

## OPEN

# Impact of Extended Duty Hours on Perceptions of Care and Objective Patient Outcomes

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**Objective:** In 2017, interns were permitted to work continuously for up to 28 hours at a time, a reversal from the previously mandated 16-hour limit. Our objective was to evaluate perceptions of care and patient outcomes on an extended (28-hour) compared with a limited (16-hour) duty-hour system on identical interdisciplinary teams.

**Methods:** Sixty-two interns, 27 residents, 28 attendings, and 449 patients participated. Patients completed surveys assessing their satisfaction. Anonymous weekly surveys were obtained from interns, residents, and attendings evaluating perceptions of intern tiredness, overall satisfaction, and performance. Nursing surveys evaluated intern and medical team performance. Objective outcome measures, including intensive care unit transfers, length of stay, readmissions, mortality, and complications, were assessed through a retrospective, blinded chart review.

**Results:** Patients reported similar satisfaction in care. Extended duty-hour interns reported significantly decreased familiarity with their patients, decreased ability to conduct physical exams on new patients, increased tiredness, and decreased overall satisfaction. Residents overseeing extended-duty interns reported significantly decreased quality in intern presentations and overall quality of teaching, and increased perception of intern tiredness and increased incorrect orders. Attending physicians reported significantly improved quality of new patient presentations by extended duty-hour interns. No significant differences in patient objective outcome measures were noted.

**Conclusions:** Extended intern duty hours do not affect patient's satisfaction with their care. Although interns in the extended duty-hour system reported significantly increased fatigue and decreased overall satisfaction and residents' perceived increases in incorrect intern orders in the extended duty-hour system, there were no detrimental effects on patient safety.

**Key Words:** duty hours, patient satisfaction, patient outcomes, medical education

(*J Patient Saf* 2022;18: e938–e946)

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The authors disclose no conflict of interest. No industry or government support was received for this study.

Supplemental digital contents are available for this article. Direct URL citations appear in the printed text and are provided in the HTML and PDF versions of this article on the journal's Web site ([www.journalpatientsafety.com](http://www.journalpatientsafety.com)).

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Recognizing the tradeoffs between continuity of care and provider fatigue, in 2017, the Accreditation Council for Graduate Medical Education began allowing programs the discretion to schedule first-year residents (interns) to work continuously for 24 hours at a time, with an additional 4 hours for ensuring education and safe and effective care transitions.<sup>1</sup> This was an increase from the previous limit of 16 hours implemented in 2011 and was accompanied by increased expectations for supervision.<sup>2</sup>

Identifying the optimal schedule for physician trainees to witness the natural history of disease and the consequences of their interventions, time for educational activities, promotion of trainee well-being, and maximization of patient safety have been complicated. Proponents of strict and limited work-hour regulations have referenced cognitive impairments that are associated with moderate sleep deprivation<sup>3–5</sup> and the potential contribution of fatigue to reduced well-being and increased errors, whereas advocates of more flexible duty hours have pointed out the potential dangers of delaying medical care, an increased frequency of error-prone handoffs, reduced continuity of care, and negative impacts on well-being that accompany less connectedness to their patients with limited duty hours.<sup>6</sup>

These discussions culminated in national, prospective trials showing that flexible work hour policies for surgical residents were noninferior to call schedules adhering to the 16-hour limit<sup>7</sup> and that, among 63 randomized internal medicine residency programs, there were no significant differences between safety and provider alertness in hospitals with 24 + 4-hour shifts compared with 16-hour shifts. However, these studies also noted that attitudes differed significantly between interns and program directors about the impact of shift length.<sup>8–10</sup>

Although survey data have suggested that patients express greater concern about fatigue and working hours than about continuity of care,<sup>11</sup> little research has evaluated the effect of intern work hours on the patient experience as well as the perceptions of the other members of the interdisciplinary care team, such as nurses.

In this prospective, controlled, mixed-methods study, we analyzed survey data from patients, interns, residents, attendings, and nurses in both “extended” (24 + 4-hour max) and “limited” (16-hour max) duty-hour intern call systems on 2 adjacent general medicine services that share identical nursing, pharmacy, and ancillary support staff. We also examined differences in objective outcome measures of patient care, including length of stay, intensive care unit (ICU) transfers, 30-day readmission rates, medication orders entered in error, rate of complications, and mortality.

