

Duty-Hour Limits and Patient Care and Resident Outcomes: Can High-Quality Studies Offer Insight into Complex Relationships?

Ingrid Philibert,¹ Thomas Nasca,^{1,2}
Timothy Brigham,^{1,2} and Jane Shapiro¹

¹Accreditation Council for Graduate Medical Education, Chicago, Illinois 60654;
email: iphilibert@acgme.org

²Jefferson Medical College of Thomas Jefferson University, Philadelphia, Pennsylvania 19107

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graduate medical education, fatigue, continuity of care, patient safety, clinical skills

Abstract

Long hours are an accepted component of resident education, yet data suggest they contribute to fatigue that may compromise patient safety. A systematic review confirms that limiting duty hours increases residents' hours of sleep and improves objective measures of alertness. Most studies of operative experience for surgical residents found no effect, and there is evidence of a limited positive effect on residents' mood. We find a mixed effect on patient safety, although problems with supervision, rather than the limits, may be responsible or contribute; evidence of reduced continuity of care and reduced continuity in residents' clinical education; and evidence that increased workload under the limits has a negative effect on patient and resident outcomes. We highlight specific areas for research and offer recommendations for national policy.

INTRODUCTION

Graduate medical education exposes physicians to the realities of medical practice, including long work hours (1) and the professional expectation that they place patients' needs above their own. Yet for some 40 years data have suggested that residents' long hours contribute to fatigue that may compromise patient and resident safety. The Accreditation Council for Graduate Medical Education (ACGME) implemented common duty-hour standards for all accredited programs in 2003 (2) and when it refined them to produce the 2011 standards (3), the debate over duty hours highlighted two competing goods: patients' safety in settings where residents learn and participate in care, and residents' attainment of clinical skills under supervision to prepare them for practice and ensure the safety of their future patients. Supporters of duty-hour limits anticipated their implementation would result in significant safety gains in teaching institutions; critics expressed concern that reducing residents' clinical role might diminish quality and safety in these settings. Medical educators and faculty worried that reducing residents' hours would have negative effects on their preparation for practice and on the development of professionally motivated effacement of self-interest. Three principles guided the development of the ACGME's 2011 standards: they sought to ensure (*a*) the safety of patients currently being cared for by residents; (*b*) the safety of patients who will be under the care of residents in their future unsupervised practice; and (*c*) a learning environment that fosters residents' professional development and teaches them effacement of self-interest to develop a healing relationship with their patients.

Research on the effect of duty-hour limits on quality and safety of care in teaching settings and on resident learning outcomes has produced contradictory findings, along with concerns about study quality, including small sample sizes, short follow-up, and use of opinion surveys and self-reports. This review aggregates studies of the effect of the 2003 ACGME duty-hour limits (2) and the

refinements to the common standards that became effective in 2011 (3), as well as research on the experience with the New York State duty-hour regulations and empirical studies that assessed elements of these standards prior to their implementation. Outcomes studied include patient safety in teaching hospitals; residents' clinical experience and learning important for their subsequent practice; continuity of care; and residents' professional development, including their development of a healing relationship with patients. Continuity of care is an important topic due to concerns that under the duty-hour limits, reductions in errors previously attributed to fatigue may be offset by added errors due to inadequate exchange of information during care transitions (4). The 2011 common program requirements included standards to enhance the effectiveness of transitions of care (3, 5). The review also assesses the effect of workload on patient and resident outcomes because of concerns that the limits resulted in work compression and thus produced higher workload and work intensity.

METHODOLOGY

The ACGME's standards consist of an 80-hour weekly limit, one day in seven free of all patient duties, a limit on call frequency, a required rest period, a 16-hour limit on continuous duty for residents in their initial years of training, and a 24-hour limit with an added four hours for transitioning care for all other residents (5). Because programs must comply with all standards, we consider them in totality, and do not attempt to isolate individual elements. The review has two aims: (*a*) to assess the effect of the set of standards on the types of residents, types of patients, and settings where the limits have a beneficial effect, and those where they may have a deleterious effect on outcomes of interest; and (*b*) to explore whether study factors may have contributed to the conflicting findings for some of the outcomes studies.

A literature search identified 1,515 studies of duty-hour limits in Medline, Embase and PsychINFO. We excluded articles from nations

other than the United States and articles that assessed the effect of duty hours on residents' cognitive and physiological function and on resident safety. This reduced the number of studies considerably. To assess the effect of the duty-hour limits, the review included only studies conducted in US allopathic residency programs after the implementation of the 2003 standards or articles on the effect of New York State's regulation of duty hours. A few of the studies of errors after certain shift types, such as overnight call, and some research on the effect of workload on outcomes of interest predate the implementation of the 2003 standards.

