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Fatigue and nurses' work patterns: An online questionnaire survey

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ABSTRACT

Background: Fatigue resulting from shift work and extended hours can compromise patient care and the safety and health of nurses, as well as increasing nursing turnover and health care costs.
Objectives: This research aimed to identify aspects of nurses' work patterns associated with increased risk of reporting fatigue-related outcomes.
Design: A national survey of work patterns and fatigue-related outcomes in 6 practice areas expected to have high fatigue risk (child health including neonatology, cardiac care/intensive care, emergency and trauma, in-patient mental health, medical, and surgical nursing).
Methods: The 5-page online questionnaire included questions addressing: demographics, usual work patterns, work in the previous two weeks, choice about shifts, and four fatigue-related outcomes – having a sleep problem for at least 6 months, sleepiness (Epworth Sleepiness Scale), recalling a fatigue-related error in clinical practice in the last 6 months, and feeling close to falling asleep at the wheel in the last 12 months. The target population was all registered and enrolled nurses employed to work in public hospitals at least 30 h/week in one of the 6 practice areas. Participation was voluntary and anonymous.
Results: Respondents (n = 3133) were 89.8% women and 8% Māori (indigenous New Zealanders), median age 40 years, range 21–71 years (response rate 42.6%). Nurses were more likely than New Zealand adults in general to report chronic sleep problems (37.73% vs 25.09%, $p < 0.0001$) and excessive sleepiness (33.75% vs 14.9%, $p < 0.0001$). Fatigue-related error(s) in the last 6 months were recalled by 30.80% and 64.50% reported having felt sleepy at the wheel in the last 12 months.
Logistic regression analyses indicated that fatigue-related outcomes were most consistently associated with shift timing and sleep. Risk increased with more night shifts and decreased with more nights with sleep between 11 p.m. and 7 a.m. and on which nurses had enough sleep to feel fully rested. Risk also increased with roster changes and more shift extensions greater than 30 min and decreased with more choice about shifts. Comparisons between intensive care/cardiac care and in-patient mental health nursing highlight that fatigue has different causes and consequences in different practice areas.
Conclusions: Findings confirm the need for a more comprehensive and adaptable approach to managing fatigue. We advocate an approach that integrates safety management and scientific principles with nursing and management expertise. It should be data-driven, risk-focused, adaptable, and resilient in the face of changes in the services required, the resources available, and the overall goals of the healthcare system.

What is already known about the topic?

- Fatigue resulting from shift work and extended hours can compromise patient care and the safety and health of nurses, as well as increasing nursing turnover and health care costs.
- The traditional approach to managing fatigue and shift work – limiting maximum work hours and minimum breaks – is increasingly being questioned in the light of new scientific

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understanding of the importance of sleep and circadian disruption as causes of fatigue and adverse health and safety outcomes.

What this paper adds

- This paper lays the foundation for a new approach to data-driven fatigue and shift work management in nursing, modelled on successful advances in other 24/7 sectors.
- Data from a national survey of nurses working in New Zealand public hospitals are used to identify aspects of work patterns that are associated with increased risk of fatigue-related outcomes. These include shift timing (particularly night shift), sleep opportunities, and factors relating to roster predictability (unplanned shift extensions and roster changes) and shift choice.
- Comparisons between practice areas highlight that rosters that are working well in one context may not be appropriate in another. This reflects the principle that, for a given level of fatigue-related impairment, the risk to nurses and patients depends on what the nurse is being asked to do, the other hazards present, and the other safety defences present.

1. Introduction

This paper describes findings from a national survey of nurses' work patterns that was designed to inform a new data-driven approach to managing fatigue and shift work in New Zealand public hospitals. The approach incorporates sector knowledge and experience with current science and international best practice (Dawson and McCullogh, 2005; Gander, 2015; Gander et al., 2017; International Civil Aviation Organisation, 2016; Steege and Pinekenstein, 2016).

