Implementation of 2011 Duty Hours Regulations through a Workload Reduction Strategy and Impact on Residency Training

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BACKGROUND: Training programs have implemented the 2011 ACGME duty hour regulations (DHR) using “workload compression” (WLC) strategies, attempting to fit similar clinical responsibilities into fewer working hours, or workload reduction (WLR) approaches, reducing the number of patient encounters per trainee. Many have expressed concern that these strategies could negatively impact patient care and learner outcomes.

OBJECTIVE: This study evaluates the medical knowledge and clinical impact of a WLR intervention in a single institution.

DESIGN & PARTICIPANTS: Nonrandomized intervention study with comparison to a historical control study among 58 PGY-1 internal medicine trainees in the 2 years after duty hour implementation [exposure cohort (EC), 7/1/2011–6/30/2013], compared to 2 years before implementation [comparison cohort (CC), 7/1/2009–6/30/2011].

MAIN MEASURES: Process outcomes were average inpatient encounters, average new inpatient admissions, and average scheduled outpatient encounters per PGY-1 year. Performance outcomes included trainee inpatient and outpatient days on service, In-Training Examination (ITE) scores as an objective surrogate of medical knowledge, Case-Mix Index (CMI), and quality of care measures (30-day readmission rate, 30-day mortality rate, and average length of stay).

KEY RESULTS: Baseline characteristics and average numbers of inpatient encounters per PGY-1 class were similar between the EC and CC. However, the EC experienced fewer new inpatient admissions (157.47 ± 40.47 vs. 181.72 ± 25.45 ; $p < 0.01$), more outpatient encounters (64.80 ± 10.85 vs. 56.98 ± 6.59 ; $p < 0.01$), and had similar ITE percentiles ($p = 0.58$). Patients of similar complexity cared for by the EC also had a greater reduction in readmissions (21.21 % to 19.08 %; $p < 0.01$) than the hospital baseline (12.07 to 11.14 %; $p < 0.01$).

CONCLUSIONS: Our WLR resulted in a small decrease in the average number of new inpatient admissions and an increase in outpatient encounters. ITE and care quality outcomes were maintained or improved. While there is theoretical concern that reducing PGY-1 inpatient admissions volumes may negatively impact education and

clinical care measures, this study found no evidence of such a trade-off.

KEY WORDS: duty hour changes; ACGME; admission numbers; workload reduction; workload compression.

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INTRODUCTION

The Accreditation Council for Graduate Medical Education (ACGME) introduced new duty hour regulations (DHR) in 2011.¹ The new guidelines reiterated the 2003 recommendations (maximum of 80 h of work per week and direct patient care shifts no longer than 24 + 4 h) and restricted post-graduate year 1 (PGY-1) trainees to a maximum shift length of 16 h, with a minimum of 8 h off between shifts.^{2,3} Studies of 2011 models, similar to outcomes following 2003 changes,^{4–8} have yet to show any improvements in quality of care,^{9–12} trainee education,¹¹ or resident well-being.¹³ Also, program director and resident surveys have conveyed strong concerns about sacrificing continuity of care and educational activities for DHR compliance.^{14,15}

Understanding how DHR impacts learner and patient outcomes is complex and may depend on *how* each program responded to the new rules and the type of work and teaching that were altered in the process. Many training programs responded to DHR by using “workload compression” (WLC) strategies. Inpatient WLC strategies generally shorten shifts and increase the number of handoffs required to ensure continuous patient care, without reducing admitting or census caps.¹³ WLC approaches also compress time devoted to didactics and structured learning. Additionally, patient complexity has increased over the last decade while average patient length of inpatient stay has decreased.¹⁶ Thus, trainees are caring for sicker patients with less continuous time, resulting in further WLC. Goitein and Ludmerer further suggest, “focusing on work hours rather than workload, the ACGME...treated the symptom, not the disease.”¹⁷(pp655)

In contrast to WLC, some educators¹⁸ have advocated for “workload reduction” (WLR) strategies for PGY-1 internal

