Abstract

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The resident 80-hour workweek and the July phenomenon have raised concern regarding the continuity of care of orthopedic patients in teaching institutions and its effect on postoperative complications and mortality. This study examined the effect of resident work-hour restrictions and the July phenomenon on patient outcomes after hip fracture at a large academic institution.

Seven hundred twenty-two patients (mean age, 76.7 years) sustaining 319 femoral neck fractures and 403 intertrochanteric fractures between 2000 and 2010 were identified. Analysis was performed before and after July 1, 2003, as well as for the month of treatment. No difference existed in the postoperative outcome measures of delay of surgery ($P = .061$), complications ($P = .904$), and mortality ($P = .981$) between patients treated before and after July 1, 2003. Patients treated after July 1, 2003, had a significantly higher median number of preoperative comorbidities (4 vs 3, respectively; $P < .0005$). Turnover months, July and August, showed no difference in the outcome measures of delay of surgery ($P = .171$), complications ($P = .776$), and mortality ($P = .524$) compared with other months.

This study suggests that 80-hour workweek restrictions or resident turnover months have no effect on patient care with respect to in-hospital time to surgery, complications, and mortality. This success can be attributed to ancillary staff support, physician extenders, and well-designed patient care protocols.
Since the widely publicized accidental death of Libby Zion in 1984, public awareness has increased with respect to resident physician work-hour restrictions and supervision. Increased rates of medical errors associated with fatigue and sleep deprivation coupled with political action resulted in several states mandating work-hour limitations for residents while in training. Soon after, on July 1, 2003, the 80-hour workweek was adopted nationally by the Accreditation Council for Graduate Medical Education (ACGME).

Modeled after other industries, such as airlines and trucking, which combat fatigue-related errors through work-hour restrictions, resident duty hours are intended to improve patient care and safety; however, many believe that these restrictions are fraught with their own difficulties. Limiting work hours requires more frequent patient handoffs between providers, which may result in unfamiliarity with patients, loss of information, and a compromise in care. Also, opponents of work-hour restrictions suggest residents spend less time in the hospital, which may lead to an inferior training experience and, ultimately, a compromise in patient care. Both theories are plausible, but they are difficult to measure, and neither has been supported by data thus far.

To complicate matters, it is commonly believed that the when new trainees begin residency in July and August, an increase occurs in complications and mortality, known as the July phenomenon. Anecdotally, it is the combination of new residents and increased handoffs from work-hour restrictions that may lead to increased complications in the months of July and August. Although this theory is widely accepted, research suggests it might be false. In reality, the majority of literature regarding the impact of the 80-hour workweek and its effects on patient care has demonstrated no change in mortality or complications with little exception. A paucity exists of orthopedic research that addresses this subject, especially focusing on turnover months. The purpose of the current study was to investigate the effect of resident work-hour restrictions on delay of surgery, surgical complications, and mortality in orthopedic trauma at a large academic institution during the turnover months of July and August.

**MATERIALS AND METHODS**

The medical records of 722 patients sustaining femoral neck and intertrochanteric hip fractures between 2000 and 2010 were reviewed following institutional approval. All patients were treated at a Level I teaching institution. Patients were initially identified with diagnosis code queries from institutional databases. Thereafter, each case was individually reviewed. Variables recorded included patient demographics, procedure type, fracture type, anesthesia data, complications, comorbidities, date of admission, date of surgery, and delay of surgery.

At the authors’ institution, all patients sustaining hip fracture are placed under a protocol used to help standardize treatment. Initially, each patient undergoes consultation and screening by a cardiologist and anesthesiologist preoperatively for risk stratification and optimization. All patients at high risk for deep vein thrombosis or with fractures more than 24 hours old are screened with lower-extremity duplex ultrasounds for deep vein thrombosis preoperatively. Furthermore, all patients are placed on appropriate deep vein thrombosis prophylaxis pre- and postoperatively unless contraindicated. House officers complete a preoperative checklist that includes appropriate labs, consults, and paperwork for each patient preoperatively. Patients are administered spinal anesthesia unless contraindicated. The conversion from spinal to general anesthesia is 1% at the authors’ institution. Surgery was performed by 1 of 6 attending surgeons. Postoperatively, each patient is seen by a physical therapist, occupational therapist, and case management worker. All patients are mobilized by postoperative day 1 by physical and occupational therapists. Patients who clear therapy are discharged with home physical therapy and nursing care. Patients who are unable to clear therapy or require additional rehabilitation are placed in an acute inpatient rehabilitation or skilled nursing facility at discharge. Furthermore, beginning in 2003, the authors’ institution hired 5 nurse practitioners to aid house officers in managing floor patients.

