Registrar sleep patterns and supervision during two different rosters in a tertiary Australasian intensive care unit

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ABSTRACT

Objective: To compare registrar sleep and supervision hours before and after a change in roster to accommodate more senior registrar (SR) positions, and to identify risky patterns of sleep on night shifts.

Design, setting and participants: Prospective study of 21 registrars on two different roster templates from September 2010 to May 2011 in the intensive care unit of Wellington Regional Hospital, Wellington, New Zealand.

Intervention: Roster change from 13 registrars and one SR to 10 registrars and four SRs.

Main outcome measures: Mean sleep and supervision hours by shift; episodes of sleep ⩽ 5 hours, wakefulness ⩾ 17 hours, sleep during shift, waking before 16:00 before night shifts.

Results: 990 sleep surveys were analysed. There was no significant difference between groups in mean sleep or supervision hours for any shift. Two hundred and thirty-six night shifts were analysed. Registrars slept ⩽ 5 hours before 19/236 (8.1%) night shifts; had ⩾ 17 hours wakefulness before 79/236 night shifts (33.5%); woke by 16:00 107/236 (45.3%) times; and slept during 86/236 (36.4%) night shifts. Registrars arrived at work having either woken before 16:00 or had ⩽ 5 hours of sleep on 114/236 (48.3%) night shifts.

Conclusions: Changing the registrar roster to meet the training demands of our senior trainees did not adversely affect registrar sleep or supervision. Registrars may be taking on unnecessary risk due to poor sleep hygiene around night shifts. We suggest sleep education and scheduled sleep time during night shifts.

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Rostering resident medical officers is a difficult task that involves balancing the conflicting demands of service provision, contractual obligations, training opportunities and the health and safety of resident medical officers and their patients. This is particularly difficult in the intensive care unit, where the provision of 24-hour high-acuity care is required and shiftwork rosters prevail. Shiftwork is associated with sleep loss, particularly during night shifts,[1-3] where the duration of daytime sleep during night work is typically 2 hours less than nocturnal sleep.[4] In addition, night work is associated with an increased risk of errors because it coincides with the 02:00–06:00 circadian performance nadir.[5] Consequently, rosters need to be carefully designed to avoid exposing resident doctors to increased risk of sleep deprivation, and the impact of roster changes on sleep patterns around night shifts need to be carefully evaluated.

The training requirements for the College of Intensive Care Medicine of Australia and New Zealand (CICM) state that advanced trainees must work for at least 6 months as a senior registrar (SR), during which time they perform some consultant duties with access to senior supervision.[6] To accommodate this requirement, largely within existing resources, our ICU changed the structure of the registrar roster, from having one SR and 13 junior registrars, to four SRs and 10 junior registrars. Other Australasian ICUs may face similar challenges.

To quantify the effect of this roster change on registrar sleep and clinical supervision, we conducted a prospective observational study. The roster change was carefully designed to have similar frequency of all shift types and access to relievers for leave. This was achieved by rostering the SRs to a mix of registrar shifts to maintain service while averaging one dedicated 24-hour on call per week where they performed the role of a supervised specialist. They were expected to perform a supervisory role whenever present in the ICU. The exact rosters are provided in an online appendix (http://wellingtonicu.com/resources/Documents/ICURoster.xls).

Our primary hypothesis was that the new roster would result in no change in sleep, and an increase in clinical supervision. A secondary goal was to identify particular patterns of registrar sleep behaviour that may place registrars and patients at increased risk of harm.