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medicine trainees, essentially reducing the admitting volume and patient census per trainee. Since 2007 one of our general medicine ward team's has had reduction in patient volume per trainee to accommodate a curricular innovation, effectively a WLR strategy.^{19–21} This strategy preserved time for patient-centered care activities and care continuity, resulted in reduced heart failure 30-day readmission and all-cause mortality rates,¹⁹ and increased resident and patient satisfaction.¹⁷ Other training programs that reduced census caps have also seen improvements in outcomes for trainees.^{18–24}

Buoyed by our earlier success with a WLR strategy, we chose to implement a WLR approach across all general medicine inpatient house staff services to comply with 2011 DHR. Given that the optimal balance between sufficient workload to provide broad patient exposure and medical knowledge overall is unclear, we attempted to understand whether the “natural experiment” with WLR to accommodate DHR at our institution had significant impacts on knowledge and clinical care outcomes.

METHODS

Study Setting and Design

Setting. Johns Hopkins Bayview Medical Center (JHBMC) is a 560-bed academic medical center located in Baltimore, Maryland, and is the primary teaching facility for the Internal Medicine residency program. Baseline demographic variables from all 60 internal medicine primary care and/or categorical track PGY-1 training program records were collected from administrative data sets (Table 1). Training tracks, primary care and categorical, differ minimally in the intern year and shift to greater outpatient (primary care) and inpatient (categorical) training time after the first year.

Prior to 2011, PGY-1 trainees on the inpatient general medical wards followed a traditional 4-day rotation call structure consisting of overnight long call (admitting duties for 24 h then leaving the hospital on the post-call day after completion of rounds and sign out), followed by a short call admitting day then a non-admitting day. For every 4-day cycle each first year

resident admitted up to seven patients. Overnight, a night float intern and resident, not assigned to specific day teams but to the entire medicine service, assumed care for acute issues and admitted patients for the three teams that were not on long call.

In the intensive care units (ICUs) and intermediate care units (IMCs) the PGY-1 trainees followed a 4-day rotating admitting and call schedule (24 + 4 h), alternating between ICU and IMC responsibilities. In both groups, as guided by ACGME rules, PGY-2 and 3 trainees provided direct supervision in all care settings and attendings were available in person during day hours or by phone overnight to answer clinical questions that might arise.

Intervention. A joint resident and residency program director team collaboratively worked to redesign the inpatient services. The most significant change was a reduction in admissions from seven to four patients per PGY-1 trainee per 4-day call cycle. The difference in admissions was absorbed by increasing the hospitalist census. Given the purposeful reduction in admission numbers, there was an intentional goal to select more medically complex patients for teaching services.

The general wards teams changed from a night float system, where trainees were not assigned to specific teams, to an integrated night and day team. On an admitting day, each PGY-1 trainee receives one patient from the night co-team trainee and admits one new patient. Teams admit every other day. Therefore, for every 4-day call cycle, each day a PGY-1 trainee admits two patients and receives two patients from the night team member and each night a PGY-1 trainee admits four patients. Additionally, the night team member consistently provided continuity of care for the same team every night and rounded with his/her team presenting new patients at the bedside to the entire team before leaving in the morning. PGY-2&3 trainees supervised admissions and did not routinely admit.

In the ICU and IMC the PGY-1 schedule shifted from a 24 + 4 rotating 4-day schedule to the following rotating day and night schedule: four 13-h day shifts, a 6-h day shift with 24 h off before the first of four 14-h night shifts, a post-night day, and a 6-h day shift followed by a 24-h off day. In all settings all other ACGME rules were met, including a maximum intern census cap of ten patients and PGY-2&3 and attending supervision requirements.

Design. The Institutional Review Board at Johns Hopkins University approved (IRB00077107) this nonrandomized intervention study with comparison to historical control. We examined trainee process and performance measures, further elucidated below, for the 30 PGY-1 trainees in the 2 years after implementation of 2011 DHR [Exposure Cohort (EC); July 1, 2011 to June 30, 2013], compared to the 28 PGY-1 trainees in the 2 years prior [comparison cohort (CC); July 1, 2009 to June 30, 2011].