For the current study, patients were stratified for 2 separate analyses to study the resident work-hour restrictions and July phenomenon. First, the patients were stratified by day of admission before or after July 1, 2003. Two hundred forty-three patients were admitted before July 1, 2003, and 479 were admitted after. Next, cases during resident and fellow turnover months of July and August, as determined by date of admission, were identified. This yielded 107 patients during these 2 months and 615 patients during the rest of the year. Analysis of each month was also performed to identify any month with significantly different outcomes. Primary outcome variables used to identify changes between groups were delay to surgery, in-hospital complications, and in-hospital mortality. Delay to surgery was defined as more than 48 hours from injury to surgery.

**Patient Characteristics**

Five hundred twenty women and 202 men were identified for the study. Mean age was 81 years (range, 19-102 years). Medical and surgical comorbidities identified were summated to obtain the total number of comorbidities for each patient. Complications were categorized as cardiac, pulmonary, postoperative anemia requiring transfusion, gastrointestinal, wound breakdown or drainage, mental status changes, acute renal failure, urologic, coagulation manifestations, pressure ulcers, and return to the operating room. Cardiac complications included...
acute myocardial infarction, arrhythmia, congestive heart failure exacerbation, and unexplained hypotension. Pulmonary complications included acute respiratory failure, prolonged intubation, pneumonia, and pleural effusion. Gastrointestinal complications included obstruction, perforation, bleed, clostridium difficile infection, and ischemia. Urological complications included urinary tract infection and urinary retention. Coagulation manifestations included cerebral vascular accident, pulmonary embolus, and deep vein thrombosis. Each category was then transformed to a bivariate variable to identify whether a patient had a complication.

Treatment was identified by procedure codes and separated into 3 categories: internal fixation, hemiarthroplasty, or total hip arthroplasty (THA). Fractures classified as 31-A were treated with internal fixation, whereas fractures classified as 31-B were treated with arthroplasty or internal fixation. Treatment and fracture type were analyzed. Only the primary surgery was included. Return to the operating room was considered a surgical complication.

Statistical Analysis

Groups were compared in terms of comorbidities and demographics in each analysis to ensure statistical similarity. Next, variables recorded were tested for association to outcome variables. Continuous variables were compared using analysis of variance. Categorical variables were compared using Pearson’s chi-square test and Fisher’s exact test where appropriate. Post-hoc power analysis for the primary outcome of mortality in the 80-hour workweek analysis was performed. At $\beta=0.8$, a 4.8% difference in mortality was detected between groups.

RESULTS

Resident Work Restriction

No difference in age ($P=.461$) or sex ratio ($P=.294$) existed between patients treated before and after work-hour restrictions (Table 1). Twelve mortalities occurred in 722 patients. The mortality rates before and after July 2003 were 4/239 (1.67%) and 8/471 (1.69%), respectively. One death occurred during turnover months. Complication rates before and after July 2003 were 14% vs 16%, respectively. Patients treated after July 1, 2003, had a significantly higher body mass index (24.35 kg/m$^2$) vs 22.92 kg/m$^2$, respectively; $P=.006$ and mean number of preoperative comorbidities (4.72 vs 3.58, respectively; $P<.0005$). No difference existed in the outcome measures of delay of surgery ($P=.149$), complications ($P=.798$), and mortality ($P=.981$) between these 2 groups (Table 2). Subgroup analysis of complications revealed that patients treated after July 1, 2003, were more likely to have wound issues ($P=.048$) and deep vein thrombosis/pulmonary embolus ($P=.053$).

