Influence of Residents’ Workload, Mental State and Job Satisfaction on Procedural Error: a prospective daily questionnaire–based study

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BACKGROUND: Previous studies have suggested positive association between residents’ workload and medical errors. However, few studies have investigated the possible associations between procedural errors, workload, and the individual characteristics of residents, including personality, mental state and job satisfaction.

OBJECTIVE: To explore possible associations of workload and individual characteristics of residents with their procedural error rates.

DESIGN: Prospective observational study based on a daily questionnaire.

PARTICIPANTS: Residents of postgraduate year 1 and 2.

MEASUREMENTS: Residents’ workload (on–calls, work hours, sleep and napping hours), residents’ physical and mental health state, personality inventory, and procedural error rate (defined as procedural error counts divided by overall procedural attempts).

RESULTS: On average, the residents (N = 49) were responsible for 9.8 inpatients per day (range, 1.9–23.1), worked for 16.0 hours per day (range, 12.6–19.8), slept for 4.4 hours per day (range, 2.8–5.7), napped for 0.2 hours per day (range, 0–0.7), and experienced 1 overnight work shift every 7.2 days. The procedural error rate was 2.2 per 10 procedures (range, 0.4–5.0). Using a multivariable adjusted regression model, significant factors associated with lower error rates included: longer napping; reflective personality; better mental state; higher job satisfaction; and, less on–call frequency.

CONCLUSIONS: Procedural error of residents is positively associated with higher on–call frequency and inversely associated with napping, reflective personality, better mental state, and higher job satisfaction. For reducing procedural error among residents, improvement of modifiable factors, such as workload and mental health, is needed.

KEY WORDS: Resident, Procedural Error, On–call frequency


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INTRODUCTION

Because of an increasing concern about residents’ fatigue and patient safety in the United States, the Accreditation Council for Graduate Medical Education (ACGME) introduced 80-hour-per-week limitation on residents on 1 July 2003. Recently, post-hoc analyses on the effect of this nation-wide reform on patients’ and residents’ well-being have been published. These analyses showed: 1) 78.3% of residents reported an improvement of their quality of life after the introduction of the work hour limitation; 2) the work hour limitation did not lead to an improvement in surgical patient safety; and, 3) some residents reported possible negative effects on patient care and resident education as a result of the introduction of work-hour limitations. Several new approaches, including “napping,” have been recently advocated to reduce residents’ fatigue more effectively.

In Japan, a 40-hour-per-week work hour limitation was proposed in the labor standards law. The Ministry of Health, Labor and Welfare of Japan also announced that this limitation applies to residents. However, several studies have reported the actual work hours of residents to be well over 80 hours and that the standard for work-hour limitation is in fact visionary in the current medical environment in Japan. In this context, there is increasing concern that residents’ fatigue leads to the deterioration of patient safety.

The oldest study on residents’ fatigue and patient safety was published as long as 35 years ago in 1971 by Friedman and his colleagues. Thereafter, multiple retrospective and cross-sectional studies have shown that long work hours and sleep deprivation might decrease residents’ cognitive function and increase medical errors. Additionally, recent studies on the effects of residents’ workload on daily clinical performance using prospective designs have shown that work hours and sleep deprivation were significantly associated with poor performance and increased risk for errors.

The psychological state of residents, especially “burnout,” have also been considered to affect clinical performance and the frequency of medical errors. However, there have been no studies that investigate individual personality attributes and the job satisfaction of residents as possible contributing factors to their clinical performance.

To explore the influence of these personal characteristics of individual residents, along with their workloads, on medical errors in a Japanese teaching hospital, we conducted a prospective observational study using a web-based daily self-record of procedural errors, workload, and multidimensional assessment about residents’ psychological states and individual personality attributes. We also investigated the working environment of residents in a teaching hospital in Japan.

METHODS AND MATERIALS

Study participants

We designed a prospective observational study to analyze individual personality attributes, psychological states, and the workloads of residents (postgraduate years 1 and 2) and the influence of these on procedural error during the care of inpatients at St. Luke’s International Hospital. This academic medical center has 520 beds for inpatients, as well as an emergency department, and provides primary to tertiary care to an urban population in the Tokyo metropolitan area.