The shift work and extended hours that are common in nursing can induce a range of symptoms with potential impact on workplace health and safety. These include subjective fatigue (mental and physical), excessive sleepiness, yawning or falling asleep at work, short term memory problems and an inability to concentrate, noticeably reduced capacity to engage in effective interpersonal communication, impaired decision-making and judgment, reduced hand-eye coordination or slow reflexes (International Air Transport Association et al., 2015; Safe Work Australia, 2013). These symptoms are experienced to varying degrees by different people and in different contexts. Successful new approaches to managing the health and safety risks associated with workplace fatigue have developed, based on an agreed definition that focuses on the physiological causes of these diverse symptoms.

Workplace fatigue is now recognised as a physiologically-based state of impaired performance caused by four main factors: 1) sleep loss (acute and chronic); 2) extended time awake (more than about 16 h); 3) working and sleeping at sub-optimal times in the circadian body clock cycle; and 4) physical and mental workload (International Civil Aviation Organisation, 2016). This scientifically-based definition highlights that work and break time limits alone are not sufficient to manage the health and safety challenges of fatigue and shift work (Dall Ora et al., 2016; Dawson and McCullogh, 2005). For example, the circadian body clock that regulates sleep timing and quality very rarely adapts fully to shift work (Folkhard, 2008). Consequently, a 10-h break from 8 a.m. to 6 p.m. provides much less sleep opportunity than a 10-h break from 8 p.m. to 6 a.m. and safety incidents are more likely on the night shift, relative to the number of patients/procedures (Chellappa et al., 2019; Gold et al., 1992; Lipscomb et al., 2002; Trinkoff et al., 2007).

Fatigue-related impairment resulting from shift work and extended hours can compromise patient care and increase the risk of clinical error. For example, studies show increased risk of reporting clinical errors among nurses who work rotating shifts compared to day or evening shifts (Gold et al., 1992), and night shifts compared to day shifts (Wolf et al., 2017). In surveys from Europe and Canada, nurses who work extended shifts report that they provide poorer quality care and patient safety (Canadian Nurses Association and Registered Nurses Association of Ontario, 2010; Griffiths et al., 2014; Stimpfel and Aiken, 2013). Nurses working shifts longer than 8 h are 2–3 times more likely to make clinical errors (Rogers et al., 2004; Scott et al., 2006) and have poorer patient outcomes, including increased patient mortality (Trinkoff et al., 2011). One study that objectively monitored sleep and psychomotor vigilance task (PVT) performance of 11 nurses working 12-h day shifts versus 11 working 12-h night shifts found that although sleep duration was comparable between the two groups, PVT performance degraded on across the night shift and was more variable than on the day shift (Wilson et al., 2019).

Two Australian studies based on nurses keeping logbooks for a month (total 64 nurses) found an independent association between self-reported clinical errors and restricted sleep on work days (Dorrian et al., 2006,2008). In a similar logbook study with 41 midwives and 21 nurses, participants reported sleep disruption on more than 50% of work days and struggling to remain awake on 27% of work days (Dorrian et al., 2011).

Several studies in the United States have reported independent associations between shift work, extended hours and workplace injuries to nurses. For example, a survey of 11,516 registered nurses (RNs) in Pennsylvania found that those who worked more than 40 h per week or more than 4 h of voluntary overtime were at increased the risk of reporting occasional/frequent work injuries and needlestick injuries in the last year (Olds and Clarke, 2010), after controlling for sex, unit type, age, years of experience as an RN, education level, hospital-level staffing, temporary employment, dependents at home, union membership, and nursing education outside the USA. A longitudinal study of 2624 RNs in two States found that increased risk of needlestick injuries was independently associated with more hours worked per day, more weekends worked per month, working other than day shifts, and working a shift of at least 13 h one or more times a week (Trinkoff et al., 2007). A study of 1163 nurses in two States found an increased age-adjusted odds ratio for musculoskeletal disorders in the neck, shoulders, and back among those who exceeded 12 h per day or 40 h per week, and those who worked on weekends and other than day shifts (Lipscomb et al., 2002). In register-based studies of Danish hospital workers, accident rates have been shown to be higher after weeks of work containing evening or night shifts than after weeks with day shifts only (Nielsen et al., 2018), and after breaks shorter than 11 h between shifts (Nielsen et al., 2019).