July Phenomenon

No statistical difference existed in age ($P=.080$), sex ratio ($P=.630$), body mass index ($P=.150$), or mean number of comorbidities ($P=.116$) between patients treated during July and August vs other months (Table 3). August had the highest body mass index (25.1 kg/m$^2$); this was not statistically significant. Patients had the most comorbidities during the month of July (5.4 comorbidities by diagnosis code); this was not statistically significant. No difference existed in the outcome measures of delay of surgery ($P=.283$), complications ($P=.776$), and mortality.
The satisfactory patient outcomes observed in this study may be explained in several ways. First, work-hour restrictions theoretically increase the amount of sleep time for residents, which in turn may reduce the number of fatigue-related errors. In addition, the authors’ institution has established several protocols and preoperative checklists designed by attending physicians to be used by junior residents as guidelines to patient care. These protocols help standardize care through a system of checks and balances delivered by multiple health care providers, thus limiting mistakes and resulting in improved patient care. Other studies have shown that protocol- or pathway-driven patient treatment can lead to improved care.\(^\text{15}\) Second, work-hour restrictions have shifted some of the burden of care from residents to attending physicians and physician extenders. Since 2003, the authors’ institution has seen a dramatic increase in the number of attending physicians on staff and the number of ancillary health care providers. Physician extenders may improve outcomes indirectly by providing consistency within a particular service and by freeing residents of work duties that may be less clinically related or educational.\(^\text{16}\) Perhaps the increased supervision and increased personnel have contributed to the positive effect on patient care and the outcomes seen in the current study.

Finally, although work-hour restrictions were initially believed to be detrimental to resident education, research suggests that residents may be receiving an improved operative experience despite ACGME changes.\(^\text{11}\) This may be related to physician extenders and ancillary staff freeing residents from nonoperative and noneducational work-related duties. Also, it is likely that upper-year residents and fellows who have more clinical experience and knowledge have been more closely involved in patient care since the work-hour restrictions were mandated. Improved

### Table 3

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<th>Month and July/August Group Characteristics</th>
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<td><strong>Variable</strong></td>
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<td><strong>BMI, kg/m(^2)</strong></td>
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<td><strong>Comorbidities</strong></td>
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<td><strong>July/August</strong></td>
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<td><strong>Pearson Chi-square Test</strong></td>
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**Abbreviation:** BMI, body mass index.

*Analysis of each month compared to the other 11 months.

*Analysis of variance.

\(P= .524\) between the 2 groups (Table 4). Subgroup analysis of complications revealed no difference in patients treated during July and August vs other months.

### Discussion

In response to public concerns regarding patient safety, this study investigated whether patient outcomes, including delay of surgery, complications, and mortality, are affected by residency work-hour restrictions. Although it was once believed that superior resident training was the result of the number of hours spent in the hospital with patients, the current literature supports no change in operative experience or educational in-training scores after the 80-hour workweek restrictions were imposed.\(^\text{10,11}\) Furthermore, data from several fields of medicine have demonstrated no decline, and possibly some improvement, in patient care after implementation of the 80-hour workweek.\(^\text{3,5-7,12}\) Similarly, the July phenomenon has yet to be proven, despite being widely accepted in academic medicine.\(^\text{13,14}\)

The current study’s findings are consistent with the current literature. The ACGME 80-hour workweek restriction demonstrated no increase in mortality. Patients treated before work-hour restrictions were implemented on July 1, 2003, showed no statistical difference from patients treated after restrictions were implemented when comparing delay of surgery \((P=.149)\), complications \((P=.798)\) and mortality \((P=.981)\). Patients admitted after restrictions were implemented had higher body mass indices and more comorbidities. This may be due to the changing referral base of the authors’ hospital and may suggest that care has improved to achieve similar outcomes in difficult patients.

Similarly, no evidence existed of worsening care during months of high resident and fellow turnover. The outcome measures of delay of surgery \((P=.283)\), complications \((P=.776)\), and mortality \((P=.524)\) were similar between the groups. The data trended toward patients admitted during July and August being less healthy.
clinical experience and closer supervision from more experienced residents may play a role in helping keep complications low during turnover months, along with work-hour restrictions.

Limitations of this study were related to its design because the data were from a single institution with its own protocols and systems; thus, the findings of this study may not be generalized to other institutions. The study is also limited by the retrospective analysis and the way in which data were originally collected: from an electronic hospital computer database that relies on coding and information from patient charts. Although this information is generally reliable, it is not as accurate as data collected prospectively. In addition, it is possible that the data were affected by a reporting bias from providers with respect to documenting and possibly underreporting complications. Finally, many confounding variables, such as technology improvements, protocol changes, and personnel additions, that occurred before and after 2003 were not accounted for but might have contributed to the results of this study.

CONCLUSION
This study found that care of orthopedic patients has not changed despite persistent fears about the 80-hour workweek restrictions or resident turnover months with respect to delay of surgery, complications, and mortality. Tertiary care centers may be seeing less healthy patients; despite this, care appears consistent. This success can be attributed to ancillary staff support, physician extenders, and well-designed patient care protocols. Successful patient outcomes are multifactorial in nature, and a controlled, prospective study may help elucidate the precise reasons for the positive outcomes found in this study.

REFERENCES