Process Measures. We obtained process measures from the hospital electronic medical record (EMR) (Meditech,

Table 1 Baseline Demographic Characteristics of Cohorts

Variable	Comparison cohort (2009 to 2011)	Exposure cohort (2011–2013)	P value
No. interns analyzed	30	30	
Demographics (no.)			
Mean age	28.30 (±2.73)	28.67 (±3.52)	0.66*
Female	17	15	0.80†
Post-graduate year 1 trainees	30	30	—
Categorical	13	18	0.30†
Primary care tract	17	12	0.30†
Education (no.)			
Master's degrees	5	6	1.00†
Doctoral (PhD) degrees	2	0	0.49†
Medical school training location			
US graduates	29	27	0.85†
International graduates	1	3	0.61†

*P value was calculated by two-sample, unpaired, unequal variance t-test

†Fisher's exact test

Westwood, MA). For unknown reasons, two trainees' identification from the CC had been removed from the EMR; therefore, encounters associated with these trainees could not be identified and were not included in the analysis.

Searching the EMR by trainee, we calculated the number of inpatient encounters during PGY-1 year by referring to electronic note documentation. Using the title of the note, we determined the type of encounter [i.e., admission history and physical (H&P), progress note, transfer note, consult note, procedure note] and location (i.e., general medicine wards, IMC, ICU) (Table 2).

Notes were classified to determine whether the encounters were *new encounters* (e.g., H&P, consult, or a transfer between levels of care) or *follow-up encounters* (e.g., progress notes). *Total encounters* were calculated by summing new encounters and follow-up encounters. To determine the average number of notes written, we calculated the total notes per trainee per cohort and then calculated the mean and standard deviation. Notes written by second- and third-year trainees, fellows, and attendings were not included in the encounter measurements.

A concern of duty hour reductions, particularly in the procedural specialties, is the theoretical reduction in exposure to and participation in procedures. Consequently, we calculated the average number of procedures performed before and after WLR implementation utilizing the number of inpatient procedure notes written in the EMR. Outpatient encounters were calculated by counting the number of attended ambulatory visits.

To assess how programmatic changes impacted the number of training days PGY-1 trainees experienced in different training settings, the number of days on rotation was extracted from the online scheduling software (Amion, Newton, MA). Scheduling data were available for all PGY-1 trainees in the CC and EC. Rotations were classified into wards, critical care (IMC and ICU), outpatient, elective, and vacation (Table 2). The days on each rotation were counted, and then the mean and standard deviation were calculated.

Performance Measures. All medical knowledge measures were obtained from training program records. We obtained USMLE Step I and Step II Clinical Knowledge (CK) scores to represent baseline medical knowledge to serve as a surrogate measure for knowledge acquired in medical school prior to the PGY-1 year (Table 2). As some of the historical data were permanently stored and not retrievable, we did not have data for 3 EC USMLE Step I, 10 CC, and 17 EC USMLE Step II CK trainees. Scores on the ITE measured knowledge outcomes after the PGY-1 training year. All PGY-2 trainees are required to complete the examination during the start of their second year of training. Of ITE examinations administered during 3 years of training, the PGY-2 ITE has the strongest correlation with the ABIM Certifying Examination (ABIMCE), the examination that is widely recognized as a standard medical knowledge assessment.²⁵

For illness severity and quality of care outcomes, hospital administrative data were collected at the intern, and for

comparison purposes, at the hospital, department of medicine, and hospitalist service level. They include institution-specific all-cause 30-day readmission rates (only include readmissions to JHBMC), institution-specific mortality rates (only include deaths at JHBMC), and average length of stay (LOS). We also obtained the Case Mix Index (CMI) adjusted for length of stay (LOS) and 3MTM All Patient Diagnosis Related Groups (APDRG) classifications to better compare patient data year to year.