Drowsy driving associated with nurses' work patterns represents a safety risk to other road users as well as to the nurses themselves. Compared to nurses who work day or evening shifts, nurses who work rotating shifts are twice as likely to have a motor vehicle accident and three times more likely to report a near-miss while driving a motor vehicle (Gold et al., 1992). Compared to nurses working shorter shifts, nurses working shifts longer than 8 h are twice as likely to report feeling drowsy while driving (Scott et al., 2007). In the Australian logbook study with midwives and nurses, 9% of participants reported suffering extreme drowsiness or experienced a near accident while travelling home on workdays (Dorrian et al., 2011).

Shift work, and particularly night work, can also have long-term negative effects on nurses' health. The US Nurses' Health Study (NHS) has found robust associations between working rotating night shifts (defined as at least 3 nights/month) and: increased all-

cause and cardiovascular disease mortality (after 5 years); increased lung cancer mortality after 15 years (Gu et al., 2015); a 4% increased risk of ischemic stroke for every 5 years of additional exposure after 15 years (Brown et al., 2009), and a monotonic increase in risk of type 2 diabetes with increasing exposure, that appears to be partly mediated through body weight (Pan et al., 2011). Nurses working rotating night shifts are also at greater risk of developing colorectal cancer (Schernhammer et al., 2003; Pan et al., 2011), and breast cancer (Schernhammer et al., 2001). The Danish Nurses cohort study has reported an increased risk of developing diabetes (Hansen et al., 2016) and all-cause mortality, cardiovascular, diabetes, Alzheimers and dementia mortality (Jorgensen et al., 2017) among nurses working night and evening shifts compared to day shifts only.

Attention is also being focused on the contribution of shift work and extended hours to increasing nursing turnover and health care costs (Steege et al., 2017a,b).

As in most countries, managing the fatigue and shift work of nurses in New Zealand public hospitals has relied heavily on working time limits defined in collective employment agreements (New Zealand Nurses Organisation, 2015). These agreements are generally a 'one-size-fits-all' approach that is applied to diverse practice areas to limit the likelihood of nurses being fatigued at work. Many different work patterns can be compliant with these requirements, but this does not mean that they are equally safe. The health and safety risks associated with a fatigued nurse depend on what she/he is being asked to do, the other hazards present, and the other safety defences present. For example, an intensive care nurse may have responsibility for only one patient and works supported by technology in a highly proceduralised environment and with support close at hand. The tasks required of a fatigued nurse in this context, and the associated risks to the nurse and patient(s), are very different from those for an in-patient mental health nurse who may be responsible for multiple unpredictable patients with little backup.

The combinations of factors that make up individual rosters, and their relationship to fatigue-related health and safety outcomes, need to be better understood and managed to improve patient care and nurses' health, safety, wellbeing, and retention. This understanding motivated the present survey as there were no national data available on the work patterns of nurses in New Zealand public hospitals. This paper describes analyses that were designed to identify which aspects of nurses' work patterns are associated with increased risk of fatigue-related outcomes.

2. Materials and methods

The national survey was designed to obtain a representative sample of nurses' work patterns in 6 practice areas with high *a priori* risk of fatigue, namely: child health including neonatology, cardiac care/intensive care, emergency and trauma, in-patient mental health, medical, and surgical nursing. These practice areas were selected based on input from an Advisory Group that included representatives from the Nursing Council of New Zealand, Directors of Nursing and other senior nurse managers from a range of hospitals, the New Zealand Nurses Organisation (NZNO, the main union representing nurses), with representatives from the two largest ethnic minority groups (Māori indigenous New Zealanders and Filipino nurses), and managers with responsibility for health and safety and safe staffing from individual District Health Boards (DHBs) and the national DHB Shared Services Group. There were no nationwide data on work patterns in these (or other) practice areas. However, variability was expected between practice areas, and within practice areas between hospitals which are governed by 20 DHBs. Ethics approval for the survey was obtained from the Massey University Human Ethics Committee (reference SOA 16/25). The survey was voluntary and anonymous. Respondents had the option of entering their name and email address in a prize draw for one of four iPad Minis and contact details were destroyed after the prize draw.

