

## Original Article

## Are long physician working hours harmful to patient safety?

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**Abstract** *Background:* Pediatricians of Japanese hospitals including not only residents but also attending physicians work long hours, and 8% work for >79 h per week. Most of them work consecutively for  $\geq 32$  h when they are on call. The aim of the present study was to evaluate the effect of long work hours on patient safety.

*Methods:* The electronic databases MEDLINE and EMBASE to searched identify the English- and Japanese-language literature for studies on work hours, medical errors, patient safety, and malpractice for years 1966–2005. Studies that analyzed the relationship between physician work hours and outcomes directly related to patient safety were selected.

*Results:* Seven studies met the criteria. Four studies suggest that reduction of work hours has a favorable effect on patient safety indicators. In the other three studies no significant changes of the indicators were observed, but no report found that shorter work hours were harmful to patient safety.

*Conclusion:* Decrease of physician work hours is not harmful but favorable to patient safety.

**Key words** malpractice, medical errors, patient safety, work hours.

In Japan 24 h pediatric emergency services are needed in all communities, but the mean number of pediatricians per hospital is 2.3, and almost all hospital pediatricians, including not only residents but also attending physicians, work above the upper limits of working hours (40 h per week) decided by Labor Standard Law.<sup>1,2</sup> According to the Japanese Pediatric Society, the mean extra work hours of pediatricians who provided emergency services was 86.7 h per month, which is above the standard of *karoshi* (death by overwork), and 8% of the pediatricians work for  $\geq 79$  h per week.<sup>1,2</sup> Several families of the pediatricians who died due to *karoshi* complained to Ministry of Health, Labour, and Welfare, and its branches inspected many hospitals with 24 h emergency service and uncovered their violations of labor-related laws.<sup>3</sup> Certainly, 97% of the pediatricians who work in emergency services work for  $\geq 32$  consecutive hours.<sup>2</sup> The working system of physicians is problematic in Japan, and, in 2005, Supreme Court of Japan judged that medical residents were workers protected by Labor Standard Law and Minimum Wage Law.<sup>4</sup> But the relationship between physicians' work hours and patient safety has not been well clarified. The aim of the present study was to review the literature on the effect of physicians' work hours on patient safety.

## Methods

The English- and Japanese-language literature on physician work hours from 1966 to August 2005 were reviewed on MEDLINE and EMBASE. The search was conducted by exploring the following medical subject heading terms: work hours and

medical errors; work hours and patient safety; and work hours and malpractice.

The abstracts of all citations from 1966 to August 2005 were reviewed. Medical specialties were not limited to pediatrics. When they described the relationship between physician work hours and patient safety, the original articles were also reviewed. Reports were selected that showed outcomes directly related to patient safety such as rates of complications, medical errors, and misdiagnosis.

## Results

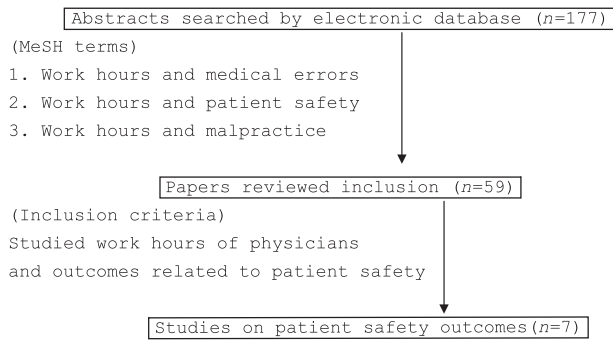
There were 177 articles that included the following terms: work hours and medical errors; work hours and patient safety; and work hours and malpractice (Fig. 1). Fifty-nine articles described the relationship between physician work hours and patient safety, and the original articles were reviewed. Finally, seven studies, which assessed patient safety outcomes, were selected (Table 1). They consisted of five interventional and two observational investigations.<sup>5–11</sup>

Four studies showed that residents with shorter duty hours tended to make fewer medical errors,<sup>6,8,9,11</sup> but in the other three reports, decrease of work hours did not change the incidence of unfavorable outcomes.<sup>5,7,10</sup> No studies reported that physicians with shorter work hours were more harmful to patient safety.

Rogers *et al.* conducted a retrospective cohort study using the trauma registry in Fletcher Allen Health Care/University of Vermont to assess the effect of schedule changes for residents in trauma services.<sup>5</sup> These changes were performed to be compliant with the Accreditation Council for Graduate Medical Education (ACGME)-mandated 80 h resident work week. In the pre-intervention period (July–December 2002), 543 patients were admitted and residents worked approximately 90 h per week. In the post-intervention period (July–December 2003), 549 patients

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**Fig. 1** Literature search used in the present study. MeSH, medical subject heading.

admitted and residents worked approximately 80 h per week. The authors reported that there was no significant difference in complication rate, delayed diagnoses, or missed diagnoses between before and after the introduction of the 80 h work limit.