These outcomes were analyzed by two separate methods. First, to best characterize the types of patients PGY-1 trainees cared for at an individual level, patient data variables (listed above) were attributed to every intern. Consequently, in some instances, since more than one intern might have cared for a patient, the identical data were attributed to more than one intern (i.e., some data were counted twice). Second, to better understand the overall trends at the hospital level, the data were then analyzed for pre-/post-changes (see below); this analysis helps interpret the first analysis in the context of secular institutional trends. In the second analysis, patients were only assigned to a group one time regardless of how many providers cared for an individual patient.

Statistical Analysis. For each encounter type, procedures, outpatient visits, and days on service, we calculated means and standard deviation for both cohorts. We analyzed all outcomes as continuous variables, comparing the averages per PGY-1 year between cohorts using the two-tailed Student's t-test when values were normally distributed and the nonparametric Mann-Whitney U test when the normality assumption was not met. To compare binary values we used the Fischer's exact test or chi-square with Yates' correction. McNemar's test was used to assess changes in readmissions between groups. Any p-value less than 0.05 was statistically significant. Statistical analyses were performed using Stata 12.1 (Statacorp, College Station, TX) and Microsoft Excel® (Redmond, WA).

RESULTS

Participant Characteristics

All baseline participant characteristics were similar between the two cohorts, including demographics (Table 1), prior educational training, and medical school examination scores (Table 2).

Process Outcomes

There was no difference in the mean total encounters between the EC and the CC (EC: 585.37 ± 125.92 vs. CC: 561.61 ± 63.43 ; $p = 0.37$). There was a 15 % decrease in the average number of new inpatient encounters in the EC (157.47 ± 40.47 vs. CC: 181.72 ± 25.45 ; $p < 0.01$). The mean number of follow-up notes increased in the EC (Table 2).

In the outpatient setting there was a corresponding 13 % increase in the number of attended clinic encounters per PGY-1 in the EC (EC: 64.80 ± 10.85 vs. CC: 56.98 ± 6.59 ;

Table 2 Impact of Workload Reduction Strategies on Process and Performance Measures Following Duty Hour Reforms*

Variable	Comparison cohort (2009–2011)	Exposure cohort (2011–2013)	P value [‡]
	Mean (SD)	Mean (SD)	
Process measures			
No. interns analyzed	28	30	
Inpatient encounters			
Total encounters [‡]	561.61 (63.43)	585.37 (125.92)	0.37
New encounters	181.72 (25.45)	157.47 (40.47)	<0.01
General medicine	133.17 (22.04)	116.53 (27.47)	0.01
Inpatient status	126.82 (22.11)	102.03 (27.12)	<0.01
Observation status	6.35 (2.75)	14.5 (4.02)	<0.01
ICU and intermediate care	48.54 (14.49)	40.93 (18.19)	0.08
Follow-up encounters	379.89 (51.20)	427.90 (91.83)	0.02
General medicine	309.32 (50.03)	323.43 (73.95)	0.4
ICU/intermediate care	70.57 (16.05)	104.47 (36.71)	<0.01
Attended outpatient encounters	56.98 (6.59)	64.80 (10.85)	<0.01
Logged procedures	15.00 (5.91)	14.07 (7.47)	0.6
No. interns analyzed	30	30	
Average days on rotation			
Wards	137.23 (5.78)	149.08 (11.85)	<0.01
ICU/IMC	111.20 (8.00)	82.08 (14.49)	<0.01
Outpatient	56.80 (2.07)	85.23 (2.54)	<0.01
Elective	25.90 (6.04)	13.93 (4.25)	<0.01
Vacation	33.87 (2.82)	35.60 (1.92)	<0.01
Performance measures			
Educational measures			
No. interns analyzed	30	30	
USMLE step I	229.10 (18.45)	229.30 (17.18) ^a	0.98
USMLE step II CK	239.30 (15.36) ^b	239.80 (15.36) ^c	0.93
ABIM ITE	64 (7)	65 (7)	0.58
Quality measures: intern level [‡]			
No. interns analyzed	28	30	
Case mix index (CMI)	1.51 (0.081)	1.54 (0.11)	0.31
30-Day readmission rate	21.67 % (2.30 %)	18.64 % (2.19 %)	<0.01
30-Day mortality rate	6.45 % (1.22 %)	6.22 % (1.84 %)	0.59
Average length of stay	8.48 (0.66)	9.28 (0.98)	<0.01