To guard against the potential that study factors in the primary research may affect the findings, we limited our review to studies with a Medical Education Research Quality Index (MERSQI) score of 12 or greater. The MERSQI assesses study quality (design, sampling, type of data, validity, data analysis, and outcomes) for a maximum score of 18 (6), and the average score for medical education studies is 9.6 (7). MERSQI scores were assigned independently by two of the authors and were compared to scores from a prior systematic review of the duty-hour literature (8). Use of this selection criterion resulted in a sample of 83 studies. Several studies assessed more than one variable of interest for a total of 86 outcomes included in the review.

RESULTS

Figure 1 shows a model of the hypothesized relationships among the variables affected by duty-hour limits. It highlights the outcomes for which the review found empirical support for a positive or negative effect of the duty-hour limits; it also identifies variables that may moderate the effect of duty-hour limits on the outcomes of interest. The relationships for which there is empirical evidence of an effect of duty-hour limits on outcomes of interest are summarized below and discussed in more detail in the remainder of this section. The review showed:

- A positive effect of the duty-hour standards on residents' hours of sleep and

objective measures of alertness, although the number of studies (three) is very small.

- A mixed effect on patient safety in teaching settings. There are significant differences between studies in medical and in surgical specialties, and between studies conducted in single-institutions and research using secondary analysis of large national databases. Single-institution studies in internal medicine were most likely to find a positive effect, whereas all four studies of quality and safety for surgical patients using large national data samples found negative effects under the limits.
- Little to no effect on operative volume (as a proxy for preparedness for practice in surgical specialties), with 18 of 27 showing no reduction in operative volume under the limits. Single-institution studies were more likely to show a negative effect on operative volume than national studies using operative log data submitted to ACGME, but some of this difference is potentially attributable to study factors.
- Evidence of a beneficial effect on resident burnout and mood, and limited evidence that low mood may have a negative effect on the relationship with patients.
- Limited evidence that increased workload possible under duty-hour limits has a negative effect on patient and resident outcomes.
- Evidence that the limits have reduced continuity of care and educational continuity for residents, and that the consequences of reduced continuity may differ for medical and surgical specialties, with the potential for a significant effect in surgical specialties that is not addressed by efforts to improve transitions of care.

Sleep and Alertness

Only three studies offered objective data on resident sleep and objective measures of alertness after limitation of resident hours, a key variable in the determination of the ultimate effect