Methods

Study design and setting

The study was conducted in the Wellington Regional Hospital ICU, in Wellington, New Zealand, with approval from the Central Regional Ethics Committee (reference no. CEN/10/EXP/52), and all participants provided written informed consent. This 18-bed tertiary ICU is accredited by the CICM for 24 months of core advanced training in

Table 1. Demographic data of intensive care registrars, Wellington Regional Hospital

	2010	2011
Total no.	11	9
Female, no. (%)	3 (27%)	3 (33%)
Mean age in years (SD)	33.23 (3.5)	31.56 (2.0)
No. studying for exam (%)	5 (45%)	5 (56%)
ICU experience < 12 months, no. (%)	4 (36%)	7 (78%)
No. with dependents (%)	3 (27%)	4 (44%)
Median Epworth Sleepiness Score (interquartile range)	6.5 (3–9.5)	4 (4–5)
Transport to work	3 cycle, 5 drive	4 cycle, 3 drive
Previous education on sleep hygiene for shiftwork, no.	0	1

Table 2. Sleep and supervision in different roster groups

	Mean hours of sleep (SD)		Mean hours of supervision (SD)	
Shift	2010	2011	2010	2011
No.	538	452	244	183
Long day (08:00–22:00)	7.1 (1.1)	7.0 (0.7)	8.7 (2.9)	9.0 (3.0)
Short day (08:00–17:00)	7.3 (1.1)	7.7 (1.1)	7.8 (2.3)	8.0 (1.3)
Night (21:00–09:00)	7.6 (2.1)	7.4 (2.2)	2.0 (1.3)	2.2 (3.3)
Flight call	8.2 (1.3)	8.5 (1.7)		
Off	8.5 (2.3)	8.2 (2.2)		

intensive care medicine. It has about 1600 admissions per year, with 500 postoperative cardiac and 80–100 paediatric cases. All surgical and medical subspecialities are covered.

To test our primary hypothesis, we examined the effect of the roster change on hours of sleep and hours of clinical supervision for each shift type. For the secondary goal, we determined the frequency of night shifts where there was a potentially hazardous sleep pattern. We defined hazardous sleep patterns as the following: night shifts where registrars came to work after 5 hours of sleep or less; woke before 16:00 (and thus had the potential to be awake for more than 17 hours or more before 09:00 shift end); or were awake for 17 hours or more while at work. We calculated the longest period of wakefulness during each night shift. We also measured the proportion of night shifts during which registrars slept.

Data collection

All data were collected using web-based electronic surveys created with SurveyMonkey (SurveyMonkey, Palo Alto, Calif, USA). To reduce the demands on participants and increase compliance with the study, data collection was limited to days in the week immediately before, immediately after and during night shifts. This is because night shifts are associated with the greatest risk of sleep disruption.[1-3]

Diaries were anonymous and were linked to the participant by a unique identification number known only to the participant. Each day, participants recorded their identification number, the date, shift worked (or day off), hours of supervision, and sleep times. Supervision at work was defined as time during which a specialist, or SR filling the role of specialist, was physically present in the hospital. Daily reminder emails were sent to each registrar, and registrars confirmed diary completion by a return email. If no email was received, participants were sent a text message reminder, and if necessary they were then reminded by personal phone call.

Data analysis

Data were imported directly from SurveyMonkey into Microsoft Excel (Microsoft Corporation, Redmond, Wash, USA) to check data integrity, and subsequent statistical analyses were undertaken using SPSS, version 12 for Windows (IBM, Armonk, NY, USA). Continuous variables are presented as mean (SD). We report categorical variables as number (%). Unpaired *t* tests were used to compare the two groups for sleep and supervision. Analysis of variance was used to compare the two groups for sleep and wakefulness during each series of night shifts. Categorical data were analysed using the χ^2 test. Statistical significance was set at $P \leqslant 0.05$ for all statistical tests.

The electronic diaries recorded sleep and supervision between 00:00 and 24:00, and the effects of shift change on daily sleep duration were determined on a 24-hour basis, relative to midnight. In the secondary analysis, to determine the frequency of potentially hazardous sleep patterns before the night shifts, additional data handling was undertaken to identify total sleep during the 24 hours before commencement of a night shift (at 21:00). The longest period of wakefulness was calculated from time of waking before beginning a night shift until either sleep onset (if the participant slept during the shift) or the end of night shift (09:00), whichever was first.