2.1. The survey questionnaire

A 5-page questionnaire was developed with input from the Advisory Group. After field testing with small groups of surgical and in-patient mental health nurses (n = 20) at a local hospital, the final questionnaire was set up in Survey Monkey (www.surveymonkey.com). The data used in the present analyses were as follows.

- Demographic data – gender; age; years of experience as a nurse; current area of practice, and ethnicity (Māori (indigenous New Zealanders) versus non-Māori).
- Usual work patterns, including shift length (8–9 h, 10–11 h, 12–13 h, other) and shift start and end times.
- How much choice the nurse had about the specific shifts he/she works (1 = none, 2 = not very much, 3 = a fair amount, 4 = quite a lot, 5 = complete).
- Work patterns in each of the two weeks prior to completing the survey – number of days worked; total hours worked; number of night shifts (shifts of any length between 11 p.m. and 7 a.m., or that extended beyond 11 p.m.); number of shifts extended by at least 30 min; total hours worked beyond scheduled shifts; number of times on call; number of breaks between shifts shorter than 9 h, number of breaks of at least 24 h; number of days on which breaks within shifts were taken; number of nights available for sleep between 11 p.m. and 7 a.m.; and number of nights of enough sleep to be fully rested (the question was 'on how many nights did you get enough sleep to be fully rested a) in the last 7 days (including today), b) in the week before'); whether there were roster changes in one or both of the last two weeks, and whether these changes were requested by the nurse.

Four fatigue-related outcome variables are considered in this paper.

1 Whether nurses had a current sleep problem, and if so for how long they had it, with at least 6 months being considered a chronic problem (Paine et al., 2005).
2 The Epworth Sleepiness Scale, which is a measure of sleepiness in recent times. It asks about the likelihood of dozing or falling asleep in eight common situations (0 = would never doze, 1 = a slight chance; 2 = moderate chance; 3 = high chance), with a maximum possible score of 24. Scores greater than 10 are considered excessive sleepiness (Gander et al., 2005a,b; Johns, 1991).
3 Whether nurses could recall a fatigue-related error in clinical practice in the last 6 months (Gander et al., 2007).
4 Whether they had felt close to falling asleep at the wheel in the last 12 months (Gander et al., 2007).

A copy of the questionnaire is available from the first author.

2.2. Recruitment

The target population was all registered and enrolled nurses (who work under the supervision of registered nurses) who were resident in New Zealand and employed to work in public hospitals at least 30 h/week in the 6 practice areas of interest.

Two parallel recruitment approaches were used. First, all members of the NZNO with a valid email address (about 23,000 nurses), were invited to complete the survey via a targeted email with a link to the online survey, with a reminder email two months later. It was not possible to preselect nurses by practice area, but based on the 2015 Nursing Council workforce survey (the latest available at the time (Te Kaunihera Tapuhi o Aotearoa Nursing Council of New Zealand, 2015)), we estimated that 7350 nurses worked in one of the 6 targeted practice areas. Second, there was a general call for participation including via advertising posters in the relevant wards, a link to a short on-line presentation sent to the Directors of Nursing for distribution to their staff, NZNO advertising on Facebook, articles in local nursing magazines, and the Safer Nursing 24/7 project website. Research team members also gave briefings at three large hospitals and to the Nurse Executives of New Zealand group and Te Rūnanga o Aotearoa (the Māori partnership arm of the NZNO) before the survey closed.

2.3. Analyses

Database development and all statistical analyses were carried out using R software (R Core Team, 2018). Measures of central tendencies (mean and median) and dispersion (standard deviation and minimum – maximum) were reported for each of the numeric variables of interest.