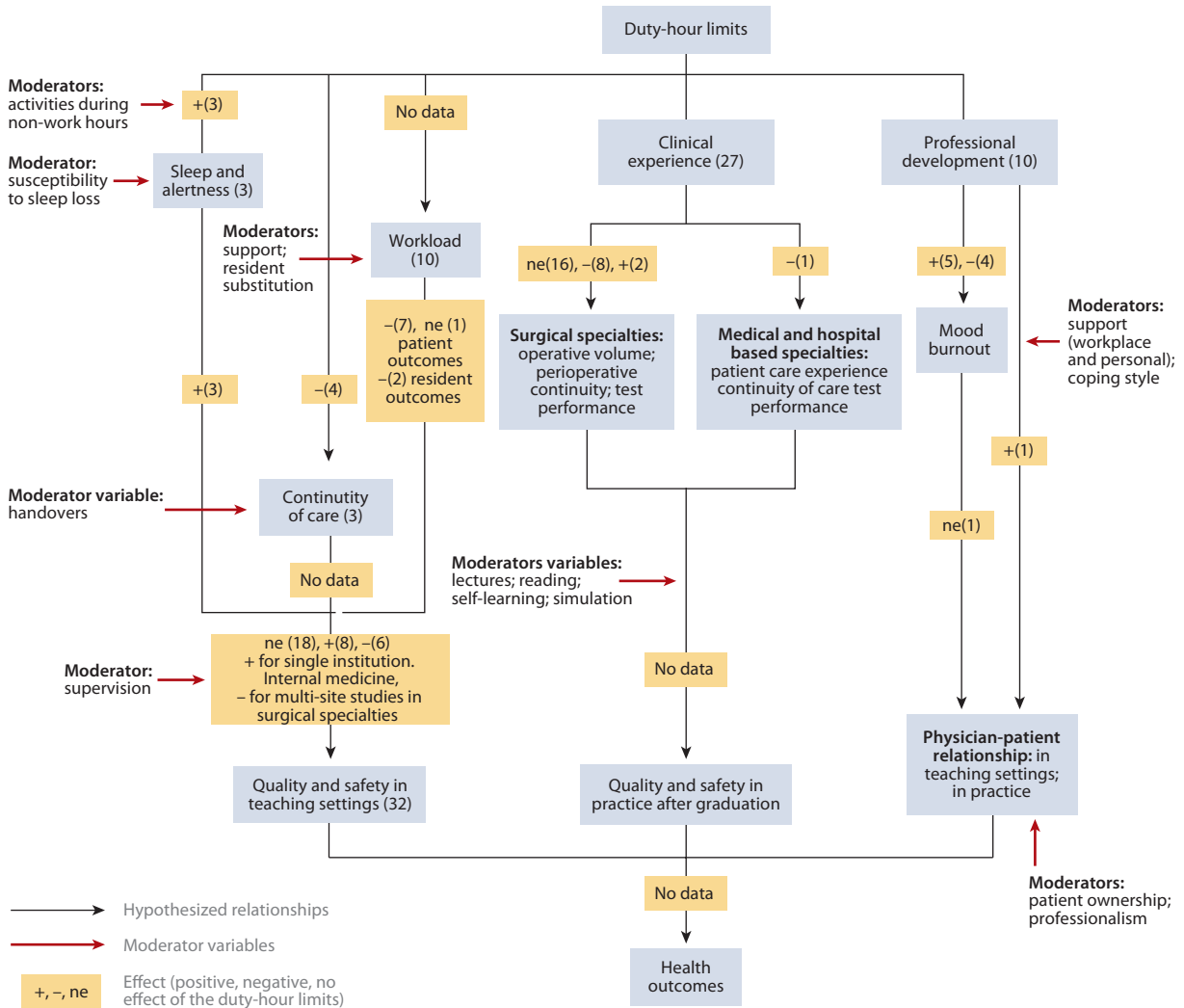


Figure 1

Model of the hypothesized relationships among variables affected by limits on resident duty hours. Numbers in parentheses are the numbers of studies assessing the given outcome.

of duty-hour limits (9–11). A study using a national sample of 4,015 interns found an average of 22 minutes of added sleep per night (9), and a single-institution study with a sample of 44 residents and fellows found an average 24-minute increase in nightly sleep for residents and a negligible increase for fellows, with improved objective measures of sleepiness (10). A study of 20 interns showed an average additional 5.8 hours of sleep per week under a 14-hour limit on

continuous duty and showed significant improvement in an objective measure of alertness (11).

Safety and Quality in Teaching Settings

A total of 22 single-institution and ten multi-institution studies assessed patient safety outcomes under duty-hour limits. They produced

mixed results. Five single-institution studies in medical specialties found a positive effect, including reductions in errors (12, 13), improvement in quality and safety measures (14), reductions in mortality, increased adherence to recommended drug therapies (15), and a higher rate of adverse events by residents working longer shifts (16). One study found no benefit (17), and another found an increase in resident ordering errors, which the authors speculated may have resulted from handover problems (18). Two studies assessed first-year residents, finding improvement in errors under duty-hour limits (12, 13) but a higher rate of errors under longer hours by first-year residents compared to residents more advanced in their training (13). Of 15 single-institution studies that assessed patient safety outcomes in surgical specialties, eight found no significant effect (19–26), two found small improvements (27, 28), and two found worsening of quality and safety, including a significant increase in admissions to surgical intensive care units attributable to provider care (29) and increased complications and morbidity in neurological surgery patients (30). One study of the effect on quality and safety for surgical patients found a reduction in bile duct injuries and complications in the years since the implementation of duty-hour limits, but this was accompanied by a significant increase in the number of surgeries that were converted to open procedures (31). One study of obstetrics-gynecology found improvement in some quality and safety measures and worsening in others (32), and a study in general surgery found improvement in surgical-site infections and bleeding requiring more than four units of blood but a worsening in acute renal failure under duty-hour limits (33). One study that found some improvement in quality and safety under the limits also found a significant increase in attending-physician involvement in care, as indicated by Medicare and Relative Value Unit (RVU) data and the notation that “no qualified resident was available” (27).

Ten studies analyzed large national samples using secondary data, with six finding no

significant effect of duty-hour limits on mortality, morbidity, length of stay, or adverse drug events (34–39). Improvements in mortality and other quality indicators were comparable for teaching and nonteaching hospitals, suggesting that they were unrelated to the implementation of the duty-hour limits. Two studies found improved outcomes for medical patients, with one showing some improved outcomes for the high-risk and older medical patients (34), while research in Veterans Affairs (VA) hospitals found reduced mortality in medical patients but no improvement for surgical patients (40). One study that found no significant overall effects showed worsening mortality for one subgroup, Medicare patients with a diagnosis of cerebrovascular accident, following the implementation of the limits (39).