Results

All registrars agreed to participate (September–December 2010, 13 registrars; March–May 2011, 10 registrars). Com-

Figure 1. Sleep hours during a set of night shifts — pooled data

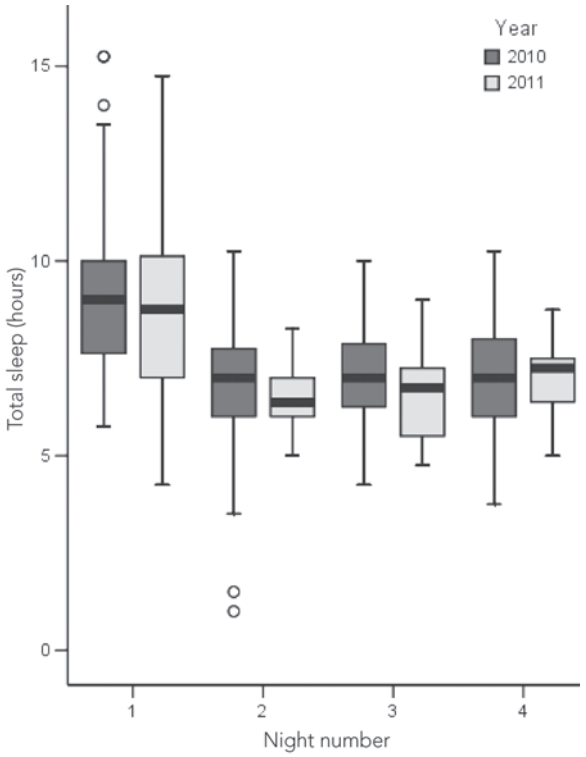
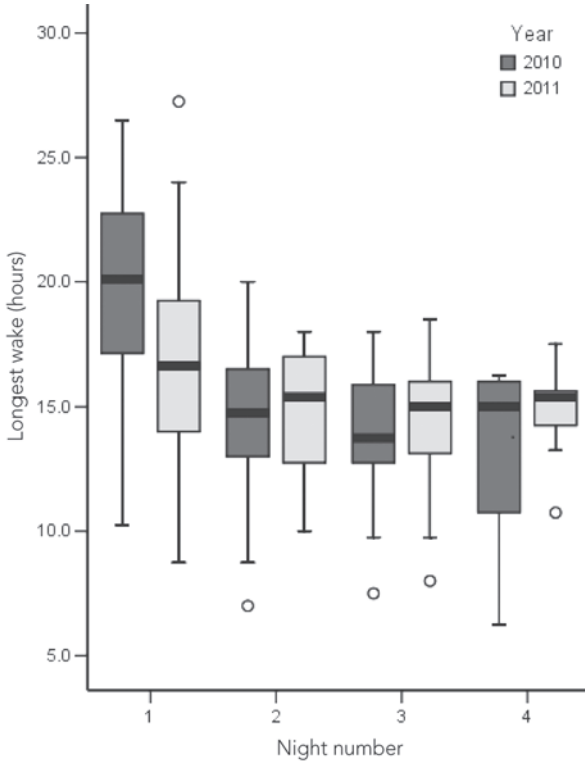


Figure 2. Wakefulness during a set of night shifts — pooled data



plete demographic data were available for all participants except one registrar in the second group. Data from two registrars who were in both groups were excluded from the first group to render the two data sets independent. Analysis thus included 11 registrars before the change and 10 registrars afterwards. Complete sleep data from 990 days were included in the analysis, representing 97% of 1022 eligible days (21 days had missing or miscoded data). Supervision data were analysed for 408 of 427 shifts, representing 96% of eligible data (19 days had missing data).

Demographic data for the two groups were similar (Table 1) and there were no statistically significant differences between groups. Prior ICU experience was dichotomised as less than 12 months and 12 months or more, and there was a trend for the second group to be less experienced ($P = 0.06$). Only one registrar had ever had education on sleep hygiene for shiftwork.

The mean duration of sleep and of clinical supervision for each shift was similar between groups (Table 2), and there were no statistically significant effects attributed to the change in roster.