Univariate regression analyses were undertaken to identify associations between aspects of work and the outcome variables. The odds ratio describes the probability of having the outcome divided by the probability of not having the outcome ($p/(1-p)$). For example, if 60% of nurses who have had roster changes in the last two weeks can recall having made a fatigue-related error, then the odds ratio for roster change is 0.6/0.4 = 1.5, i.e., they are 1.5 times more likely to recall errors than nurses who have not had roster changes.

3. Results

3.1. Participants

There were 3133 nurses who met the study inclusion criteria of being employed to work at least 30 h per week in one of the target practice areas. This represents a response rate of 42.6%, based on the 2015 Nursing Council workforce survey (Te Kaunihera Tapuhi o Aotearoa Nursing Council of New Zealand, 2015). The majority (89.8%) were women and 8% identified as Māori. The age distribution was bimodal, with peaks at around 25 years and in the early 50 s (median age = 40 years, range 21–71 years).

3.2. Fatigue-related outcomes

Table 1 summarises the percentages of nurses who answered yes for each of the outcome variables.

3.3. Work patterns

Table 2 summarises aspects of work patterns in the two weeks prior to completing the survey. To conserve the overall snapshot of work patterns, this table includes all eligible nurses who completed the questionnaire. A small proportion were on annual and/or sick leave in one or both weeks, hence the zero minimum values in Table 2.

Across the 6 practice areas, most nurses (69.5%) reported a usual shift length of 8–9 h. A further 20.8% had usual shifts of 12–13 h and 3.6% had usual shifts of 10–11 h (1.4% report usual shifts of other lengths and 4.4% did not answer the question).

Given the minimal reporting of on-call work and breaks less than 9 h between shifts (median = 0 times in the last 14 days for both variables), these variables are not considered further.

During both weeks, nurses were able to take breaks during 73% of their shifts. They were also asked to rate the extent to which they had choice over the specific shifts they worked. Responses

Table 1
Percentage of nurses reporting fatigue-related outcomes.

Outcome Variable	Number of nurses who answered			Percentage yes
	Yes	No	Missing	
Sleep problem >6 months	916	1486	731	38.13%
Excessive sleepiness (Epworth Sleepiness Scale >10)	793	1554	784	33.75%
Recall a fatigue-related clinical error in the last 6 months	727	1635	769	30.80%
Felt sleepy at the wheel in the last year	1532	840	759	64.56%

Table 2
Work patterns during the two weeks prior to completing the survey.

Work Pattern variable	Days 1–7 prior		Days 8–14 prior	
	Mean (SD)	Median (min, max)	Mean (SD)	Median (min, max)
Number of days worked	4.24 (1.15)	4 (0,7)	4.11 (1.23)	4 (0,7)
Total hours worked	37.15 (11.69)	40 (0,168)	35.43 (11.99)	36 (0,108)
Number of night shifts[a]	1.38 (1.60)	1 (0,7)	1.21 (1.55)	0 (0,7)
Number of shifts extended by at least 30 min	1.62 (1.70)	1 (0,7)	1.53 (1.69)	1 (0,7)
Total extended hours	1.34 (2.52)	0.5 (0,45)	1.29 (2.68)	0.5 (0,62.5)
Number of times on call	0.15 (0.70)	0 (0,7)	0.16 (0.75)	0 (0,7)
Number of breaks between shifts less than 9 h[b]	0.18 (0.64)	0 (0,7)	0.18 (0.65)	0 (0,7)
Number of breaks between shifts of at least 24 h[c]	1.51 (1.24)	1 (0,5)	1.54 (1.25)	1 (0,5)
Number of nights able to sleep between 11 p.m. and 7 a.m.	3.58 (2.37)	4 (0,7)	3.69 (2.42)	4 (0,7)
Number of nights got enough sleep to feel fully rested	2.74 (2.22)	3 (0,7)	2.89 (2.29)	3 (0,7)

[a] The collective employment agreement defines night shift as any duty which, as part thereof, comprises the hours between midnight and 5:00 a.m. on any day of the week.
[b] A 9-h break between shifts is the minimum allowed by the collective employment agreement.
[c] The collective employment agreement specifies 2 breaks of at least 24 h per week, to be consecutive except by agreement or in case of emergency.

were: none (9.62%); not very much (32.46%); a fair amount (34.07%); quite a lot (18.26%); complete (5.59%). Roster changes in one week were reported by 32.7% of nurses, and in both weeks by 38.3%.