For surgical patients, a large-sample study of the effect of New York State’s duty-hour limits found a significant increase in the rates of two types of patient safety indicators (accidental puncture or laceration and postoperative pulmonary embolus or deep venous thrombosis) in teaching hospitals, with no increase in the nonteaching comparison group (41). Another large-sample study found a significant increase in complications for patients undergoing surgery for hip fracture in teaching hospitals following implementation of the duty-hour limits, including increases in pneumonia, hematoma, transfusion, and renal complications, as well as increased cost (42). Finally, a study of quality and safety in surgical and procedural patients, which used patient safety indicators (PSIs) that allow collection of data on patient safety events from secondary (billing) data, found a significant increase in the odds for a PSI grouping related to technical skills (foreign body left in during the procedure, postoperative hemorrhage or hematoma, postoperative wound dehiscence, and accidental puncture or laceration) during the first year after implementation of the 2003 limits for Medicare patients (43). For patients receiving care in a VA hospital, the study found an increase in PSIs in a grouping that included iatrogenic pneumothorax, selected infections,

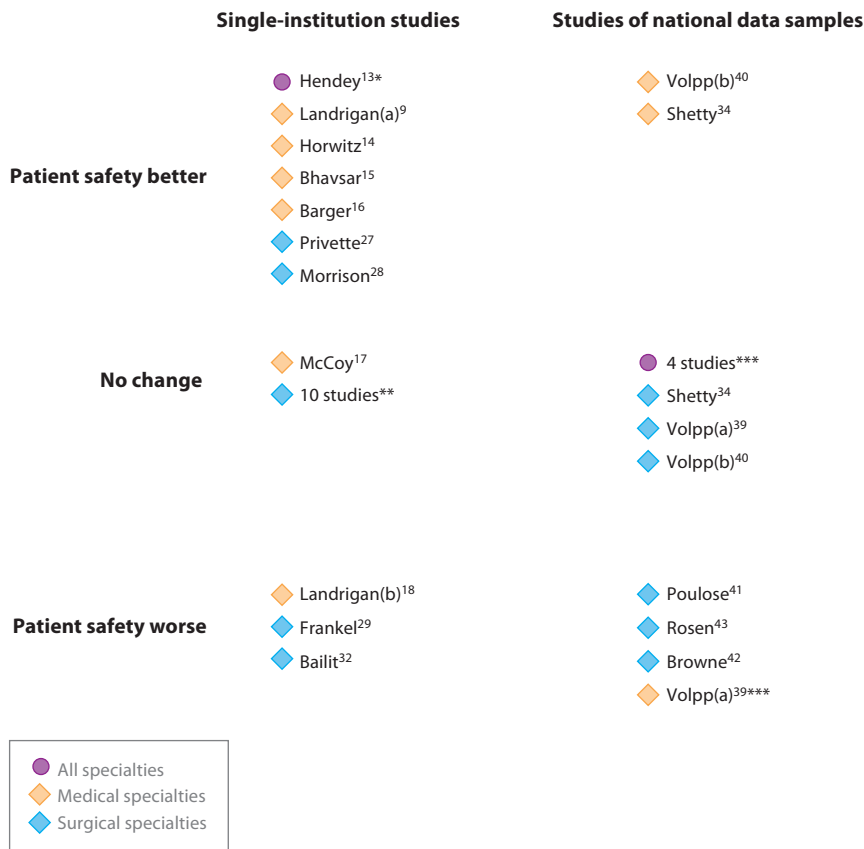


Figure 2

Duty-hour limits and quality and safety in teaching hospitals. *Study of multiple specialties in a single institution: internal medicine, family medicine, emergency medicine, obstetrics, pediatrics, and surgery. **Hutter (19), Yaghoubian(a) (20), Yaghoubian(b) (31), Shonka (21), Naylor (22), Schenarts (23), Ellman (24), Kaafarani (33), de Virgilio (25), Jakubowicz (26). ***Prasad (35), Howard (36), Silber (37), Mycyk (38). ****Volpp(a) (39) for the subgroup of patients with cerebrovascular accident (CVA).

and pulmonary embolus or deep venous thrombosis in the second year under the limits. No change was found for a PSI grouping the researcher had labeled “continuity of care,” which included perioperative physiologic or metabolic derangement, postoperative respiratory failure, and postoperative sepsis (43).

To illustrate the complexity of the findings and the differences among specialties and types of study, a graphic analysis of the effect of duty-hour limits on quality and safety is shown in **Figure 2**. The analysis shows that single-site studies in a medical specialty are more likely to show a positive effect of the limits, whereas

studies assessing the effect on patient safety in surgical specialties using secondary analysis of very large national samples are more likely to show a negative effect. Plotting study quality as measured by the MERSQI against outcomes showed no association, with study quality for this subgroup of studies uniformly high. Although the MERSQI assesses internal validity and, for example, gives a high score for randomization of subjects, the validity dimension of this tool does not address generalizability. Some of the high-quality studies of the duty-hour limits have good to excellent internal validity but may have limited generalizability, as

several of the highest-quality studies were conducted on relatively small samples of residents in a particular setting, such as first-year residents in an intensive care unit. In contrast, the large secondary analyses provide a high degree of confidence in the generalizability of findings, yet even with sophisticated methods to attempt to isolate performance differences for teaching hospitals, the findings do not afford clear insight into the mechanisms that produced these outcomes. It remains necessary to identify the extent to which duty-hour reductions, supervision, the care contribution of other professionals such as faculty and nurses, and factors such as loss of continuity of patient care may have interacted to produce the finding of a neutral or negative effect of the duty-hour limits on quality and safety.