The secondary analysis, to determine the frequency of potentially hazardous sleep patterns, was undertaken using 236 complete data sets. There was no difference in the duration of sleep before shift, of wakefulness, or frequency of sleeping during night shift between the groups for any night shift. There was a main effect ($P \leqslant 0.001$) for the shift number within a series of nights because participants had more sleep before the first night shift and were awake longer (Figure 1 and Figure 2).

On 19/236 night shifts (8.1%), registrars came to work after 5 hours sleep or less (Table 3).

Registrars had woken by 16:00 on 54/70 (77.1%) of the days that preceding their first night shift, in contrast to 107/236 (45.3%) of nights overall ($P < 0.001$). Registrars had 17 hours or more of wakefulness during 79/236 night shifts (33.5%). During 10/236 night shifts, registrars remained awake for greater than 24 hours (4.2%). They remained awake for 17 hours or more on 51/70 (72.9%) of first nights and 24 hours or more on 9/70 (12.9%) of first nights (Table 3).

Registrars slept during the shift on 86/236 nights (36.4%). Sleep during the first night shift occurred at a similar rate to other shifts in the set of nights (24/70 nights [34.3%]) (Table 3).

Registrars arrived at work having either woken before 16:00 or had 5 hours of sleep or less on 114/236 (48.3%)

Table 3. Registrar sleep hygiene during periods of night shifts — pooled data

	Total no. of episodes (%)*	No. of episodes on first night in set (%)†
Sleep ⩽ 5 hours	19 (8.1%)	1 (1.4%)
Wakefulness ⩾ 17 hours	79 (33.5%)	51 (72.9%)
Wakefulness ⩾ 24 hours	10 (4.2%)	9 (12.9%)
Sleep during night shift	86 (36.4%)	24 (34.3%)
Woke up by 16:00 before night shift	107 (45.3%)	54 (77.1%)
Potential sleep risk exposure‡	114 (48.3%)	54 (77.1%)
Actual sleep risk exposure§	91 (38.6%)	51 (72.9%)

* Of 236 nights. † Of 70 nights. ‡ Commenced shift with either ⩽ 5 hours sleep or woke by 16:00. § Completed shift with either ⩽ 5 hours sleep or wakefulness ⩾ 17 hours.

night shifts. Taking sleep during the night shift into account, inadequate sleep hours or excessive wakefulness occurred during 38.6% of night shifts (Table 3).

Discussion

Our primary finding is that there has been no significant change in sleep or supervision hours with the change in roster. We have, however, found sleep hygiene habits during night shifts that may predispose registrars to risks from prolonged wakefulness or reduced sleep.

The changes to our roster have allowed compliance with the CICM requirement for advanced trainees to acquire 6 months of experience at the level of an SR. In addition, they have enabled introduction of a greater number of SRs and thus improved retention of advanced trainees, and they have increased the number of layers in the hierarchy. Because this was achieved within the existing staffing levels, there were no extra cost, as SRs were shifted from previous standard registrar positions. We think this represents a better roster for our unit with no identified detriment to registrars.

Concerning sleep hygiene, we identified adequate mean sleep hours per night (7.9 hours [SD, 2.1 hours]) that were similar to the population mean (7.4 hours).[7] We focused on night shifts because this is the time of highest risk for sleep disruption and fatigue,[1-3] and we found that registrars presented to work with either reduced sleep (5 hours or less in the 24 hours before shift commencement) or potential prolonged wakefulness (waking 17 hours or more before the end of their shift) on about half of night shifts.

Excessive wakefulness was the most frequent potential problem, and was particularly common on the first night in a set. It has been shown that wakefulness of 17 hours or more is associated with reduced performance in neurobehavioural testing that can be equated to the deficit seen with a blood alcohol concentration of 0.05%.[8] Prolonged wakefulness has also been associated with reduced clinical performance in high-fidelity simulation of critical care scenarios.[9] Our data showed that registrars frequently started night shifts with potential for prolonged wakefulness (45% of night shifts), and that 17 hours or more of wakefulness eventuated 34% of the time (due to limited sleep during night shifts). It was interesting to note that the first night appeared to be the riskiest for prolonged wakefulness, and that when registrars woke before 16:00 before coming in (77% of first nights), they only managed to avoid prolonged wakefulness with sleep during the shift on three occasions and breached 17 hours of wakefulness 73% of the time. The first night accounted for nine out of 10 episodes of 24 hours or more of wakefulness. This equates to 0.10% blood alcohol concentration on cognitive psychomotor testing.[8] Examination of the sleep data indicates that registrars generally prepare for night shifts by sleeping in on the day before night shifts rather than napping later in the day.