3.4. Associations between aspects of work and the outcome variables

Univariate logistic regression analyses were undertaken to identify associations between aspects of work and whether or not nurses reported each of the fatigue-related outcomes. Because the independent variables were aspects of work patterns in the prior two weeks, these analyses were restricted to nurses who worked an average of 30 h per week in the prior two weeks and completed all the relevant questions. All work variables were averaged across these two weeks (e.g., the average number of night shifts/week). For the roster change variable, nurses who had changes in both weeks were compared with nurses who had no change in either week. The findings are summarised in Table 3.

Older nurses were more likely to report a chronic sleep problem and sleepiness at the wheel, but less likely to recall a fatigue-related clinical error in the last 6 months. More experienced nurses were more likely to report sleepiness at the wheel, but less likely to report excessive sleepiness or to recall a fatigue-related clinical error in the last 6 months. Men were less likely to report fatigue-related clinical errors than women, and Māori were more likely than Non-Māori to report a chronic sleep problem, which is consistent with national prevalence data (Paine et al., 2005).

The odds ratios in Table 3 indicate increased likelihood of fatigue-related outcomes with more night shifts and decreased likelihood associated with more opportunities for sleep between 11 p.m. and 7 a.m., and more nights with enough sleep to feel fully rested. They also suggest that having more breaks per week of at least 24 h increased the likelihood of reporting a fatigue-related error in the last 6 months. However, this is confounded by the fact that nurses who work 12-h shifts have more days off per week and therefore more breaks of at least 24 h.

3.5. Variability in work patterns between practice areas

There was considerable variability in work patterns between the 6 practice areas. To illustrate this, they were ranked on each of the 10 work pattern variables from Table 3, from lowest fatigue risk = 1 to highest fatigue risk = 6. For example, averaging the fewest days worked per week was ranked as 1 and averaging the most nights of sleep between 11 p.m. and 7 a.m. was ranked as 1. Intensive care/cardiac care scored the lowest total ranking (lowest fatigue risk) at 23.5/60. In-patient mental health scored the highest total ranking (highest fatigue risk) at 57/60. Fig. 1 compares the work patterns of nurses who, in the two weeks prior to completing the survey, were employed to work at least 30 h per week exclusively in either intensive care/cardiac care (n = 337) or in-patient mental health (n = 225).

Wilcoxon Mann-Whitney tests found the following significant differences for the data in Fig. 1.

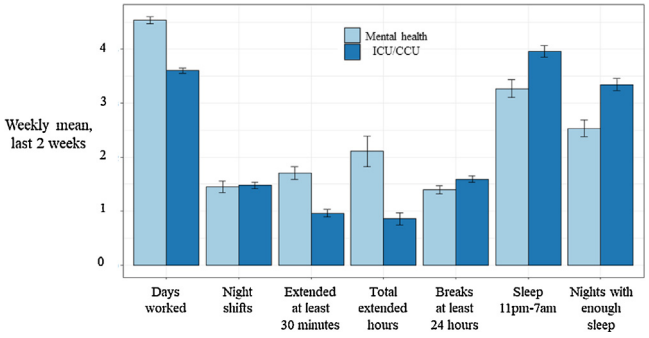

Fig. 1. Comparing the work patterns of nurses who work exclusively in either intensive care/cardiac care or in-patient mental health, averaged across the two weeks before completing the survey.

Table 3
Factors associated with fatigue-related outcomes (univariate logistic regression).