Figure 3 shows the subset of studies for which an odds ratio of the effect of the duty-hour limits was provided or could be calculated. The effect of the limits on safety and quality of care is positive in studies of medical specialties but negative in surgical specialties. This effect is influenced neither by study quality (**Figure 3a**) nor by assessments of the ability to generalize on the findings (**Figure 3b**).

Resident Procedural and Clinical Experience

Concern about the educational effect of duty-hour limits has centered on reduced patient contact and clinical learning that may result in reduced preparation for practice. Of the 27 studies that assessed patient and procedural experience, 18 found no significant reductions under the limits. Studies of the effect of the limits on patient and operative experience included 23 single-institution studies that focused on surgical specialties. Of these, seven studies found reductions in volume (44–50) and one found reduced operating room time (51), while thirteen found no change (19, 52–63) and two found increases in operative volume (25, 64). Three studies assessed national operative experience for residents in surgical specialties after the implementation of the limits, with two finding no

effect (65, 66). One study found no change in plastic surgery, an increase in urology procedures, and volume increasing in some surgical categories while declining in others (67). It is possible that “ceiling effects” (residents’ reporting tapering off once they have reached the required number of procedures) may affect these findings and that the impact of the limits on operative experience is not truly known. The only study in a medical specialty found a reduction in patient visits for family medicine residents working under duty-hour limits (68).

Of the six studies that explored the effect of the duty-hour limits on resident learning outcomes, four found no effect on in-training exam scores (25, 52, 56, 63), and one showed improvement (54). Research on board examination performance for neurological surgery residents found a decline (51).

Physician-Patient Relationship

Of the ten studies that analyzed the effect of the limits on variables relevant to the physician-patient relationship, only one directly assessed the effect of duty hours on this relationship. It found that sleep-deprived pediatrics residents were less patient centered in their communication (69). The other nine studies explored duty-hour limits on residents’ mood and burnout, with five showing a positive effect (70–74), and four finding no change (75–78).

Resident Workload and Work Compression

Educators have expressed concern that limitation of total duty hours leads to compression of work into fewer hours. Ten studies assessed the effect of workload. Two of these explored the effect on the physician-patient relationship; they found high workload associated with reduced empathy in medical interns (79) and with residents selectively discharging older inpatients earlier (80). Six studies assessed workload and patient outcomes, finding increased risk for mortality (81, 82) and readmission (83), lower patient satisfaction (84), greater use of