The participants started their residency programs from April 2005 (postgraduate year 2) and from April 2006 (postgraduate year 1). The rotation units of the participants included internal medicine, surgery, pediatrics, obstetrics–gynecology, emergency medicine, anesthesiology, psychiatry, and community medicine. All participants provided a written informed consent, and prior ethical approval was obtained from the Research Ethics Committee of St. Luke’s International Hospital.

Data collection

We collected baseline data of the participants, including age, gender, postgraduate year, and scores on the Synthetic Personality Inventory 2 (SPI2, Recruit management solutions Co., LTD., Tokyo, Japan). The SPI2 measures two basic dispositions, “ability” and “personality” of personal competencies. This instrument has shown high reliability, validity, and standardization based on 30 years of use in Japan. The SPI2 dimensions included: 1) behavioral profiles (social introversion, reflection, activity, persistence, and reflection); 2) motivational profiles (achievement motivation and vitality); 3) emotional profiles (nervousness, despondence, emotional wavering, independence, over assurance, and heightened mood); and, 4) ability profile (general ability). The average score of each dimension in the Japanese population is standardized to be 50. This personality inventory has been used to assess the individual personality attributes of residents at the beginning of their residency training at St. Luke’s International Hospital since 1998.

We administered a daily, web-based survey to the participants about their workload and procedural errors during the study period from October 16 to December 22, 2006. The procedural errors were reported as procedural...
mistakes made at bedside. There were no individual definitions of errors for specific types of procedures.

We then calculated the procedural error rates through dividing procedural error counts by overall procedural attempts. The residents’ bedside procedures included venipunctures, peripheral artery punctures, intravenous line placements, central venous line placements, nasogastric intubations, percutaneous gastrostomy tube replacements, urethral catheterizations, paracenteses, thoracenteses, lumbar punctures, and bone marrow aspirations. These procedures are frequently performed by residents at bedside in Japan. The participants were also asked to count procedural errors when several mistakes were made before successfully completing the task.

For workload data, we asked the participants to keep a record of daily step counts using portable pedometers (PW-900, Yamasa Co., LTD., Tokyo, Japan). We also obtained data for self-reported daily work hours and the number of inpatients for whom they were responsible during the study period. The schedules of on-call days for each resident were obtained using an official hospital worksheet. The participants were also asked to report daily sleep time as well as napping time. Because residents in this hospital are allowed to take short sleep in napping room near their wards, we considered napping as short time sleep in a bed (not at desks) during work hours.

The study participants were asked to answer a series of questions in a daily questionnaire, including: 1) When did you start work today? 2) When did you finish work today? 3) How many steps were recorded on pedometers? 4) How many bedside procedures (defined above) did you perform today? 5) How many procedural mistakes did you make today? 6) How many patients were you responsible for caring for today? 7) How long did you sleep yesterday? 8) If you napped today, how long? 9) How much stress did you feel today? (self-estimation of residents’ stress on a 7-grade scale).

During the study period the study participants were also asked to answer other questionnaires, which included the Pines’ burnout scale, the physician job satisfaction scale, and the SF-8 quality of life measure. The SF-8 generates two summary measures: a physical component summary (PCS8) and a mental component summary (MCS8). This instrument is scored by assigning the mean SF-36 scale score for the Japanese population, as measured in 2002, to each response category of the SF-8 based on previous studies. The higher these scores are the better the health state.

**Statistical analysis**

For the purposes of this study, the independent variables were: age; gender; postgraduate year; scores of the SPI2 dimensions and Pines’ burnout scale, physician job satisfaction scale, and SF-8 QOL measure; hours worked daily; the number of on-call duty periods for inpatients, daily walk distance, and the durations of sleep and napping. Mean values were used for covariates, including daily work hour, the number of on-call duty periods for inpatients, daily walk distance, and the durations of sleep and napping. The dependent variable was the procedural error rate, a ratio of reported procedural error counts to total procedural counts.

We described the baseline characteristics of the participants and calculated the mean and standard deviation of each independent variable. A multivariable adjusted linear regression model was constructed using a stepwise method for variable entry at p = 0.05 and removal at p = 0.10, since the purpose of this study was to explore hypothesis generation for future confirmatory studies. Two-tailed p-values < 0.05 were considered statistically significant. SPSS software version 14.0 J (SPSS Japan, Tokyo, Japan) was used for all statistical analyses.
RESULTS

Descriptive analysis

From among a total of 50 residents in the St. Luke’s International Hospital residency program, forty-nine (98.0%) participated in this study. One resident did not participate because of a rotation schedule outside the hospital. The remaining 49 participants were surveyed for 48 days with a daily, weekday questionnaire (Monday to Friday), and the overall response rate on daily questionnaires was 81.5%. All the participants completed the personality inventory, job satisfaction scale, the burn-out measure, and the SF-8 QOL measure.