Landrigan *et al.* conducted a prospective, randomized study comparing the rates of serious medical errors made by interns while they were working according to a traditional schedule with extended work shifts ( $\geq 24$  h per shift) every third night, and while they were working according to an intervention schedule with less extended work shifts (up to 16 h per shift) and reduced weekly work hours.<sup>6</sup> During a total of 2203 patient-days involving 634 admissions, interns made 35.9% more serious medical errors during the traditional schedule compared with the intervention schedule (136.0 vs 100.1 per 1000 patient-days,  $P < 0.001$ ).

Davydov *et al.* performed a prospective cohort study in two internal medicine units to assess the correlation between the frequency of prescribing errors and the number of hours worked during a 24 h shift by hospital house staff. There was no significant relationship between the two factors.<sup>7</sup>

Bailit and Blanchard conducted a retrospective cohort study in the Department of Obstetrics and Gynecology at Metro Health Medical Center using the prenatal database, medication error

database, incident reports field in the legal department, and quality management database to assess the effect of work hour reforms for house staff.<sup>8</sup> Before the reform period (July 2001–June 2002), house staff worked on call every fourth night, and they slept for 1–2 h per on-call night. There were no limits of weekly work hours. After the reform period (July 2002–June 2003), all residents worked no more than 24 h per shift and 80 h per week. The interns took 24 h call every fourth night. Statistically significant fewer post-partum hemorrhages and neonatal resuscitations occurred after work-hour restrictions.

Baldwin *et al.* performed a descriptive study of randomly selected postgraduate year 1 and year 2 residents.<sup>9</sup> Postgraduate year 1 and year 2 residents reported working for 83 h and 76.2 h per week on average, respectively. The residents averaging  $>80$  work hours per week were 1.58-fold more likely to have experienced a serious accident or injury.

Lee *et al.* conducted a prospective self-controlled study to evaluate the advantages and disadvantages of a night shift call system (NSCS) compared with those of a conventional overnight call system (ONCS) in a surgical training program.<sup>10</sup> During the ONCS, basic surgical trainees (BST) were on call every fourth night and worked for approximately 28 consecutive hours per shift and 70–80 h per week. During the NSCS, each BST rotated to work 1 week of night duties and 7 weeks of daytime duties, and in night duties BST worked for 12 consecutive hours. There were no significant differences of the number of errors committed and misdiagnosis between the NSCS and ONCS.

Mann and Danz used a prospective cohort study to evaluate the number of ‘discordant’ diagnoses between residents and attending physicians during night coverage in a radiology program.<sup>11</sup> The intervention in that study was an addition of a ‘night stalker’, a night floating resident in the radiology program who assisted on-call residents. On-call residents with and without the night floating resident slept for 5.75 h and 2.75 h, respectively, in spite of a 33 h consecutive work per shift. The authors reported that there were fewer discordant cases per shift in the night floating resident system compared with the conventional system.

**Table 1** Effects of changes of work hours on patient safety indicators

Study	Control	Intervention	Outcomes
Rogers <i>et al.</i> <sup>5</sup>	PGY1:90.82 $\pm$ 16.29 h/week PGY2:85.95 $\pm$ 23.3 h/week PGY4:91.75 $\pm$ 13.92 h/week	PGY1:76.85 $\pm$ 5.24 h/week PGY2:80.66 $\pm$ 8.73 h/week PGY4:81.80 $\pm$ 12.98 h/week	No difference of complication, delayed diagnosis, and missed injuries
Landrigan <i>et al.</i> <sup>6</sup>	34 h/shift	16 h/shift	Malpractice: 136 vs 100.1/1000 patient-days
Davydov <i>et al.</i> <sup>7</sup>	Prescribing errors and no. hours worked		No relationship
Bailit and Blanchard <sup>8</sup>	36 h/shift	24 h/shift	Post-partum hemorrhage: 2.0% vs 1.2% Neonatal resuscitations: 30.1% vs 26.3%
Baldwin <i>et al.</i> <sup>9</sup>	$>80$ h/week vs $<80$ h/week		Residents who worked $>80$ h were 1.58-fold more likely to have experienced a serious accident or injury
Lee <i>et al.</i> <sup>10</sup>	28.2 $\pm$ 1.6 h/shift	12.0 $\pm$ 0 h/shift	Malpractices: No differences (9 events/month vs 6 events/month)
Mann and Danz <sup>11</sup>	33 h (2.75 h sleep)/shift	33 h (5.75 h sleep)/shift with night-floating resident	Misdiagnosis: 1.69/shift vs 1.0/shift

PGY, post-graduate year.