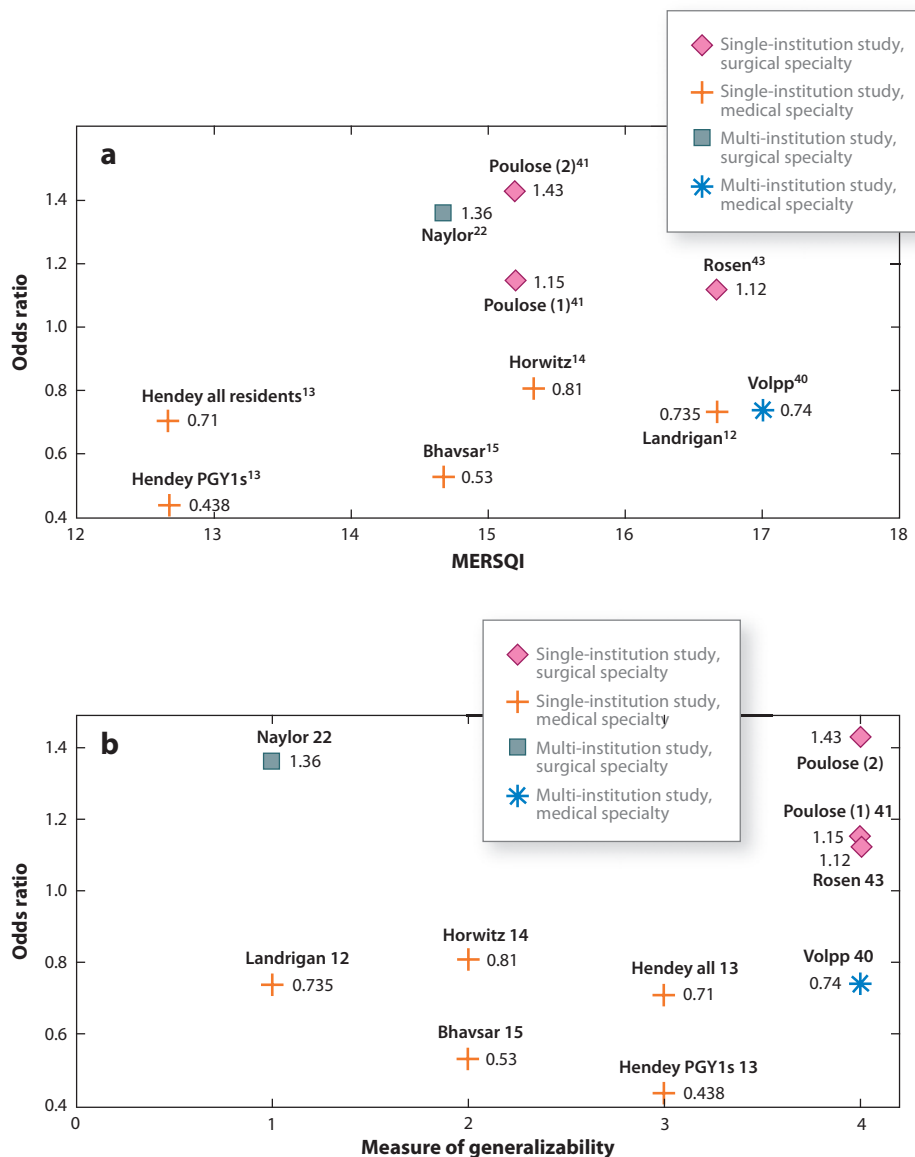


Figure 3

Studies showing a significant effect of duty-hour limits on quality and safety, (a) arrayed by MERSQI score and (b) arrayed by a simple generalizability measure. Sample represents the subset of studies for which an odds ratio of the effect was provided or could be calculated. Abbreviation: MERSQI, Medical Education Research Study Quality Instrument. Poulose (1), accidental puncture or laceration; Poulose (2), postoperative pulmonary embolus or deep venous thrombosis.

diagnostic tests (85), and shifting from active patient care to monitoring to keep workload manageable (86). One study found no effect (87). Studies of the effect of workload on

resident outcomes found reduced educational participation with increased workload (88), and improved conference attendance with a limit on patient admissions (83).

Continuity of Care

Beyond being important for quality and safety, continuity of care of an individual patient by a resident is essential to the resident's development of clinical judgment. Absent from the literature is a clear agreement on the dimensions of continuity required in each specialty, or group of specialties, to prepare the resident to intellectually understand and provide care, as well as emotionally attach effectively to each individual patient. In surgery, in particular, there have been concerns that preservation of operative volume may have come at the expense of perioperative continuity.

Four studies analyzed the effect of the duty-hour limits on continuity. Findings include reduced ambulatory continuity for pediatrics residents (89), reduced perioperative continuity for surgeries requiring reoperation (90), and reduced continuity in follow-up after emergency surgery (44). A study of resident and fellow continuity of care on a vascular surgery service operating under the duty-hour limits found 0% continuity of care, despite 131 opportunities for continuity of care during the study's two-month observation period (91).

PRACTICAL IMPLICATIONS AND LIMITATIONS

The findings highlight the complexity of assessing the effect of the duty-hour limits. There are multiple outcomes of interest in both resident education and patient care quality, and a multitude of factors in the learning environment may influence outcomes (**Figure 1**). Empirical evidence since 2003 has shown some positive effects, and the development of the ACGME's 2011 standards incorporated this scientific knowledge. At the same time, the studies most likely to find a positive effect on patient safety were single-institution studies in medical specialties, and the negative findings for patient quality and safety and for continuity of care in surgical specialties raise questions about the generalizability of the standards, particularly their applicability and utility for surgical disciplines.

Quality of care and patient safety in teaching hospitals are affected by multiple factors, including variables that moderate the relationship of duty-hour limits and the outcomes of interest. This is particularly true for quality and safety of care in teaching hospitals, the outcome that has garnered most of the public interest. Yet residents are more likely to mention lack of supervision and handover problems as causes or factors in errors (92–94), and research on closed malpractice claims found lack of supervision and handover problems to be common contributing factors (95). Thus, although supervision and handovers were beyond the scope of our review, their importance in safety in teaching hospitals cannot be dismissed. Added evidence that improvement or worsening of quality in teaching hospitals appears to be related to faculty supervision and presence in the clinical setting comes from a study showing that improved quality and safety after the implementation of the limits were associated with significantly increased attending-physician involvement in care (27), and from anecdotal evidence that lack of faculty supervision and involvement in the patient's care were contributing factors in the death of Libby Zion (96), which prompted New York State to implement limits on resident hours and requirements for supervision, and in the demise of the live liver donor at a New York teaching institution, which occurred after the implementation of these limits (97). It is thus possible that worsening of care under the reduction in hours was related to the withdrawing of residents, who in some settings, or for some periods during the day or week, may have served as the major or sole providers of medical care, with little or no faculty involvement. This does not completely explain differences in the findings regarding the impact of the limits in medical and surgical specialties, but rather serves as a reminder of other important elements to consider in efforts to enhance quality and safety in settings where residents participate in care.