Table 1 presents the baseline characteristics of the residents. There were 34 (71.4%) men in the study, 24 (49.0%) PGY-2 residents, and the mean age was 26.6 years (range, 24–31). On average, the participants were responsible for 9.8 inpatients per day (range, 1.9–23.1), worked 16.0 hours per day (range, 12.6–19.8), slept 4.4 hours per day (range, 2.8–5.7), napped 0.2 hours per day (range, 0–0.7; two of 49 participants did not nap during the study period), walked 4,107 meters per day (range, 2342–6264), performed 2.9 procedures per day (range, 0.9–8.5), and experienced an overnight work shift every 7.1 days on average. The mean procedural error rate was 2.2 per 10 procedures (range, 0.4–5.0) (shown in Table 2).

The top ten of residents’ bedside procedures included the following: 1) venipunctures and blood cultures (272 times per week for all residents) ; 2) intravenous line placements (255 times per week for all residents) ; 3) urethral catheterizations (99 times per week for all residents) ; 4) peripheral artery punctures (31 times per week for all residents) ; 5) nasogastric intubations (24 times per week for all residents) ; 6) central venous line placements (22 times per week for all residents) ; 7) lumbar punctures (5.0 times per week for all residents) ; 8) paracenteses and percutaneous gastrostomy tube replacements by residents (3.0 times per week respectively for all residents) ; and, 10) thoracenteses and bone marrow aspirations (2.0 times per week respectively).

Results of the SPI2 were as follows. The participants are more reflective, active, persistent, cautious, and less socially introverted in behavioral profiles than the general population of Japan. They showed higher achievement motivation and vitality in motivational profiles; they were more assured and
less nervous; and, they were less despondent, more emotionally stable and independent, and showed a heighten‐
ed mood in their emotional profiles. The overall ability score was higher than the Japanese general population.

Average scores of SF–8 QOL measure were 48.9 (range, 30.8–58.6) on the physical component summary and 40.9 (range, 22.5–56.4) on the mental component summary. The average score of the physician job satisfaction scale was 39.3 (range, 31–55), while that of the Pines’ burnout scale was 2.9 (range, 1.1–5.1).

The minimum procedural error rate (0.4 per 10 procedures) was reported by two participants and the characteristics of these two residents were as follows: they had one on‐call period per 5.9 and 4.3 days; they worked 19.8 and 18.1 hours per day; they slept 2.8 and 3.5 hours per day; and, they napped 0.7 and 0.6 hours per day. The physician job satisfaction scale results were 47 and 31; the SF–8 mental component summaries were 47.4 and 39.1; and, the SPI2 reflection scores were 55 and 60, respectively. The maximum procedural error rate (5 per 10 procedures) was reported by one participant and the characteristics of this resident were as follows: one on‐call per 4.8 days; worked 17.5 hours per day; slept 4.2 hour per day; napped 0.06 hour per day; the physician job satisfaction scale was 35; the SF–8 mental component summary was 27.6; and, SPI2 reflection score was 45.

### Multivariable adjusted linear regression analysis

**Table 3** shows the results of multivariable adjusted linear regression analysis. Significant factors associated with lower procedural error rate were: 1) longer napping, 2) more reflective personality in the SPI2, 3) higher score of MCS–8, 4) higher physician job satisfaction scale, and 5) less on‐call times. Age, gender, work hours, sleep hours, burnout measure, walk distance, the number of procedures, and the number of inpatients did not have significant association with procedural error rate. Figure 1 presents a scatter plot of procedural error rate with napping hours, showing an inverse correlation of these variables.