**Table 2** Upper limits of working hours of resident physicians (in 2002)

	UK		Netherlands		Denmark	France	Germany	Ireland	USA
	On call	Shifts	On call	Shifts	On call and shifts	On call and shifts	On call and shifts	On call and shifts	On call and shifts
How hours are regulated	Ministerial agreement		National legislation		Legislation and collective agreement	N/A	Collective agreement	N/A	Legislation (New York State) and collective agreement (other states)
Maximum continuous duty (hours)	32 h week days and 56 h at weekend	16–24 h	24 h	24 h	N/A	N/A	24 h	72 h	24 h
Maximum averaged hours per week	56 h (cycle time not specified)		48 h over cycle period of 13 weeks		Not regulated; average: 45 h	Not regulated; average: 50 h + on call	56 h over cycle time of 24 weeks	65 h, (however, exceeded up to 129 h)	80 h (cycle period not specified)

## Discussion

Some studies evaluated the link between performance and sleep deprivation in the medical profession. For example, residents handled a laparoscopic surgery simulator worse after a sleepless night compared with a normal night,<sup>12</sup> and sleep-deprived interns had more mistakes in reading electrocardiograms than those who slept well the previous night.<sup>13</sup> The studies of the effects of sleep deprivation reported that task performance of the residents tended to degrade with sleep deprivation. After nearly 24 h without sleep, psychomotor performance can be impaired to an extent greater than is currently acceptable for alcohol intoxication.<sup>14</sup>

Reduced physician work hours, however, often result in increased discontinuity and may be harmful to patient safety. It is very difficult to determine which one provides safer care to patients: a well-rested resident whose knowledge of the patient comes only through a report, or a fatigued resident who performed the history taking and physical examination. Certainly, Laine *et al.* reported that restricted work hours of house staff were

associated with increased delays in diagnostic tests.<sup>15</sup> Petersen *et al.* also showed that potentially preventable adverse events were strongly associated with coverage by a physician from another team,<sup>16</sup> but with a computerized sign-out program, continuity of inpatient care was improved and adverse events were prevented.<sup>17,18</sup> No studies in the present review reported that reducing work hours harmed patient safety.<sup>5–11</sup> Therefore it is concluded that limitation of physician work hours can be favorable to patient safety by the introduction of a well-designed sign-out system. Most hospital physicians in Japan, especially pediatricians, work consecutively for above 32 h when they are on call,<sup>2</sup> and reducing their work hours below 24 h per shift may be favorable to patient safety, as shown by Landrigan *et al.*<sup>6</sup> and Bailit and Blanchard.<sup>8</sup>

Safe patient care is most important in the medical practice, and in order to maintain this, reforms of personnel management of medical workers are essential. As the review illustrates, only few studies are available on the outcomes of past interventions to

**Table 3** Study design, strengths and weaknesses

Study	Design	Strength	Weakness
Rogers <i>et al.</i> <sup>5</sup>	Retrospective cohort study	Reported important clinical outcomes such as complication, delayed diagnosis, missed injuries	The number of neurosurgical or orthopedic patients treated by the residents decreased because of reduced work hours
Landrigan <i>et al.</i> <sup>6</sup>	Prospective, randomized study	Clinical outcomes such as incidence of serious medical errors, and number of incidents, patients, and physicians	
Davydov <i>et al.</i> <sup>7</sup>	Prospective cohort study	No. prescribing errors was given	No attention to confounding factors such as circadian rhythm
Bailit and Blanchard <sup>8</sup>	Retrospective cohort study	Clinical outcomes of mothers and babies were given	No. physicians not shown
Baldwin <i>et al.</i> <sup>9</sup>	Descriptive study	Described in detail	No attention to medical specialties
Lee <i>et al.</i> <sup>10</sup>	Prospective self-controlled trial	Important clinical outcomes such as medical errors were shown	Small samples
Mann and Danz <sup>11</sup>	Prospective cohort study	Rates of misdiagnosis (discrepancy of radiological diagnoses between residents and attending physicians) were shown	No comparison of baseline patients characteristics

decrease house staff work hours. In order to determine the effect of work hour reforms on outcomes directly related to patient safety, much larger, multi-institutional studies with careful measurement for possible confounders are needed.

Many countries limit work hours per shift and per week of resident physicians (Table 2).<sup>19,20</sup> In Japan there is no upper limit to physician work hours in order to prevent medical errors by overworked physicians. For occupational health, only Labor Standard Law protects all the workers including employed physicians in Japan. Therefore, in order to prevent medical malpractice, the strict application of this law is needed, or new legislation for the regulation of work hours of medical workers should be brought in. Furthermore, because of the shortage of pediatricians, it is necessary to concentrate the staff into big pediatric centers, which cover a wide area, in order to maintain 24 h emergency services.

These results must be interpreted cautiously. These studies are of variable quality (Table 3), and different interventions were used. Therefore, generalizations are difficult to make. In addition, publication bias may be present in that negative studies may not have been published, and unmeasured confounding is still a potential problem of non-randomized studies. Rogers *et al.* reported no significant differences in the rate of complications, delayed and missed diagnoses between before and after the intervention.<sup>5</sup> But, because of reduced work hours, the number of patients treated by the residents decreased. Davydov *et al.* analyzed the correlation of the rate of prescribing errors by medical house staff and the number of hours worked.<sup>7</sup> Their 24 h shift began at 07:00 hours, but the authors paid no attention to the confounding effect of circadian rhythm. Baldwin *et al.* asked residents about their work hours and serious accidents or injury,<sup>9</sup> nevertheless, they performed no analysis of the specialty-specific relationship between work hours and malpractice.

There have been few analyses of the relationship between physician work hours and patient safety. There should be further investigations to find the best balance of physician workload and continuity of patient care.

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