*Refer to text for detailed discussion of the difference between cohorts

[‡]P value was calculated by two-sample, unpaired, unequal variance t-test[‡]See text for definitions. Data were unavailable for a3, b10, and c17 PGY-1 trainees

$p < 0.01$). There was no difference in the total number of procedures logged between cohorts (Table 2).

Comparing the EC to CC rotation structure (Table 2), there were statistically significant increases in the number of days of wards (137.23 ± 5.78 vs. 149.08 ± 11.85 ; $p < 0.01$) and outpatient time (56.80 ± 2.07 vs. 85.23 ± 2.54 ; $p < 0.01$). In contrast, the time assigned to critical care decreased from 111.20 ± 8.00 to 82.08 ± 14.49 days ($p < 0.01$). On average, 12 days of elective time was discontinued for the EC.

Performance Outcomes

Baseline medical knowledge was similar in both groups. There was no significant difference in the mean percentile ITE scores in the EC vs. CC. At the individual intern level (Table 2) there was a non-statistical increase in CMI (EC: 1.54 ± 0.11 vs. CC: 1.51 ± 0.081 ; $p = 0.31$), an increase in LOS (EC: 9.28 ± 0.98 vs. CC: 8.48 ± 0.66 ; $p < 0.01$), and a decrease in 30-day readmissions in the EC (EC: $18.64 \% \pm 2.19 \%$ vs. CC: $21.67 \% \pm 2.30 \%$; $p < 0.01$). Conversely, at a group analysis level (Table 3) there were uniform trends of decreasing CMIs, LOS, and 30-day readmission rates across all comparison groups (i.e., hospitalist to hospitalist and PGY-1 to PGY-1) in the post-2011 (EC) period as compared with the pre-2011 (CC) period.

Absolute changes in readmissions (EC vs. CC) demonstrated a greater reduction in PGY-1 rates (2.13 %) compared to hospital baseline (0.93 %; $P < 0.0001$). Mortality rates were not changed in the EC versus the CC cohort (Table 3).

DISCUSSION

This WLR approach resulted in a small decrease in new patients admitted and an increase in outpatient encounters over the course of the first year of training. To our knowledge, this is the most in-depth analysis of a WLR approach assessing both ambulatory and inpatient effects of this implementation method. The complexity of patients was greater in the EC, consistent with hospital-wide trends. To this end, interns had the opportunity to learn from sicker, more complex patients. This study found no negative impact on medical knowledge or quality of care outcomes.

Process. We posit our observation of a small, albeit statistical, reduction in new inpatient encounters is not clinically or educationally meaningful (absolute reduction of 24) and was countered by an increase (of 24) in total outpatient encounters.

