A Narrative Review of Surgical Resident Duty Hour Limits: Where Do We Go From Here?

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Abstract

Background Resident duty hour limits have been a point of debate among educators, administrators, and policymakers alike since the Libby Zion case in 1984. Advocates for duty hour limits in the surgical subspecialties cite improvements in patient safety, whereas opponents claim that limiting resident duty hours jeopardizes resident education and preparedness for independent surgical practice.

Methods Using orthopaedic surgery as an example, we describe the historical context of the implementation of the duty hour standards, provide a review of the literature presenting data that both supports and refutes continued restrictions, and outline suggestions for policy going forward that prioritize patient safety while maintaining an enhanced environment for resident education.

Results Although patient safety markers have improved in some studies since the implementation of duty hour limits, it is unclear whether this is due to changes in residency training or external factors. The literature is mixed regarding academic performance and trainee readiness during and after residency.

Conclusion Although excessive duty hours and resident fatigue may have historically contributed to errors in the delivery of patient care, those are certainly not the only concerns. An overall "culture of safety," which includes pinpointing systematic improvements, identifying potential sources of error, raising performance standards and safety expectations, and implementing multiple layers of protection against medical errors, can continue to augment safety barriers and improve patient care. This can be achieved within a more flexible educational environment that protects resident education and ensures optimal training for the next generation of physicians and surgeons.

Background: Historical Context

Resident duty hour limits have been a point of debate for several years. As recently as the mid-1980s, residency training could be likened to an apprenticeship that had features of indentured servitude. The demand to learn an entirely new craft within a relatively short period of time heightened the intensity of residency training. This stress was compounded by a schedule that included overnight call every other night and 100+ hour workweeks for many residents. This left little room for work-life balance and may have contributed to resident fatigue and possibly early burnout.[1,2]

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Over the past 2 decades, the philosophies and policies regulating resident duty hours have changed dramatically. Duty hours are now tightly regulated, with specific rules mandating sufficient time spent out of the hospital. Also, direct supervision of patient care by attending physicians has become a greater priority.[3,4] These policies were designed with the goal of increasing patient safety, but some have argued that they may compromise resident education.[5,6] Although the number of hours resident spent at work has decreased, the amount of knowledge needed to be a competent physician is constantly expanding, and the total number of years of residency training has remained unchanged. It is unclear whether duty hour limits have resulted in significant improvement in patient care, and there is concern that the quality of education of residents has been affected by these changes, especially with regard to case volume in the surgical disciplines.[7,8]

In 1984, Libby Zion, the daughter of *Daily News* columnist Sidney Zion, was admitted to New York Hospital. She was prescribed multiple medications from several practitioners, including sedatives, antihistamines, antidepressants, narcotic pain medication, and antibiotics.[9]

During a hospitalization after days of chills, body aches, and fever at home, she died, reportedly as a result of an adverse medication interaction.[9] After a campaign by her father against excessive resident duty hours, the case served as a catalyst to restructure resident education and resulted in groundbreaking New York State policies regulating work hours of medical trainees.[10]

In 1989, New York's health commissioner appointed a committee, headed by Dr Bertrand M. Bell, tasked with making specific recommendations on several aspects of patient care and resident education.[11] While the Bell commission emphasized the importance of resident supervision, ensuing debates primarily focused on limiting resident work hours.

Although these new policies were made official in New York State, enforcement was relatively lax until the late 1990s.[12] In 2003, the Accreditation Council for Graduate Medical Education (ACGME) created nationwide duty hour limits for residency programs across all specialties and subspecialties. The ACGME required a minimum of one 24-hour period off duty each week averaged over a 4-week period, overnight call no more frequent than once every 3 nights, and expanded *duty hours* to include any assignment to clinical or educational activity, limiting them to 80 hours per week. Subsequently, a committee charged by the Institute of Medicine (IOM) cited studies that continuous time awake upward of 30 hours can result in measurable fatigue[13] and called for further modification of the 2003 ACGME duty hour standards. In 2010, the ACGME released a new set of duty hour standards, to become effective in 2011, which shortened the consecutive duty period of first-year residents to 16 hours and required that more senior residents have 14 hours off after a 24-hour call shift. Previously, residents were permitted to stay at the hospital for an additional 6 hours to aid in the transition of care to covering practitioners. This "transition time" was shortened to 4 hours.[14]