## METHODS

Partners Healthcare Human Research Committee institutional review board approval was obtained in August 2017. Perceptions and attitudes of interns, residents, attendings, nurses, and patients were collected using anonymous paper surveys.

### General Medicine Team Units

Interns and residents were assigned to a general medicine team with either an extended duty-hour or limited duty-hour schedule. Both teams shared the same nursing, pharmacy, and ancillary support staff. Patient admission criteria were identical, up to a cap of 10 patients per intern. Each team consisted of 2 attending physicians, 2 supervising residents, and 4 interns who could collectively be assigned up to 20 patients. Interns on the extended duty-hour team experienced 24 + 4-hour shifts every 4 days from 7 AM to 11 AM the following day, with 4-hour protected off-pager for in-hospital rest in private call rooms from 2:00 to 6:00 AM (extended duty hours); no new admissions could be assigned to an intern after 1 AM, so that the last 10 hours of the shift was protected from new admissions. Interns on the limited duty-hour team experienced a “long call” admitting shift every 3 days with a maximum single-day work hour limit of 16 hours. Day interns on the limited duty-hour team transferred care to a single “twilight” intern each evening. In a 24-hour period, there were 2 transitions of care (or “hand-offs”) in the extended-duty team and 3 transitions of care in the limited duty-hour team. Interns were assigned to the teams based on preference (30% extended; 27.5% limited) or, if they expressed no preference, were randomly assigned (42.5%). Per Accreditation Council for Graduate Medical Education rules, both units maintained a maximum weekly work hour limit of 80 hours.

### Surveys

Surveys (Supplement 1, <http://links.lww.com/JPS/A467>) were developed in consultation with a statistician and reviewed and revised by the internal medicine program director. Resident and intern surveys were finalized after consultation with a group of residents.

Patients (Table 1) were randomly sampled, consented, and completed anonymous surveys, from September 2017 to May 2018. Patients were only told that the study aimed to evaluate the care by the interdisciplinary care team. Patients were not told about differences in work hours. Patients were asked how many times they saw their doctor or the medical team, how well the doctors knew their medical issues, how well the doctors listened, and their overall satisfaction. Patients were offered to have the survey questions and possible answers read to them by the surveyor, who recorded the patient’s responses and verbatim comments. Patients were excluded if they were non-English speakers or were not oriented to person and place.

Physician surveys evaluated perceptions of intern tiredness, overall satisfaction, and performance, including quality of presentations, completion of physical exams, and incorrect order placement. For interns, residents, and attendings, individual surveys were distributed and collected weekly for the 2017–2018 academic year starting in September, to first allow interns and junior residents to become adjusted to general hospital workflows, through May 2018. Surveys were not collected during holidays because of changes in resident coverage schedules. To evaluate changes over the course of the rotation, an analysis was conducted for each week of the monthlong rotation, in the aggregate. To evaluate for changes over the course of the academic year, data were analyzed in sequential 3-month blocks over the course of the academic year.

Anonymous nurse surveys were distributed and collected, 5 times from September 2017 to the end of May 2018, which assessed their perception of the quality of care provided by the interns, intern responsiveness to pages, and the overall team dynamic compared with other unit. These were spaced throughout the study periods to maximize participation and identify whether nursing perceptions changed over the 9-month duration of the study.

### Objective Patient Outcome Data

For all consented patients, charts were reviewed to determine length of stay, 30-day readmission rate, 30-day emergency department visits, ICU transfers, complications, and mortality. Complications were determined by electronic chart review of progress notes and problem lists, with 2 physician reviewers who were blinded to the unit and were done dependently. Disagreements were resolved with discussion and further chart review. Each chart review took approximately 7 to 10 minutes to complete.

After discharge, the charts of consented patients were also reviewed by hospital pharmacists and evaluated for flagged pharmacy-level interventions (IVENTs, an Epic tool used to communicate and record ASP recommendations and interventions) during the patient stay, including dose/schedule changes, product changes, inappropriate therapies, and necessary therapeutic substitutions. Each patient chart was independently reviewed by 2 pharmacists, with disagreements resolved with subsequent discussion. Pharmacy flags for antimicrobial stewardship improvements