Table 3 Hospital and Department Trends: CMI, LOS, Readmission, and Mortality

		Comparison period (2009–2011)		Exposure period (2011–2013)			
		Variable					
CMI		Hospital discharges	45,080	44,266			
			Mean (SD)	Mean (SD)	<i>P</i> value*		
		Hospital	0.96 (1.03)	0.94 (0.94)	<0.01		
		Medicine	0.88 (0.61)	0.86 (0.55)	<0.01		
		Hospitalists	0.76 (0.39)	0.75 (0.36)	<0.01		
LOS		PGY-1 s	1.23 (0.95)	1.19 (0.93)	<0.01		
		Hospital	4.41 (6.36)	4.58 (7.64)	<0.01		
		Medicine	3.89 (4.71)	4.06 (5.6)	<0.01		
		Hospitalists	3.33 (3.56)	3.54 (3.94)	<0.01		
		PGY-1 s	6.34 (7.5)	6.72 (10.12)	<0.01		
Readmission			Rate	Rate	<i>P</i> value†	Absolute difference	
		Hospital	12.07 %	11.14 %	<0.01	0.93 %	
		Medicine	13.74 %	12.55 %	<0.01	1.19%‡	
		Hospitalists	11.79 %	10.67 %	<0.01	1.12%‡	
		PGY-1 s	21.21 %	19.08 %	<0.01	2.13%‡	
Mortality		Hospital	1.79 %	1.85 %	0.58		
		Medicine	2.02 %	2.03 %	0.94		
		Hospitalists	0.39 %	0.44 %	0.65		
		PGY-1 s	4.75 %	4.92 %	0.68		

**P* value was calculated by two-sample, unpaired, unequal variance *t*-test

†*P* value was calculated by chi-square with Yates' correction

‡Compared to hospital absolute difference as a reference, each category is statistically different (e.g., PGY-1 s vs. hospital): $p < 0.0001$ by McNemar's analysis

Our results are similar to other studies in that reducing census or admitting caps did not substantially change total patient encounters.^{23,26} The restructuring changes increased the exposure of residents to an increased number of outpatients, which some educators have made strong arguments in favor of instituting.^{27,28} It is important to note that the inpatient WLR approach, by necessitating shifts in overall scheduling, increased patient encounters across a spectrum of care settings (inpatient and ambulatory).

Performance. In our study, ITE scores, measuring a component of medical knowledge, were no worse in the EC. Another study of DHR implementation, using a similarly designed WLR approach, showed similar ITE scores and improved attendance at educational activities.²⁹ A national concern, in the post DHR era has been for decreased conference attendance.³⁰ While conference attendance data were not measured, our program did not alter the frequency or duration of our didactic training between the time frames.

Depending on the method of analysis [individual (Table 2), where some patients' data were counted twice, or group (Table 3), where patient data were counted only once], PGY-1 trainees saw either no change (individual) in the complexity (CMI) or a decrease (group), aligning with hospital wide trends, in CMI. Over the entire time frame of this study, PGY-1 trainees cared for sicker patients in both the CC and EC when compared with the hospitalists, department of medicine, and hospital overall. PGY-1 trainees had a paradoxical increase in LOS for the patients they cared for (in EC) compared to hospital-wide trends of decreasing LOS. Readmission rates were lower for PGY-1 trainees (Table 2) but this aligned with hospital-wide trends (Table 3). There were no changes in mortality rates.

A prior WLR study at our hospital demonstrated reduced 30-day heart failure readmission rates.²¹ In contrast, in this study,

we looked at all cause readmissions (not heart failure alone). While PGY-1 trainee reduction in readmission was aligned with the larger secular trend at the hospital level, PGY-1 trainees had a greater absolute reduction in readmission. While the current design cannot establish causality, this hypothesis, WLR reduces readmission rates, could be tested in a future study.

Finally, we think our experience was successful in large part because our housestaff worked closely with program leadership not only to restructure to meet the new DHR, but also with a deliberate effort to try to preserve patient care and education in the process. Other DHR-type interventions have also found improved resident outcomes (e.g., learner satisfaction, value of rounds, and educational conferences).^{18–24} While these should be studied at our institution, in the current study these variables have not been captured; nonetheless, we hypothesize similar findings would be identified. The ongoing, prospective iCOMPARE study will further clarify many of the questions we seek to address in this retrospective study.³¹

