mortality. This trend was not seen in the 3rd epoch (July 2006—June 2009). Deaths considered to be avoidable or possibly preventable were few and the rate remained unchanged after introduction of the work-hour restriction (Fig. 2). Of interest, similar studies measuring change in surgical complications after implementation of the work-hour restriction have measured similar increases in morbidities with declines in mortality.2,4

The ACGME-mandated work-hour restriction was instituted in response to public opinion and with little evidence to support the claims that decreased hours would improve patient care.7 Since the introduction of the ACGME-mandated work-hour restriction, the neurosurgical community has documented a sentiment of diminished quality of education and patient care.5 While quality of care is difficult to measure, we reluctantly share one neurosurgery residency’s experience with the work-hour restriction. An over-arching question, unanswered by this study, is why the goals of the ACGME have not been met by the resident work-hour restriction. Increased complication rates after initiation of the work-hour restriction have also been reported on other surgical subspecialty services.2,4 At the University of Vermont, the work-hour restriction has built more handoffs into patient care. We hypothesize that this is among the reasons for increased morbidity after introduction of the work-hour restriction. Bias may, however, represent another hypothesis. Our complications database is maintained by the neurosurgery residents and attending physicians, introducing potential for reporting bias—the disfavor for the work-hour restriction within the neurosurgical community is well documented.5 A national trend of increased perioperative complications after introduction of the work-hour restriction2,4 favors the former hypothesis rather than the latter. We hypothesize that additional work-hour restriction for 1st-year residents6 will compound this effect.

Conclusions

The morbidity rate on an academic neurological surgery service increased in the years following implementation of the mandatory work-hour restriction. The relationship between work-hour restriction and morbidity rates is unclear. Additional study into the validity of mandated work-hour restrictions in surgical subspecialty training is warranted.
Disclosure

The authors report no conflict of interest concerning the material or methods used in this study or the findings specified in this paper.

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