**TABLE 1.** Patient Demographics, Anonymous Survey Responses, and Objective Outcomes

Patients	Extended Duty	Limited Duty	$\chi^2$ P Value	95% CI
Total participants	228	221		
Mean Age, y	60.5	60.8	0.984	0.12 to 0.48
Women, %	52.6	50.2	0.429	2.3 to 2.49
Patients who reported unfavorable ratings, n (%)				
Overall satisfaction of the medical team	12 (5.2)	11 (5.0)	0.936	0.02 to 0.38
How well the doctors listen	15 (6.6)	15 (6.8)	0.901	0.02 to 0.32
How well the doctors know their problems	14 (6.1)	22 (9.9)	0.135	3.61 to 3.98
Objective data				
ICU transfers	3	5	0.453	−0.035 to 0.015
Average length of stay, d	7.62	6.96	0.301	−0.589 to 1.909
Patients who developed complications during admission	69	63	0.469	−0.064 to 0.104)

For each survey item, the response choice was dichotomized into a binary response of negative effect (“unfavorable”) versus no effect or positive effect. Of patient surveys, 439 of 449 (97.8%) answered every analyzed survey question; 7 (1.6%) of the patient surveys had 1 question unanswered, and 1 (0.72%) had 3 analyzed questions unanswered.  $P < 0.05$  was used to identify significance.

CI, confidence interval.

or optimization of therapy were not counted as errors. Subsequently, these interventions were reviewed dependently by 2 physician reviewers in a blinded fashion to stratify the flags based on potential clinical significance. All medication errors involving opiates, benzodiazepines, therapeutic anticoagulation, dual antiplatelet therapy, antiepileptics, and nonprophylactic antimicrobials were classified as clinically significant. The classification of other medication errors was based on further chart review and discussion between physician reviewers.

## Statistical Methods

Perceptions and attitudes were measured with survey questions that asked for responses on a 5-point Likert scale. For the purpose of data analysis, survey responses were collapsed into positive (beneficial) and negative (unfavorable) categories and analyzed using  $\chi^2$  tests for independence. We have also included calculations and confidence intervals in Tables 1–4.

In those instances where survey data could not be analyzed in this way, for instance, patient length of stay in the hospital, data were treated as continuous and analyzed using independent-samples *t* tests. We use an  $\alpha$  of 0.05 throughout this study to denote statis-

tical significance, although we report specific *P* values throughout. Data analysis was conducted using IBM SPSS Statistics for Windows, Version 25.0 (IBM Corp., Armonk, New York).

## RESULTS

### Survey Results

#### Patients

There were 228 patients on the extended duty-hour unit and 221 on the limited duty-hour unit who consented to be part of the study and completed the survey (Table 1). There was no significant difference in the average age and sex of the patients recruited, the number who declined to participate, or the number who had the surveys conducted verbally. Patient survey data indicated no significant differences in the patients' perception of the number of times they saw their doctors or the medical team, how well the doctors knew their medical problems, how well the doctors listened, or overall satisfaction.

Nineteen patients (4.3% of total patients), on subsequent chart review, were discovered to not have been under the care of either medicine service. They were patients cared for by either oncology

**TABLE 2.** Physician Demographics and Survey Responses

	Extended Duty	Limited Duty	<i>P</i>	95% CI
<b>Intern demographics and responses</b>				
Total responses (% of total)	57 (41.0)	82 (59.0)		
Women, %	47	76	<0.001	28.8 to 29.2
Interns who reported a beneficial effect, n (%)				
Knowing their assigned patients	14 (24)	60 (73)	<0.001	48.7 to 49.3
Presenting patients they know	10 (17)	42 (51)	<0.001	33.7 to 34.3
Conducting a physical exam on new patients	15 (26)	61 (74)	<0.001	46.71 to 47.3
Quality of teaching	23 (40)	67 (82)	<0.001	40.8 to 41.8
Level of tiredness	4 (7)	44 (54)	<0.001	46.7 to 47.3
Overall satisfaction	7 (12)	64 (78)	<0.001	62.7 to 65.3
<b>Resident demographics and responses</b>				
Total responses (% of total)	34 (57.6)	25 (42.4)		
Women, %	66	48	0.201	18.7 to 19.2
Residents who reported a beneficial effect, n (%)				
Quality of intern presentations of new patients	18 (53)	11 (44)	0.248	8.59 to 9.414
Quality of intern presentations of patients known to the service	8 (24)	10 (40)	0.093	15.6 to 16.4
Overall quality of care provided by the interns	18 (53)	20 (80)	0.016	26.5 to 27.4
Perception of intern tiredness	1 (3)	15 (60)	<0.001	56.5 to 57.5
Incorrect orders placed by intern	4 (12)	10 (40)	0.006	27.6 to 28.4
Overall teaching on the service	15 (44)	18 (72)	0.016	27.5 to 28.5
<b>Attending demographics and responses</b>				
Total responses (% of total)	32 (58.1)	23 (41.8)		
Women, %	13	26	0.197	12.8 to 13.2
Attendings who reported a beneficial effect, n (%)				
Quality of intern presentations of new patients	28 (88)	8 (35)	<0.001	52.7 to 53.3
Quality of intern presentations of patients known to the service	16 (50)	10 (43)	0.305	6.64 to 7.36
Overall quality of care provided by the interns	14 (43)	10 (43)	0.500	−0.32 to 0.32
Overall teaching on the service	17 (53)	14 (65)	0.187	8.57 to 9.43

