Extended Work Shifts and the Risk of Motor Vehicle Crashes among Interns

[Original Articles]

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Abstract
Background: Long work hours and work shifts of an extended duration (greater/equal 24 hours) remain a hallmark of medical education in the United States. Yet their effect on health and safety has not been evaluated with the use of validated measures.

Methods: We conducted a prospective nationwide, Web-based survey in which 2737 residents in their first postgraduate year (interns) completed 17,003 monthly reports that provided detailed information about work hours, work shifts of an extended duration, documented motor vehicle crashes, near-miss incidents, and incidents involving involuntary sleeping.

Results: The odds ratios for reporting a motor vehicle crash and for reporting a near-miss incident after an extended work shift, as compared with a shift that was not of extended duration, were 2.3 (95 percent confidence interval, 1.6 to 3.3) and 5.9 (95 percent confidence interval, 5.4 to 6.3), respectively. In a prospective analysis, every extended work shift that was scheduled in a month increased the monthly risk of a motor vehicle crash by 9.1 percent (95 percent confidence interval, 3.4 to 14.7 percent) and increased the monthly risk of a crash during the commute from work by 16.2 percent (95 percent confidence interval, 7.8 to 24.7 percent). In months in which interns worked five or more extended shifts, the risk that they would fall asleep while driving or while stopped in traffic was significantly increased (odds ratios, 2.39 [95 percent confidence interval, 2.31 to 2.46] and 3.69 [95 percent confidence interval, 3.60 to 3.77], respectively).

Conclusions: Extended-duration work shifts, which are currently sanctioned by the Accreditation Council for Graduate Medical Education, pose safety hazards for interns. These results have implications for medical residency programs, which routinely schedule physicians to work more than 24 consecutive hours.


Residents in their first postgraduate year (interns) in the United States frequently work shifts of an extended duration (greater/equal 24 hours), a practice that results in long workweeks. [1,2] Both the number and the distribution of work hours can affect sleep, productivity, and safety. [3] The risk of fatigue-related crashes, a leading cause of truck crashes that have been fatal to the driver in the United States, [4,5] increases markedly as a function of truckers' consecutive driving hours. [6] Despite long-standing concerns regarding the effects of work hours on performance and safety among postgraduate physicians, [7-10] prior studies have not directly associated safety outcomes with such a specific characteristic of their work schedule.

To address this issue, we administered a monthly Web-based questionnaire to interns nationwide to investigate the association between validated work hours, extended work shifts, and driving safety. Assessment of driving safely included documented motor vehicle crashes, near-miss incidents, incidents involving falling asleep while driving, and incidents involving falling asleep while stopped in traffic.

Methods
Data Collection

In April 2002, advertisements announcing the Harvard Work Hours, Health, and Safety study and offering the chance of a monetary incentive for participation were sent by e-mail to people who were matched to a residency by the National Resident Matching Program and to graduates of U.S. medical schools. The advertisement that was used is contained in the
Supplementary Appendix (available with the full text of this article at http://www.nejm.org). Thereafter, responses to detailed questions regarding work hours, shifts of extended duration (greater/equal 24 hours), motor vehicle crashes, near-miss incidents (near-miss motor vehicle crashes in which property damage or bodily harm was narrowly avoided), and incidents of involuntary sleeping were collected monthly through May 2003, when responses regarding the overall first postgraduate year were also collected. Although this report addresses only data regarding extended shifts, motor vehicle crashes, and near-miss incidents, the questions regarding these exposure and outcome variables were distributed among 60 other questions on the monthly surveys. The Human Research Committee of Brigham and Women's Hospital and Partners HealthCare approved all the study procedures, and all the participants provided electronic written informed consent.

Validation of Work Hours

A random subgroup of participants (7 percent) completed daily work diaries. We validated these diaries in a separate study in which direct observation was used for continuous monitoring of work hours. A very high correlation was found between work hours \( r=0.98 \) and shifts of extended duration \( r=1.0 \) as reported by observers and as recorded in the diaries. [11] This work-diary subgroup recorded their work hours for at least 21 out of 28 days and completed the corresponding monthly survey. Pearson's product-moment correlation was used to determine the association between the daily average number of work hours and the number of extended-duration work shifts that were reported in the diary and in the monthly survey.

Documentation Process for Crashes

Participants who reported a motor vehicle crash were requested to provide documentation of the crash. A police report, an insurance claim, an auto-repair record, a medical record, a photograph of the damaged vehicle, or a written description of the crash was accepted as documentation. For participants who did not complete the year-end survey, no additional crashes were identified, either through a search of the Social Security Death Index or through inquiries to the interns' designated emergency contacts.

Statistical Analysis

We used two independent techniques to quantify exposure and to assess relative risk. First, the subgroup of crashes and near-miss incidents that occurred on the commute from work was analyzed with the use of a within-person case-crossover design. For each participant, we assessed the number and proportion of crashes and near-miss incidents that had occurred after an extended work shift, as compared with a shift that was not extended. The Mantel-Haenszel test (with each subject as a separate stratum) was used to calculate the odds ratio for crashes and near-miss incidents that occurred after an extended work shift as compared with a nonextended shift. [12] Second, to address potential reporting bias (because both the crashes and the number of extended shifts were reported in each monthly survey), we also prospectively assessed whether the mean monthly number of scheduled extended shifts (collected on the baseline survey) was associated with the subsequent occurrence of motor vehicle crashes as reported on the monthly surveys. We then used Poisson regression analysis that was adjusted for age and sex to determine whether the mean monthly number of scheduled extended shifts was associated with the occurrence of crashes. For each participant, the time at risk for the Poisson regression was considered to be the number of monthly surveys that each participant completed.

A case-crossover analysis was used to determine whether the number of extended shifts that interns worked per month was associated with incidents of falling asleep while driving or
while stopped in traffic. The Mantel-Haenszel test was used to calculate odds ratios. The case-crossover study design eliminated the need to account for potential confounders, such as differences in age, sex, commuting time or distance, or medical specialty, since participants served as their own controls. [13] All data are reported as means +/-SD. All odds ratios are reported with 95 percent confidence intervals; all P values are two-sided. Additional information about the methods used is provided in the Supplementary Appendix.

Results

A total of 3429 interns volunteered to participate in the study. Of those, 2737 (80 percent) completed the baseline survey and were thus deemed the study cohort. Each month, an average of 1548+/-376 surveys were completed. Ninety-three percent of the study cohort completed at least one monthly survey and were eligible for the analysis of crashes and near-miss incidents; 82 percent completed at least two monthly surveys and were thus eligible to be included in all analyses (Figure 1). We collected a total of 19,740 surveys, including 2737 baseline surveys and 17,003 monthly surveys.