In the context of short-term sleep loss, 5 hours of sleep or less has been associated with impaired vigilance[10] and increased risk of road traffic accidents.[11] Reduced sleep hours in our study were a lesser problem than excessive wakefulness, although still present for 8% of night shifts. In general, 5 hours or less of sleep occurred on different shifts to excessive wakefulness, with only one episode of 5 hours or less of sleep on the first night, when the risk of prolonged wakefulness was greatest.

Registrars in our study only slept during the night shift on one-third of nights, despite having access to a sleep room with a telephone, and having two registrars rostered to cover the ICU overnight. This should usually provide opportunities to nap. Napping is beneficial to performance,[12] provided time is available for recovery from sleep inertia (temporary grogginess experienced on awakening).[13]

Our study had several strengths. We performed a prospective study and collected complete data for almost 1000 nights of sleep, although the number of registrars studied was small. Direct daily contact optimised compliance with the sleep diary, and the format of sleep diaries allowed us to trace and correct some errors in data input such as accidental data duplication.

Our study also had some weaknesses. On the basis of previous studies of risk attributed to sleep loss and excessive wakefulness, we have inferred risk to the registrars and their patients, as well as public health risk attributed to driving while potentially impaired. However, we did not evaluate these outcomes with this study design, and such conclusions are speculative. Dawson and Reid's work on

prolonged wakefulness showed a performance deterioration when participants were kept awake until 02:00,[8] but our registrars finished their night shifts at 09:00 (ie, during the rising phase of the circadian performance rhythm), which may attenuate any performance deterioration.[14] In addition, we did not explore the causes of poor sleep patterns while on night shifts, and there are several factors that can influence sleep.

We were surprised that our study did not demonstrate increased supervision, even though the new roster provided an SR in the hospital, in a supervisory role, for 89 hours per week. This appears to have been due to a misinterpretation of our study question, which asked participants to record the number of hours "either a fellow or consultant" was present in the hospital to assist if required. We believe that participants did not include SRs in the "fellow" category, despite that being our intention.

In conclusion, our study demonstrates that we have been able to change the registrar roster to better meet the training requirements of the college without adversely affecting sleep or supervision of the remaining registrars. Although we have not demonstrated an expected benefit in supervision, we think that this is due to misinterpretation of our survey rather than a real lack of effect.

Excessive wakefulness, particularly on the first night, is common. Risk from wakefulness may be attenuated by the rising phase of the circadian performance rhythm. Reduced sleep hours is a less common phenomenon, but still presents a potential risk. Sleep opportunities during nights may not be fully realised, although we recognise there may be some risk inherent in napping during night shifts because of sleep inertia if registrars are required to be immediately functional upon waking. Overall, these factors potentially increase risk to registrars from road traffic accidents or needle-stick injuries, to the public from road traffic accidents, and potentially to patients. Registrars have not had adequate education about safe sleeping habits.

We recommend that registrars try to sleep for more than 5 hours before commencing work, and after 16:00 before commencement of night duty. Our unit plans to discuss sleep hygiene with registrars, and to institute a culture change from one with no stated expectation regarding naps to one whereby registrars are expected to nap during night shifts. When possible, the expectation will be for one registrar to nap from 01:30–03:30 and the other from 04:00–06:00 to coincide with the circadian nadir and avoid sleep inertia. If wakefulness remains a problem, then naps before driving or cycling home will be encouraged or taxi chits (vouchers) will be available.

Competing interests

None declared.

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