For each survey item, the response choice was dichotomized into a binary response of positive effect ("beneficial") versus no effect or negative effect. Of intern surveys, 136 of 139 (97.8%) answered every analyzed survey question; 2 (1.4%) of the intern surveys had one question unanswered, and 1 (0.72%) had 3 analyzed questions unanswered. Of resident surveys, 136 of 139 (97.8%) answered every analyzed survey question; 1 (1.6%) of the resident surveys had 1 analyzed question unanswered, and 1 (1.6%) had 2 analyzed questions unanswered. Of attending surveys, 54 of 55 (98.2%) answered every analyzed survey question; 1 (1.8%) of the attending surveys had 1 question analyzed unanswered. *P* < 0.05 was used to identify significance.

CI, confidence interval.

**TABLE 3.** Chronological Changes in Intern Survey Responses Over Study Period

Trimester of Study	Extended-Duty Service Interns Who Reported a Beneficial Effect	Limited-Duty Service Interns Who Reported a Beneficial Effect	P	95% CI
Knowing their assigned patients				
1	5 (8.7%)	12 (14.6%)	0.298	-0.16 to 0.04
2	4 (7.0%)	22 (26.8%)	0.003	-0.31 to 0.08
3	5 (8.7%)	26 (31.7%)	0.001	-0.35 to -0.10
Total	14 (24%)	60 (73%)	<0.001	48.7 to 49.3
Presenting patients they know				
1	6 (10.4%)	16 (19.5%)	0.153	-0.20 to 0.02
2	3 (5.3%)	11 (13.4%)	0.116	-0.17 to 0.01
3	1 (1.7%)	15 (18.3%)	0.003	-0.25 to -0.07
Total	10 (17%)	42 (51%)	<0.001	33.7 to 34.3
Conducting a physical exam on new patients				
1	3 (5.0%)	18 (21.9%)	0.007	-0.27 to -0.06
2	4 (7.0%)	23 (28.0%)	0.002	-0.32 to 0.09
3	8 (14.0%)	20 (24.4%)	0.133	-0.23 to 0.02
Total	15 (26%)	61 (74%)	<0.001	46.71 to 47.3
Quality of teaching				
1	9 (15.7%)	13 (15.8%)	0.992	-0.12 to 0.12
2	7 (12.3%)	24 (29.3%)	0.018	-0.30 to -0.03
3	7 (12.3%)	30 (36.6%)	0.001	-0.37 to -0.10
Total	23 (40%)	67 (82%)	<0.001	40.8 to 41.8
Level of tiredness				
1	2 (3.5%)	18 (21.9%)	0.002	-0.28 to -0.08
2	2 (3.5%)	12 (14.6%)	0.032	-0.20 to -0.02
3	0 (0.0%)	14 (17.1%)	0.001	-0.25 to -0.08
Total	4 (7%)	44 (54%)	<0.001	46.7 to 47.3
Overall satisfaction				
1	4 (7.0%)	21 (25.6%)	0.005	-0.30 to -0.07
2	1 (1.7%)	19 (23.2%)	<0.001	-0.31 to -0.11
3	2 (3.5%)	24 (29.3%)	<0.001	-0.36 to -0.14
Total	7 (12%)	64 (78%)	<0.001	62.7 to 65.3

Intern responses over initial 3 months (trimester 1, September–November), subsequent 3 months (trimester 2, December–February), and final 3 months (trimester 3, March–May) of study period. For each survey item, the response choice was dichotomized into a binary response of positive effect (“beneficial”) versus no effect or negative effect.  $P < 0.05$  was used to identify significance.