The elements of faculty supervision and involvement in clinical care appropriately

received expanded emphasis in the ACGME's 2011 standards (3), and in Clinical Learning Environment Review (CLER) visits to sponsoring institutions that are being implemented as part of the ACGME's Next Accreditation System (98, 99).

Little empirical evidence exists on the effect of the limits in many specialties. Particularly underresearched is the effect of the limits on residents' preparation for practice, probably because the standards did not result in reductions in hours in many hospital-based and some medical specialties. In other critical areas, such as the effect of the limits on the physician-patient relationship, it is not clear whether improvement in intermediate outcomes that have been studied, such as resident burnout, have a positive effect on the variables of ultimate interest. For example, a study found a significant decrease in burnout but no reduction in residents' self-reports of engaging in suboptimal patient-care practices (74).

No studies to date have truly assessed the effect of the limits on resident professionalism. This has been a topic of many editorials and commentaries (19, 100, 101), voicing the concern that residents trained under the duty-hour limits may exhibit "shift mentality" and fail to appreciate that the needs of patients come first. At the same time, there are data suggesting residents make explicit decisions that are influenced by their patients' care needs and the learning context. In one study, interns offered protected naps did not take them, citing concerns about discontinuity (102). Research has also shown that residents' decisions to remain in the hospital were influenced by a host of circumstances, with the residents aware of trade-offs between compliance with duty-hour limits and their obligation to patients (103). These findings suggest a need for flexibility in application of the standards in individual clinical circumstances, while generally adhering to a principle that beyond a certain number of hours there is a negative effect on patient and resident outcomes. Residents' professionalism also is influenced by aspects of their learning environment; recent editorials suggest that

the stress of the health care environment and residents' long hours contribute to reduced empathy and disrespectful behavior toward patients and colleagues (104).

Given the stringent selection criteria, the number of studies in the review is a limited subset of the expansive literature on duty-hour limits. To address the question whether inclusion of a larger number of studies would affect the results, we performed sensitivity analysis. Inclusion of relevant US studies with a MERSQI score of 9.6 (the average of studies in medical education) (7) or higher would have increased the number of studies in the review by 49 but would have had a negligible effect on outcomes, as the majority of these studies found no effect of the duty-hour limits. It also is unlikely that unpublished studies exist that would offer added evidence or a significant positive or negative effect of the duty-hour limits. Going to a MERSQI score lower than 9.6 would result in inclusion of a sizable number of articles reporting the opinions of faculty, program directors, and residents. Many of these studies predict a negative effect of the limits on outcomes of interest, but the data reported in these studies are stakeholder assumptions about the likely impact, not empirical findings.

This review shares some of the limitations of the underlying studies, particularly the inability to isolate the impact of the duty-hour limits from the influence of the multitude of other factors operating in the learning environment. It also highlights the limitations of the existing literature in important areas, including the longer-term effects of training under duty-hour restrictions on the preparedness of physicians entering practice to meet patients' and society's expectations for technical proficiency and professional attributes. A key area is the effect of the limits on the nature and quality of the doctor-patient interaction. Here the literature is largely limited to commentaries suggesting reduced "professional commitment to patients" in cohorts recently having completed their training, and calls for interventions to teach effacement of self-interest and putting the needs of patients first (3). These attributes

of the profession are not learned in lecture halls but modeled at the bedside. It is thus of note that some of the outcomes for continuity of care and the patient-physician relationship may be attributable to the duty-hour limits but also appear to be experienced by faculty and physicians in practice. These outcomes may be partly due to more general fragmentation in the way care is provided, which reduces continuity for all providers and teaches residents that discontinuity is “accepted” practice.

CONCLUSION

The support for limits on resident hours comes from scientific data that clearly indicate a positive effect of restedness on alertness and performance (105). This review found areas where research offered empirical support for the beneficial impact of duty-hour limits; it also highlighted the complex relationships among the variables in the learning environment, and how this complexity makes it impossible to reproduce the “incontrovertible scientific findings” of research in sleep laboratories. It is not possible to make an unqualified statement that patient care has been improved by the implementation of the duty-hour limits. Some findings suggest a negative effect of the limits on quality and safety for surgical patients receiving care in teaching settings, with data showing increased complications, higher rates of patient-safety indicators, and reduced perioperative continuity. The question thus is not whether there should be duty-hour limits for physicians in training, but where they should be set, whether they should be identical for all specialties, and what other attributes of the learning environment, particularly faculty supervision and presence in patient care settings, contribute to safe and effective care.