Failure to comply with these standards can result in an adverse action, ranging from citations to probation to loss of accreditation. Recent revision of resident duty hour standards has increased scrutiny of their effect on both patient safety and quality of resident education.[4,5,15–18] However, there is no evidence-based consensus on whether resident duty hour limits are beneficial because of conflicting literature and methodological concerns, including those surrounding the use of a wide range of outcome metrics.[4,19–21]

Duty Hour Limits: Effect on Patient Safety

Ideally, resident duty hour limits would result in more rested residents and would decrease their likelihood of committing medical errors. In addition to morbidity and mortality, surrogate outcome measures, such as frequency of medical errors, feelings of resident fatigue, and resident performance on working-memory tests, have been used to evaluate patient safety in the era of duty hour limits. Individual reports in the literature have supported duty hour limits, citing improved patient safety.[22,23] However, larger systematic reviews have concluded that these studies suffer from a number of limitations, including small sample sizes, lack of robust methods for measuring patient safety outcomes, lack of control groups, and the potential for both cultural and publication bias.[4,20,21,24,25] In addition, many systematic reviews did not focus specifically on surgical disciplines, which may limit their applicability to surgical trainees.

The effect of duty hour limits on sleep patterns and cognition has previously been investigated in medical residents. A reduction in duty hours increased the amount of hours slept both on a nightly[26] and weekly[22] basis. Gohar and colleagues[26] demonstrated the negative cognitive effects of being on-call, which showed substantial deficits in working-memory capacity up to 4 days post-call, whereas Lockley and colleagues[22] were able to demonstrate that duty hour limits had the positive effect of decreased "attentional failures" (as measured by continuous electrooculography) by half while increasing weekly sleep totals by 1 hour for every 4 hours in reduced work totals.

Although these findings are noteworthy, an influence of resident sleep patterns on patient outcomes has not been demonstrated. Observational studies have shown decreases in all-cause mortality[23,27] and in the frequency of "complications due to the provider"[23] in the period following implementation of resident duty hour limits, but these outcome measures are nonspecific in delineating the role of duty hour restrictions in directly improving patient outcomes. Furthermore, although each study controlled for patient-specific confounders, without comparing to nonteaching hospitals as controls, it is unclear whether the improved outcomes seen were mainly due to limited resident duty hours or to advances in technology or to other initiatives, which contributed to improved patient safety across hospitals as a whole.

Although these studies indicated that duty hour limits might be associated with greater patient safety, evidence from 4 large epidemiologic studies indicates that there may be no such improvement. First, a study[28] of 14 million Medicare and Veteran Administration (VA) patients showed no difference in morbidity, mortality, continuity of care, and technical care metric indicators under limits on resident hours. Two additional studies evaluated 30-day all cause mortality in 8.5 million Medicare[29] and 318 636 Veterans Administration (VA)[30] patients before (2000–2003) and

after (2003–2005) implementation of the ACGME duty hour standards. In both studies, hospitals were stratified by teaching intensity and compared. Although medically managed patients in the VA-based study had improved mortality rates in the second postreform year, there were no differences in mortality rates of surgical patients in either study. Furthermore, the improvements noted in the medical patients in the VA cohort were not seen in the larger Medicare cohort.[29,30] Finally, analysis of the National Data Trauma Bank, before (2001–2002) and after (2004–2005) the 2003 duty hour limits, revealed a statistically significant (but clinically indeterminate, according to the authors) decrease in mortality in teaching hospitals, with data from nonteaching hospitals used as a control.[31]

A systematic review of available literature by Baldwin et al[19] demonstrated a decrease in mortality following duty hour limits. Similar improvements, however, were noted in nonteaching institutions (odds ratio, 1.12; $P < .05$), calling into question the exact contribution of the duty hour limits in the improved mortality rate. Additionally, there were no dose-response improvements in mortality following duty hour limits, indicating that further reductions may not be beneficial.[19] A smaller sample of 10 North Carolina hospitals examined after implementation of duty hour limits showed an odds ratio of 0.99 per year of "rate of harms" per 1000 patient-days, indicating no improvement in patient safety.[32]

Two notable studies demonstrated that certain patient outcome measures have worsened since the reduction of resident duty hours. Evaluation of the Nationwide Inpatient Sample database for morbidity and mortality in patients with hip fractures revealed an increase in overall morbidity for both teaching and nonteaching institutions, indicating a general increase in illness severity of patients with hip fractures.[33] However, this study noted that the teaching institutions suffered from a significant *increase* in perioperative pneumonia, hematoma, transfusion, renal complications, nonroutine discharge, and length of stay in association with restricted duty hours.[33] Assessment of 614 000 patients with coronary artery bypass grafting from the Nationwide Inpatient Sample database showed that although there was a global decrease in mortality and hospital length of stay, there was an *increase* in operative morbidity in teaching hospitals after implementation of duty hour limits compared with nonteaching hospitals.[34] Interestingly, this study was performed by the same group of researchers that had reported mortality improvement in a smaller, institution-based study the previous year.[27]