CI, confidence interval.

or neurology services who had been placed on these units because of bed availability. Their data were included in the survey responses because of the anonymous nature of the surveys and inability to identify these surveys in retrospect. However, these patients were excluded from the objective outcome analyses. One patient was misidentified as being on limited duty-hour unit when they were under the care of the extended duty-hour team. This patient’s data were included in the survey responses because of the lack of identifying markers but were assigned to the appropriate service for the objective outcome data analyses.

**Physicians**

Sixty-two unique interns (40 women; ages, 25–34 years), 27 unique residents (16 women), and 28 unique attendings (5 women) participated. The total number of surveys (including subsequent weekly survey administrations over the course of the rotation) resulted in 139 completed intern surveys, 59 completed resident surveys, and 55 completed attending surveys (Table 2). Over 36 separate survey administrations during the 9-month survey

period, the overall survey response rates were 64.4% for interns, 81.9% for residents, and 39% for attendings. The rates that each intern, resident, and attending filled out the survey at least once were 83.7%, 73.0%, and 58.8%, respectively.

Interns assigned to the extended schedule reported less familiarity with their assigned patients (24% versus 73% reporting a beneficial effect,  $P < 0.001$ ), a decreased ability to conduct physical exams on new patients (27% versus 74%,  $P < 0.05$ ), increased perceptions of tiredness (7% versus 54%,  $P < 0.001$ ), decreased quality of teaching (41% versus 82%,  $P < 0.001$ ), and decreased overall satisfaction (12% versus 78%,  $P < 0.001$ ; see Table 2 and Fig. 1 for full responses).

Residents overseeing interns on the extended schedule reported lower quality of care provided by the interns (53% versus 80% reporting a beneficial effect,  $P = 0.016$ ), increased perceptions of intern tiredness (3% versus 60%,  $P < 0.001$ ), increased incorrect orders (12% versus 40%  $P = 0.006$ ), and lower overall quality of teaching on the service (44% versus 72%,  $P = 0.016$ ; Table 2).

There were no significant differences in resident perceptions of intern performance during new patient presentations or presentations



**TABLE 4.** Nurse Demographics and Responses

Patients	Extended Duty	Limited Duty	$\chi^2$ P Value	95% CI
Total participants, n (%)	31 (61)	20 (39)		
Women	30 (97)	16 (80)	0.049	−0.018 to 0.354
Years in nursing, n (%)				
<1	3 (9.7)	4 (20)	0.293	−0.307 to 0.101
1–5	9 (29)	2 (10)	0.107	−0.017 to 0.397
6–10	8 (25.8)	10 (50)	0.077	−0.509 to 0.026
10–20	6 (19.4)	2 (10)	0.368	−0.097 to 0.285
20+	5 (16.1)	2 (10)	0.535	−0.123 to 0.245
Nurses who reported a beneficial effect, n (%)				
Quality of care provided by interns	21 (68)	15 (75)	0.703	6.81 to 7.19
Overall team effectiveness	6 (19)	4 (20)	0.952	0.79 to 1.21
Intern responsiveness to pages	7 (23)	5 (25)	0.841	1.77 to 2.23

For each survey item, the response choice was dichotomized into a binary response of positive effect (“beneficial”) versus no effect or negative effect. Of nurses’ responses, 47 (92.2%) answered all analyzed survey questions. Nurses were asked to compare “overall team effectiveness” and “intern responsiveness to pages” only if they had rotated on both services. Four nurses (7.8%) did not answer this question.  $P < 0.05$  was used to identify significance.

CI, confidence interval.

of previously admitted patients. In a separate question posed only to residents in the extended duty-hour schedule, 47.1% of the residents reported that extended duty-hour interns performed at an “inferior” or “far inferior” level, whereas 16.7% of resident surveys reported that the extended duty-hour interns performed at a “superior” or “far superior” level compared with their prior experiences supervising limited duty-hour interns on other general medicine services. There was no difference in responses between PGY-2 and PGY-3 residents.

Attending physicians were significantly more likely to report higher-quality new patient presentations by interns working on the extended duty-hour schedule as superior to interns that they had supervised on other services with limited duty-hour schedules 88% (extended duty hours) versus 35% (limited duty hours;  $P < 0.001$ ), without significant differences in perceptions of the quality of presentations of patients known to the service, overall quality of care, or overall quality teaching (Table 2).