The results of this review are useful to medical educators and policy makers, and they offer a starting point for future research. This should include study of the effect of the limits on preparedness for practice in surgical specialties, as residents in these specialties experience the greatest reductions in hours of patient contact. It should also include further study

of the effect of the limits on safety in surgical teaching settings and on efforts to address reduced continuity of care for surgical residents, a negative consequence of duty-hour limits that is not addressed by efforts to improve the handover. This research is important to safety in teaching settings as well as the safety of residents’ future patients once they enter practice. Operative volume alone may be a suboptimal measure for surgical competence, particularly decision making around interventions and managing complications, as suggested by a comparison of Canadian and Dutch surgeons (106). This study found no difference in technical skills or knowledge, but lower management skills in the Dutch group, which trained under severely reduced duty hours. Research should include studies of approaches to optimize resident education to ensure proficiency for practice in all specialties, including the role of curricula, simulation, and teaching and faculty assessments using the educational milestones (98), and efforts to facilitate residents’ transition into practice. Finally, the potential impact of duty-hour limits on the formation of the professional’s commitment to the patient, the demonstration of effacement of self-interest for the needs of the patient, and the ability of each new physician to recognize his or her physical and emotional limits in the care of patients must be assessed.

Improving handovers and ensuring that care teams have access to relevant information have emerged as important practical interventions to mitigate any negative effects of the limits in medical specialties (4, 107). However, addressing the negative effect of the limits in surgical specialties, including the apparent reduction in perioperative continuity, may require different interventions, and the role of faculty supervision and involvement in the care process is a critical element in quality and safety of care in teaching settings. Beyond that, it may be necessary to enhance surgery residents’ continuity around preoperative decision making and the management of follow-up and handling of complications after the surgery. Interventions proposed include use of a “resident return”

model, overcoming logistical challenges in how cases are assigned and providing a system to alert residents when their patients are returning (91). There also may be benefit in addressing the loss of hours of patient contact in surgical specialties, and national policy in this arena should be driven by the safety and quality of care provided to patients in the teaching environment, rather than by physiologic phenomena in experimental subjects studied in sleep laboratories.

Our review demonstrates the complexity of the learning environment in clinical medicine and should motivate all engaged in medical education to refine redundant systems to maximize safety, rather than concentrate solely on limiting resident duty hours. The profession must assure that each new physician is prepared to enter the unsupervised practice of medicine equipped with the knowledge, skills, attitudes, and behaviors required to serve his or her patients.

SUMMARY POINTS

1. The literature on the effect of residents' duty hours on quality and patient safety, and on residents' professional development and preparation for practice, produced mixed findings. Following implementation of duty-hour limits, there is evidence of a positive effect on some outcomes, particularly in medical specialties, but a negative effect in surgical specialties.
2. It is not possible to unequivocally attribute changes in quality and safety of care to the duty-hour limits. Studies suggest that the improvement or worsening of quality and safety indicators are related in part to faculty supervision and involvement in care, or lack thereof, after implementation of the limits.
3. The limits appear to have no effect on operative volume in surgical specialties. However, study factors may influence these findings, and operative volume may be an insufficient measure of operative experience. Loss of perioperative continuity under the limits may have negative consequences for residents' professional development and preparation for practice in a surgical specialty.
4. The limits have reduced burnout and improved resident mood, yet few studies have assessed whether this in turn has had a beneficial effect on the physician-patient relationship.
5. The duty-hour limits appear to have reduced continuity of care and educational continuity for residents, and these losses may have serious consequences for the quality of care and the professional development of physicians in surgical specialties that are not addressed by efforts to improve transitions of care.

FUTURE ISSUES

1. Research to demonstrate whether the beneficial effects of duty-hour limits on patient safety for medical specialties and in selected settings are generalizable, how information from these studies could be useful to other settings and specialties, and how duty-hour limits and other attributes of the learning environment interact in producing the mixed outcomes in safety and quality of care.

2. Testing of approaches to optimize education to ensure graduating residents' proficiency for practice, including the role of curricula, simulation, and teaching and faculty assessments using the educational milestones, and efforts to facilitate residents' transition into practice.
3. Study of the effect of duty-hour limits in surgical teaching settings, including study of interventions to address the apparent negative effect of the limits on safety and quality. This should include investigation of the patient-care and learning effects of reduced perioperative continuity, as well as testing interventions to enhance perioperative continuity from a patient and a learner perspective.
4. Research on the complex interplay between mood, empathy, professional socialization, and environment factors to assess the effect of the duty-hour limits on graduating residents' capacity for effacement of self-interest, and on their ability to form healing relationships with patients.

DISCLOSURE STATEMENT

All authors are employed by the Accreditation Council for Graduate Medical Education, which established and enforced the duty-hour standards for resident in accredited allopathic training programs. T.N. and T.B. are faculty of the Jefferson Medical College of Thomas Jefferson University.

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