These data reveal mixed outcomes with regard to patient safety and underscore the potential for unintended consequences from restricting resident duty hours. One explanation is that restricted resident duty hours increased the number of transitions in patient care between physicians, which may offset or even outweigh any potential improvements linked to better rested residents.[35] Controlled observational studies of resident-physician sign-out procedures have shown that important information is not routinely conveyed and that residents overestimate the effectiveness of their sign-out communication.[36]

Duty Hour Limits: Effect on Resident Education

The effect of resident duty hour limits on the quality of graduate medical education is also of serious concern, particularly for procedure-based training programs. The demand to develop operative skills in addition to the ACGME core competencies[15] in a relatively shortened period creates a difficult challenge. The effect of resident duty hour limits on the quality of education is difficult to track because studies are limited by imprecise and largely nonvalidated outcome measures.[4,20,21,25]

Current assessments include operative volume, in-training examination scores, national board examination passing rates, and survey studies of residency program directors and residents.[4,20,21,25] Many studies have concluded that there has been no change in resident education since the implementation of the duty hour limits. Examinations of self-reported resident case logs, a residency requirement by the ACGME for surgical residencies, have shown unchanged operative volume within specific institutions.[18,37] A study conducted in a single residency program reported an increase in resident surgical caseload of 12.5%.[38] Neither study reported how this relates to the hospitals' overall surgical volume. However, a separate, independent analysis[39] of the New York Statewide Planning and Research Cooperative System database for the teaching hospital in that study revealed a 27% increase in inpatient discharges during that same period, which is a reasonable surrogate for surgical volume in specialty hospitals. A study of 14 600 surgical cases at one institution showed a 1250% increase in coding for "no qualified resident available" after duty hour limits were enacted.[23] Another cause for concern is that surgical program directors have been unable to provide adequate volume and breadth of cases that residents should be able to competently perform upon completion of training.[7]

Limiting duty hours presumably permits residents to study more and thus improves performance on annual nationally standardized examinations. This, however, has not been shown reliably. One study[18] revealed no difference in orthopaedic in-training examination raw scores across years of test administration before and after implementation of the duty hour limits. These results are limited, however, by the inability to adjust for varying test difficulty

between years of administration. Surveys of residents and attending surgeons yield mixed results. One survey of 500 orthopaedic residents revealed a sense of improved quality of life but diminished quality of training, and those rotating on trauma services had the most difficulty adhering to duty hour limits.[40] Residents reported feeling more rested and more content but not better prepared or more attentive. Additionally, program directors and senior residents surveyed did not believe that resident performance had improved as measured by perceptions of performance on standardized tests.[41] A single-institution survey of 48 orthopaedic surgery residents and 39 attending surgeons showed that senior residents felt that their education was negatively affected by the work rules.[42] Junior residents expressed a more neutral view but were more likely to report that duty hour limits negatively affected their operative experiences. Although all agreed that resident quality of life had improved, it is unclear whether that justifies a perceived negative effect on education, continuity of care, and operative experience.[42]

Residency program directors and attending surgeons are in a unique position to observe residents' professional development. Surveys of residency program directors and attending surgeons show that there are growing concerns about training quality with increasing duty hour limits. Seventy-eight percent of 464 residency directors across multiple disciplines (internal medicine, pediatrics, and general surgery) believe that there has been a decrease in the ability of residents to develop 5 of the 6 ACGME core competencies.[15] Another survey[5] showed that 92% of surgical educators recognized a difference between residents trained under duty hours limits and those who were not, namely a diminished work ethic, delayed development of decision making/critical thinking and technical skills, and a decreased sense of patient ownership. Faculty surgeons entrusted residents less with patient care, and they had less confidence in residents to operate independently; 89% reported that more restrictions would impede the effort to obtain a timely and comprehensive resident education.[5]

Finally, standardized objective data have shown a negative effect on resident education. The rate of failure on the American Board of Orthopaedic Surgeons (ABOS) board certification examinations increased from 13% in 2006 to 19% in 2010.[43] Unlike many standardized in-training examinations, a subset of consistent examination items (''equators''), across years of examination administration, allow for standardization across years and adjustment of yearly fail rates by examination difficulty. Conversely, orthopaedic in-training examination scores are normalized year to year, and raw scores are not standardized yearly by difficulty, making them subject to confounding when used as a measure of resident academic performance. This is evidenced by orthopaedic in-training examination scores predicting failure of ABOS examinations in only the lowest 20% of test takers.[44]