Throughout the academic year, extended duty-hour interns reported a significantly increased perception of their ability to perform physical exams and a decreased perception of presenting patients unfamiliar to them, whereas limited duty-hour interns reported increased perceptions in overall knowledge of their patients and the quality of teaching (Table 3). Intern perceptions of tiredness and overall intern satisfaction did not significantly change in either unit as the academic year progressed. Resident and attending survey response scores did not change significantly in either unit as the academic year progressed.

## Nurses

Forty-eight surveys were completed by 31 nurses over the duration of the study. There was no significant difference in nursing perceptions of the quality of intern care, team dynamics, or responsiveness to pages (Table 4). There were no significant differences in nursing responses across the 5 separate survey administrations.

## Objective Patient Outcome Data

### Patient Chart Review

There were no significant differences between length of stay, ICU transfers, 30-day readmission rates, 30-day emergency department

visits, complications (see Table 5 for the full list of complications), or mortality.

## Pharmacy Data

There was a significant increase in “clinically insignificant” dose/schedule pharmacy interventions on the limited duty-hour team compared with the extended duty-hour team. There were no significant differences in the number of drug change interventions, inappropriate therapy interventions, or therapeutic substitution interventions (Table 6).

## DISCUSSION

This prospective, controlled study examined the impact of the implementation of an extended duty-hour work schedule compared with a limited duty-hour work schedule on patient, intern, resident, attending, and nursing perceptions of care and objective patient outcomes on a general medicine service in an academic medical center. Our study demonstrates, on the one hand, significant intern reports of tiredness, dissatisfaction, and perceptions of suboptimal clinical skills in the extended duty-hour group compared with the limited duty-hour group, and on the other hand, identical rates of patient satisfaction and no significant adverse objective patient outcomes between patients on the extended duty-hour group and the limited duty-hour group over a 9-month period.

Our patient results demonstrate that patients cared for by extended duty-hour interns do not note significant differences in their overall satisfaction, the amount they saw their medical team, how well the doctors knew their medical problems, or how well the doctors listened to them. Although prior literature has suggested that patients have greater concerns about fatigue and working hours than about continuity of care,<sup>11</sup> our data show no indication that the patients perceived differences between the 2 groups. However, in our study, patients were not informed of the differences in intern duty hours between the 2 units. They were only asked to evaluate the quality of care they were receiving. We believe that the absence of patients’ bias makes our patient satisfaction survey data a distinct strength of our study. In addition, this study is the first study to date that includes both anonymous patient surveys focusing on patient perceptions and satisfaction with



FIGURE 1. Graphical representation of anonymous intern, resident, and attending survey responses over a 9-month survey period. \*P < 0.01. \*\*P < 0.05.

care as well as objective outcome data for those same patients, in the context of extended intern duty hours.

There are well-documented cognitive impairments that are associated with mild and moderate sleep deprivation.<sup>3-5</sup> The potential contribution of fatigue has been also shown to reduce well-being and increase errors in the medical setting.<sup>4</sup> Intern tiredness and dissatisfaction were significantly higher in the extended duty-hour system. This was noted despite maintaining a work-week less than 80 hours, accounting for initial intern preference in assigning units, and implementing a dedicated 4-hour rest period from 2:00 AM to 6:00 AM for the extended duty-hour intern. Similar dissatisfaction has been shown in fully randomized cohorts,<sup>9</sup> suggesting that satisfaction remains an issue in extended duty-hour systems caring for general medicine patients. As a direct result of dissatisfaction among interns and residents with the extended duty-hours schedule, extended-duty hours for general

medicine services was stopped at our hospital in July 2018, two months after this study was concluded.

Despite overall intern dissatisfaction and fatigue with extended duty hours, there were no notable differences in overall mortality, ICU transfers, length of stay, 30-day readmission rates, 30-day emergency department visits, or in-hospital complications. Given the increased perceived rate of incorrect order placement, we theorize that objective and subjective harm to patients was minimized because of heightened resident awareness and vigilance on the extended duty-hour teams.

Notably, interns in the extended duty-hour structure also reported decreased ability to perform physical exams on new patients and decreased knowledge about the patients under their care. One possible explanation for these findings is that there was a daily need to redistribute patients from the postcall intern to the remaining interns on the extended duty-hour team.