Limitations

The study design (non-randomized, single-site intervention study with comparison to a historical control) limits our ability to assign causality among the outcomes. There is much unmeasured (e.g., conference attendance, topics covered) about the learning environment that limits our ability to generalize these findings to other institutions. Future studies should attempt to distinguish the type of method of DHR implementation (i.e., WLR vs. WLC) that was followed. Additionally, the health-system-wide trends (for example, trends shown in Table 3) might have influenced the EC group differently than the CC group. We do not believe the impact of these historical events is completely independent of the overall DHR-influenced residency training program restructuring. There were likely

interactions among these important events, such as WLR allowing PGY-1 trainees to be more involved with interdisciplinary rounds, family meetings, and other team-based activities related to reducing readmissions. Our data are limited to analysis of existing measures, and, as such, our study did not include measures of trainee fatigue or burnout. We have no measure to describe whether attendance at or participation in educational conferences was impacted or whether non-clinical work, such as research and scholarly projects, were altered.

CONCLUSION

Overall, we designed a workload reduction system that adhered to regulatory requirements without decreasing clinical exposure. Trainee and hospital quality outcomes were maintained or improved with implementation of a WLR program. While there is appropriate concern that reducing PGY-1 inpatient admission volumes may negatively impact educational and clinical care, this study found no evidence of such a trade-off.

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Author contributions: Drs. Thorp, Ghanem, and Christmas had full access to all of the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis. Study concept and design: Thorp, Ghanem, Christmas. Acquisition, analysis, or interpretation of data: Thorp, Ghanem, Christmas. Drafting of the manuscript: Thorp, Dattalo. Critical revision of the manuscript for important intellectual content: Thorp, Dattalo, Ghanem, and Christmas. Statistical analysis: Thorp, Ghanem. Study supervision: Ghanem, Christmas.