### DISCUSSION

To our knowledge, this is the first study to investigate the influence of resident workload, personality, and mental and emotional background in relation to patient safety (quantified as a procedural error rate) using a multivariable adjusted linear regression model in a Japanese teaching hospital. The results of this study indicate that napping, higher physician job satisfaction, a reflective personality, and better mental score of residents were associated with reduced procedural errors. In addition, the higher frequency of on‐call was related to increased procedural errors.
The mean napping time was relatively short (0.2 hr/day) in the participants of this study. However, napping seems to offer substantial reduction on procedural error rates. This finding is in line with several previous studies. Some field studies have suggested that napping, even less than 60 minutes, could improve sleep inertia. A randomized controlled trial in nighttime highway drivers also showed that 30 minutes napping and 200 mg of caffeine were equally effective to reduce sleep inertia and driving errors. Moreover, Arora and colleagues observed that cross coverage to allow a nap during an extended duty hour shift could increase sleep time and decrease fatigue of residents. Residents who were more satisfied with their jobs tended to conduct daily procedures more successfully than those who were less satisfied. Aiken and colleagues reported that hospital nurse shortages have a substantial effect on nurses’ career dissatisfaction and patients’ mortality in United States; however, no studies to date have investigated the relationship between job satisfaction of residents and patients’ safety. Furthermore, taking into consideration improved job satisfaction among US residents after introducing the ACGME work–hour limitations, implementation of work hour regulation is highly recommended in Japanese residency programs.

Consistent with the previous study, we found that higher on–call frequency was significantly associated with increased procedural error rates. However, sleep hours itself was not a significant factor for procedural error. This may indicate that no on–call duty, even with shorter sleep time, is preferable for reducing procedural errors than the same amount of sleep with on–call duty.

Residents with reflective personal attributes showed significantly lower rates of procedural errors in their daily bedside procedures. Studies about medical students also imply that personality has certain effects on clinical skills. These findings are understandable based on the favorable nature of reflective personality attributes for undergoing procedures. Educational feedback for individual residents based on personality assessments, such as the SPI2, may be helpful to improve patient safety.

Regarding residents’ QOL, a better score on the SF–8 mental component was associated with a reduced procedural error rate. This finding is compatible with that of a previous study, which reported that residents who committed more medical errors had significantly lower overall QOL. Moreover, in the same study, personal distress and decreased empathy were associated with increased odds of future self–perceived errors, suggesting that improved resident mental QOL results in better patient safety.

Interestingly, the residents’ self–estimation of stress on a 7–grade scale did not have significant association with procedural error. This result may indicate the potential weakness of subjective measures for perceived stress and the need to examine reliable and
valid measures for mental health, such as SF-8 mental component score.

Many previous studies have tried to figure out the effects of several physical and mental variables for residents, such as sleep deprivation and burnout, on patient safety variables, including medication and procedural errors. But most studies used a univariate model for analysis and provided unadjusted results. Furthermore, the majority of these studies have adopted retrospective questionnaires for investigating medical errors (for instance, once a month) to minimize discontinuity of patient care, but this may cause a recall bias. In this study, we included residents’ personality attributes (scores of the SPI2 dimensions), psychological states (Pines’ burnout scale), physician job satisfaction scale, and the SF-8 QOL measure as independent variables, along with their multidimensional workload profiles. Moreover, daily prospective records by residents are likely to minimize the recall bias, allowing us to capture more accurate data about residents’ workload and its effect on procedural error rate.

We have also reported the frequency of residents’ procedural incident counts in our institution over the same period as our study. When data for self-reported procedural incident counts were used for analyzing procedural error counts as defined in the current study, the counts of invasive procedures, such as arterial punctures, percutaneous gastrostomy tube replacements, urethral catheterizations and central venous line placements, comprised 27% of total procedural error counts during the survey period. Based on this analysis, our data about residents’ procedural errors were also likely to make up around 30% of invasive procedures, and thus the procedural error rate used in our study could be a useful outcome measure to evaluate patients’ safety.

Our study had several limitations. First, using a single institution as a data source may limit the generalizability of the results: the working environment in this hospital might have unique effect on the results. Also, we used a nonrandomized observational study design and had a relatively small sample size. Therefore, the possibility remains for unmeasured confoundings and type 2 errors for identifying other possible significant factors associated with procedural error rates. Third, self-reporting may cause a bias because of possible incomplete capture of errors among some participants. Fourth, although our study design using daily recordings minimized substantial recall bias, there might still have been reporting bias about some variables.

In conclusion, taking a nap, higher job satisfaction, good mental QOL, and less frequent on-call are associated with decreased residents’ errors in daily bedside procedures. Making improvements in these aspects of residents’ working conditions and mental wellbeing may well make inpatient care safer.

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