**TABLE 5.** Total Complications on Extended Duty-Hour and Limited Duty-Hour Services

Complication	Extended-Duty Service	Limited-Duty Service
<b>Neurologic/behavioral/psychiatric</b>		
Hospital delirium without agitation/violence	1	4
Psychosis or hospital delirium with agitation/violence episodes	1	2
Vertigo or lightheadedness	1	1
Altered mental status	1	2
Focal neurologic deficit	1	1
Seizure	1	1
Suicidal ideation	1	0
<b>Cardiovascular</b>		
Hemodynamic compromise (hypotension, shock)	6	9
Atrial arrhythmia or nonsustained ventricular tachycardia without hemodynamic compromise	4	7
Hyper/hypokalemia with ECG changes	2	4
Hyper/hypokalemia without ECG changes	0	4
Myocardial infarction	0	3
Cardiac arrest	0	2
Complete heart block	1	0
Hypertensive emergency	0	1
Angina	1	0
Volume overload without sequelae	0	1
<b>Pulmonary</b>		
Respiratory failure or hypoxia	6	8
Pulmonary embolism	1	0
Airway edema	1	0
Iatrogenic pulmonary edema after transfusions	1	0
Pneumothorax (without hypoxia or requiring intervention)	1	1
Asthma exacerbation (without hypoxia or hypercarbic respiratory failure)	1	0
<b>Infectious</b>		
Bacteremia	1	0
Catheter-associated urinary tract infection	2	1
Urinary tract infection, <i>Candida</i>	1	0
Urinary tract infection, <i>Pseudomonas</i>	1	0
Urinary tract infection, unspecified	0	1
pneumonia	2	1
Cellulitis	1	0
<i>Clostridium difficile</i> colitis	1	0
Cholangitis	0	1
Viral upper respiratory tract infection	1	2
Thrush (1)	0	1

(Continued next page)

**TABLE 5.** (Continued)

<b>Renal/metabolic</b>		
Symptomatic hypoglycemia	5	7
Diabetic ketoacidosis	0	3
Refeeding syndrome (characterized by metabolic derangements including low phosphorus)	2	0
Symptomatic Hypokalemia	1	0
Iatrogenic hypercalcemia requiring intervention	1	0
Transient acute kidney injury secondary to diuresis	3	8
Transient acute kidney injury secondary to tube feeds	0	1
Asymptomatic hypoglycemia	1	3
Hyperglycemia	2	1
Orthostasis secondary to diuresis	1	0
<b>Gastrointestinal</b>		
Acute abdomen	1	0
Constipation	1	1
Partial small bowel obstruction (self-resolved)	0	1
<b>Hematologic</b>		
Deep venous thrombosis	1	2
Bleeding requiring transfusion	1	0
Hemolytic transfusion reaction	0	1
Heparin-induced thrombocytopenia	1	0
Subtherapeutic or supratherapeutic INR without sequelae	2	1
Bleeding not requiring transfusion	1	1
Febrile nonhemolytic transfusion reaction	0	1
Superficial venous thrombosis	1	1
<b>Drug reaction</b>		
Drug-induced urinary retention requiring intervention	3	1
Drug-induced organ dysfunction, hepatitis (1), pancreatitis (1)	2	0
Drug-induced SIADH	1	0
Drug rash	3	0
Drug-induced transaminitis without other hepatic dysfunction	1	2
Drug-induced sodium derangement	1	2
Temporary drug side effect	1	2
Drug-induced constipation	1	0
Drug-induced diarrhea	0	2
Drug-induced pruritus	1	1
Drug fever	1	0
Drug-induced thrombocytopenia	1	0
<b>Postprocedural</b>		
Postprocedure pain requiring nerve block	1	0
Postprocedural bacteremia	2	0

(Continued next page)

**TABLE 5.** (Continued)

Complication	Extended-Duty Service	Limited-Duty Service
Postprocedural bleeding or hematoma	0	3
Myalgias postprocedure	1	0
Ascitic fluid leak after paracentesis	1	0
Postprocedural volume overload	1	0
Other		
Death	1	1
Illicit drug use during admission	0	1
Pathologic fracture during admission	0	1
Rhabdomyolysis	0	1
Fever of uncertain origin	1	0
Bleeding bullous pemphigoid lesion	1	0
Alcohol withdrawal	0	1
Penile lesion	0	1

ECG, electrocardiogram; INR, international normalized ratio; SIADH, syndrome of inappropriate antidiuretic hormone.