Balancing Patient Safety and Resident Education: Systematic Improvements

The ''Swiss cheese model of medical errors''[45] has been used to analyze the causes of systematic failures. The system is analogous to a stack of slices of Swiss cheese. The holes are opportunities for a failure to occur, with each of the slices representing the layers of the system. These multiple layers of protection prevent medical errors from occurring, and an error will occur only if the ''holes align'' and the error penetrates all of the safeguards. In the case of Libby Zion, multiple doctors were prescribing her multiple medications for several different conditions.[9,10] As a victim of a disjointed outpatient medical system, she presented to the hospital after developing serotonin syndrome.[47] A communication breakdown between her inpatient and outpatient physicians may have contributed to a missed diagnosis.

With regard to duty hour limits, small controlled studies and systematic reviews have shown some improvements in certain patient safety indicators. However, the most robust, large-scale studies that evaluated morbidity and mortality in which nonteaching hospitals were used as controls have shown no direct correlation between patient safety and resident duty hour limits in surgical specialties. The reductions in duty hours increase the number of transitions in hospital coverage, and with each transition, there is an opportunity for critical information to be lost. There is a loss of continuity in patient care, which has the potential to introduce new safety concerns. In addition, resident education may be affected, with both subjective and objective measures indicating new deficiencies in graduate medical education. The most recent duty hour standards have been estimated to cost an already overextended health care system an estimated $1.6 billion in additional labor costs, as additional providers are required to operate a hospital.[46] Finally, although subjective measures of resident quality of life have shown improvement, limiting duty hours is not associated with the same increase in number of hours slept. A reduction in hours worked by 20 h/wk increased weekly sleep totals by only 6 hours,[22] and residents have shown poor adherence to protected sleep time.[21] Time and cost-saving, systematic safety improvements, in addition to the employment of physician extenders, may improve patient safety by adding more safeguards to the Swiss cheese model, while at the same time, minimizing the negative effect on resident education.

Conclusions and Future Direction

To maintain patient safety and maximize resident education, there needs to be more flexibility in the educational system; further reduction in resident duty hours may not be appropriate. Furthermore, a single, sweeping policy should not dictate duty hour limits for all residents because different specialties have different educational needs and unique cultures that need to be considered when structuring the residents' experience. Even within subspecialties, service-based work hour regulations should be permitted. Extending weekly and monthly averaging of hours, or implementing a voucher-type system that allows residents to exceed the duty hour standards for a limited number of weeks of trauma or emergency-based rotations, counterbalanced by tighter restrictions on elective blocks, would build more flexibility into the system. This would enhance resident education, maximize clinical experiences, and minimize the fragmentation of care of nonelective surgical patients. Defining *duty hours* might be adjusted to exclude educational time in the hospital away from patient care (eg, reading, anatomy dissection). Some have also proposed improving continuity of care by exempting reoperations during the same hospitalization to improve both patient care and resident education.[35] Supervising surgeons can appropriately delegate tasks in the operating room based on factors such as number of hours worked. For instance, a resident who has been on duty for a longer number of hours may assist and retract rather than act as the first assistant. Finally, further redistribution of ancillary staff and physician extenders (eg, physician assistants, nurse practitioners) would allow for most of a resident's time to be spent on education and clinical care, rather than nonessential tasks.[40,41]

Although excessive duty hours and resident fatigue may have historically contributed to errors in the delivery of patient care, they are certainly not the only concern. In addition to duty hour limits, there needs to be a focus on improving the quality of communication, supervising the transition of patient care, minimizing resident shift turnover, and ensuring systematic safety improvements including electronic health records and computer ordering systems that alert prescribers of medication interactions. Further revisions to the duty hour standards should increase flexibility in an effort to maximize resident education and maintain patient safety, improve supervision, and optimize a resident's time spent in the hospital, rather than attempting to create ''one size fits all'' directives. The goal should be to promote an overall culture of safety,[48] which includes ensuring systems-based advances, identifying potential sources of error, raising performance standards and safety expectations, and implementing multiple layers of protection against medical records, rather than disproportionately overemphasizing resident duty hour limits. Future outcomes research should include standard, consistently measurable outcome metrics and the use of control data, whenever possible.

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