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REFERENCES

- Ulmer C, Miller Wolman D, Johns MME, eds. Resident Duty Hours: Enhancing Sleep, Supervision, and Safety. Washington, DC: National Academies Press; 2009.
- Pilibert I, Amis S, eds. The ACGME 2011 Duty Hour Standards: Enhancing Quality of Care, Supervision, and Resident Professional Development. Chicago, IL: ACGME; 2011.
- Nasca TJ, Day SH, Amis ES Jr, ACGME Task Force. The new recommendations on duty hours from the ACGME task force. *NEJM*. 2010;363(2):e3.
- Friesen LD, Vidyarthi AR, Baron RB, Katz PP. Factors associated with intern fatigue. *J Gen Intern Med*. 2008;23(12):1981-1986.
- Arora VM, Georgitis E, Siddique J, et al. Association of workload of on-call medical interns with on-call sleep duration, shift duration, and participation in educational activities. *JAMA*. 2008;300(10):1146-1153.
- Volpp KG, Rosen AK, Rosenbaum PR, et al. Did duty hour reform lead to better outcomes among the highest risk patients? *J Gen Intern Med*. 2009;24(10):1149-1155.
- Volpp KG, Rosen AK, Rosenbaum PR, et al. Mortality among patients in VA hospitals in the first 2 years following ACGME resident duty hour reform. *JAMA*. 2007;298(9):984-992.
- Volpp KG, Rosen AK, Rosenbaum PR, et al. Mortality among hospitalized Medicare beneficiaries in the first 2 years following ACGME resident duty hour reform. *JAMA*. 2007;298(9):975-983.
- Patel MS, Volpp KG, Small DS, et al. Association of the 2011 ACGME resident duty hour reforms with mortality and readmissions among hospitalized Medicare patients. *JAMA*. 2014;312(22):2364-2373.
- Block L, Jarlenski M, Wu A, et al. Inpatient safety outcomes following the 2011 residency work-hour reform. *J Hosp Med*. 2014;9(6):347-352.
- Rajaram R, Chung JW, Jones AT, et al. Association of the 2011 ACGME resident duty hour reform with general surgery patient outcomes and with resident examination performance. *JAMA*. 2014;312(22):2374-2384.
- Desai SV, Feldman L, Brown L, et al. Effect of the 2011 vs 2003 duty hour regulation-compliant models on sleep duration, trainee education, and continuity of patient care among internal medicine house staff: a randomized trial. *JAMA Intern Med*. 2013;173(8):649-654.
- Sen S, Kranzler HR, Didwania AK, Schwartz AC, et al. Effects of the 2011 duty hour reforms on interns and their patients: a prospective longitudinal cohort study. *JAMA Intern Med*. 2013;173(8):657-662.
- Drolet BC, Khokhar MT, Fischer SA. The 2011 duty-hour requirements—a survey of residency program directors. *NEJM*. 2013;368(8):694-697.
- Garg M, Drolet BC, Tammamo D, Fischer SA. Resident Duty Hour: a survey of internal medicine program directors. *J Gen Intern Med*. 2014;29(10):1349-1354.
- Goitein L, Ludmerer KM. Resident workload—let's treat the disease, not just the symptom. *JAMA Intern Med*. 2013;173(8):655-656.
- Ludmerer M. Let Me Heal: The Opportunity to Preserve Excellence in American Medicine. New York, NY: Oxford University Press; 2015.
- McMahon GT, Katz JT, Thorndike ME, et al. Evaluation of a redesign initiative in an internal-medicine residency. *NEJM*. 2010;362(14):1304-1311.
- Ratanawongsa N, Federowicz MA, Christmas C, et al. Effects of a focused patient-centered care curriculum on the experiences of internal medicine residents and their patients. *J Gen Intern Med*. 2012;27(4):473-477.
- Ratanawongsa N, Rand CS, Magill CF, et al. Teaching residents to know their patients as individuals. The Aiki Initiative at Johns Hopkins Bayview Medical Center. *Pharos Alpha Omega Alpha Honor Med Soc*. 2009;72(3):4-11.
- Record JD, Rand C, Christmas C, et al. Reducing heart failure readmissions by teaching patient-centered care to internal medicine residents. *Arch Intern Med*. 2011;171(9):858-859.
- Thanarajasingam U, McDonald FS, Halvorsen AJ, et al. Service census caps and unit-based admissions: resident workload, conference attendance, duty hour compliance, and patient safety. *Mayo Clin Proc*. 2012;87(4):320-327.
- O'Connor AB, Lang VJ, Bordley DR. Restructuring an inpatient resident service to improve outcomes for residents, students, and patients. *Acad Med*. 2011;86(12):1500-1507.
- Coit MH, Katz JT, McMahon GT. The effect of workload reduction on the quality of residents' discharge summaries. *J Gen Intern Med*. 2011;26(1):28-32.
- McCoy CP, Stenerson MB, Halvorsen AJ, et al. Association of volume of patient encounters with residents' in-training examination performance. *J Gen Intern Med*. 2013;28(8):1035-1041.
- Theobald CN, Stover DG, Choma NN, et al. The effect of reducing maximum shift lengths to 16 hours on internal medicine interns' educational opportunities. *Acad Med*. 2013;88(4):512-518.
- Nadkarni M, Reddy S, Bates CK, et al. Ambulatory-based education in internal medicine: current organization and implications for transformation. Results of a national survey of resident continuity clinic directors. *J Gen Intern Med*. 2011;26(1):16-20.

-
28. **Wieland ML, Halvorsen AJ, Chaudhry R, et al.** An evaluation of internal medicine residency continuity clinic redesign to a 50/50 outpatient-inpatient model. *J Gen Intern Med.* 2013;28(8):1014–9.
 29. **Vucicevic D, Mookadam F, Webb BJ, et al.** The impact of 2011 ACGME duty hour restrictions on internal medicine resident workload and education. *Adv Health Sci Educ Theory Pract.* 2015;20(1):193–203.
 30. **Drolet BC, Soh IY, Shultz PA, Fischer SA.** A thematic review of resident commentary on duty hours and supervision regulations. *J Grad Med Educ.* 2012;4(4):454–459.
 31. **Comparative Effectiveness of Models Optimizing Patient Safety and Resident Education (iCOMPARE trial).** <http://www.jhcct.org/icompare/default.asp> Accessed June 28, 2016