Additional analyses of intern and resident responses over 3-month blocks for the academic year demonstrated that extended duty-hour interns continued to consistently report lower satisfaction and increased perception of tiredness throughout the entire academic year, without any significant change from the earlier months compared with the later months of the study. This suggests that increased clinical skills do not offset the effect of perceptions of fatigue and dissatisfaction that accompanied working extended hours.

The schedules of the supervising residents were identical in each unit. However, residents' awareness of interns' tiredness mirrored the ratings of the interns themselves, with residents perceiving significantly increased intern tiredness in the extended duty-hour work schedule.

The residents on the extended duty-hour unit in this study reported a significant increase in incorrect orders placed by interns. However, this observation did not correlate with an objective increase in medication order entry errors as documented by the pharmacists. Based on the resident free-text survey responses, we speculate that this discrepancy may be due to hypervigilance on the part of residents supervising extended duty-hour interns. This may have resulted in the identification and correction of incorrect orders before pharmacy-level screening. Alternatively, it is possible that the extended duty-hour interns were seeking additional assistance from residents, nurses, or pharmacists before placing medication orders. It is also worth noting that, because not all orders are medication based, the true difference in incorrect order errors cannot fully be elucidated by solely looking at pharmacy-level flags.

Attendings on the extended duty-hour work schedule reported improved performance with new patient presentations suggesting that one of the major benefits of the extended duty-hour structure is the ability of the overnight admitting intern to present his or her patients during morning rounds, and the mitigation of an additional hand-off between providers.

Nurses' perceptions of the care provided by the interns or their responsiveness to pages were not significantly different for the extended duty-hour versus the limited duty-hour physicians. Our results are in contrast to prior literature, which has suggested that nurses have generally had less positive views of resident coverage systems that used a night-float system.<sup>12</sup>

Notable limitations of this study include that it was performed at a single academic medical center. The study was a nonrandomized trial where interns were assigned to units based on preference, introducing the possibility of selection bias. Because interns and residents were aware of their duty-hour schedule and the schedule of the counterpart team, the study was not able to be double-blinded. Although the surveys were created after discussion with residents and after review by the program director and statistician, they were not validated by pilot studies. The survey responses in the limited duty-hour arm had significantly more female respondents and the attendings had predominantly male respondents, which may suggest sex-based differences or gender bias. Our surveys did not ask about home responsibilities and whether they factored into the decision of which call schedule was preferred. In the overall residency program, 57% of the interns and 39% of the residents were women, suggesting that women were oversampled in our study. However, additional analysis showed no differences in survey responses based on sex, limiting the significance of this oversampling.

Although no significant difference was seen in complication or mortality data, post hoc analysis revealed that the study was insufficiently powered to fully evaluate these 2 outcome measures. There was a lower response rate among interns and attendings compared with residents, raising a concern about sampling bias. In the patient survey data, 19 patients who were not under the care of either medicine team were included. Because of the anonymity of the surveys, we were unable to identify and therefore remove the surveys of these patients. Although it is possible that the addition of these surveys affected the survey results, the numbers were small enough (10 patients erroneously included in the extended duty-hour unit, 9 erroneously included on the limited duty-hour unit; overall 4.2% of total responses) that we consider this unlikely.

**TABLE 6.** Pharmacy Interventions

Pharmacy Intervention Flags	Extended Duty (No. Interventions)	Limited Duty (No. Interventions)	P
Dose/schedule change	62	86	<0.001
Clinically significant	40	48	0.074
Not clinically significant	22	36	<0.001
Drug/product changed	9	5	0.319
Clinically significant	2	1	0.476
Not clinically significant	7	4	0.363
Inappropriate therapy	12	9	0.192
Clinically significant	8	2	0.083
Not clinically significant	4	7	0.231
Therapeutic substitution	8	3	0.092
Clinically significant	1	0	0.496
Not clinically significant	7	2	0.071



## CONCLUSIONS

This prospective, controlled study suggests that objective outcomes of patient care and patients' perceptions of care are not significantly affected by extended intern duty hours on a general medicine service. However, this study raises concerns about the implementation of extended duty hours given the increased fatigue and significant dissatisfaction among interns and residents as indicated by anonymous survey data.

## ACKNOWLEDGMENTS

We thank Meredith A. Beers, JD, for her generous support of the Charlotte and Cameron Beers Medical Education Fellowship named in honor of her parents. We also thank Dr. Marshall Wolf for his sustained support of the Brigham and Women's Hospital Medical Education Fellowship.

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