	Clinical error, last 6 months	Sleepy at the wheel, last year	Sleep problem >6 months	Excessive sleepiness
Demographic variables (odds ratio, p)				
Age (years)	0.981***	1.023***	1.013***	ns
Nursing experience (years)	0.974***	1.028***	ns	0.989**
Male vs Female	0.673*	ns	ns	ns
Māori vs Non-Māori	ns	ns	1.472*	ns
Work Pattern Variables (odds ratio, p)				
Number of days worked	1.308***	ns	1.118*	1.156*
Total hours worked	ns	1.017**	ns	ns
Number of night shifts	1.086*	1.116**	1.170***	1.124**
Number of shifts extended ≥30 min	1.133***	ns	1.117***	1.149***
Total extended hours	1.055**	ns	ns	1.041*
Number of breaks between shifts ≥24 h	1.123**	ns	ns	ns
Roster change both weeks versus no changes	1.587***	ns	1.648***	1.543***
Fatigue Mitigations (odds ratio, p)				
Number of nights able to sleep 11 p.m.–7 a.m.	0.956*	0.942**	0.893***	0.929***
Number of nights enough sleep to feel fully rested	0.870***	0.926**	0.744***	0.820***
Shift choice	0.687***	ns	0.750***	0.837***

ns, not significant $p > 0.05$.
An odds ratio >1.0 indicate a direct relationship, for example OR = 1.086 indicates that the likelihood of recalling a fatigue-related error in the last 6 months increases with more nights worked. An odds ratio <1.0 indicates an inverse relationship, for example OR = 0.956 indicates that the likelihood of recalling a fatigue-related error in the last 6 months decreases with more nights of sleep between 11 p.m. and 7 p.m..
* $p < 0.05$.
** $p < 0.01$.
*** $p < 0.001$.

- In-patient mental health nurses worked more days ($p < 0.0001$ for both weeks). This is consistent with the fact that the majority (78.90%) only worked 8-h shifts (0.92% only worked 12-h shifts). In contrast, the majority of intensive care/cardiac care nurses (60.29%) only worked 12-h shifts (21.35% only worked 8-h shifts).
- In-patient mental health nurses had more shift extensions >30 min ($p < 0.0001$ for both weeks). The findings in Table 3 suggest that this could have contributed to their being more likely to recall a fatigue-related clinical error in the last 6 months, a chronic sleep problem, and excessive sleepiness, compared to intensive care/cardiac care nurses.
- In-patient mental health nurses worked more total hours in excess of their usual shift length ($p < 0.0001$ for both weeks). From Table 3, this could have contributed to their being more likely to report a fatigue-related clinical error in the last 6 months and excessive sleepiness, compared to intensive care/cardiac care nurses.
- In-patient mental health nurses had fewer days on which they were able to sleep between 11 p.m. and 7 a.m. (1–7 days prior, $p = 0.0174$; 8–14 days prior, $p = 0.0035$). From Table 3, this could have contributed to their being more likely to report all the fatigue-related outcomes, compared to intensive care/cardiac care nurses.
- In-patient mental health nurses experienced fewer days on which they felt fully rested ($p < 0.0001$ for both weeks). From Table 3, this could have contributed to their being more likely to report all the fatigue-related outcomes, compared to intensive care/cardiac care nurses.

In-patient mental health nurses also worked more total hours on days 8–14 prior (Wilcoxon Mann-Whitney test $p = 0.0062$; means for in-patient mental health nurses, week 1 = 38.70 h, week 2 = 39.08 h; means for intensive care/cardiac care nurses, week 1 = 38.19 h, week 2 = 35.39 h).

The collective employment agreement that was in force at the time of the survey had the following limits on weekly work hours: 40 h/week; or for 12-h shifts, 80 h/fortnight, a maximum of 120 h in three weeks, with a maximum of four 12-h shifts in a row (48 h in one week). Most in-patient mental health nurses (78.90%) worked 8-h shifts and so were covered by the 40-h weekly limit (0.92% worked 12-h shifts). On the other hand, most intensive care/cardiac care nurses worked 12-h shifts (60.29%) and so were covered by that provisions that permitted working more than 40 h under specified circumstances. Nevertheless, more in-patient mental health nurses (40.08%) than intensive care/cardiac care nurses (20.32%) reported working more than 40 h on days 8–14 prior to completing the survey (test for proportions $p < 0.0001$). For days 1–7 prior to completing the survey, the groups were not significantly different (37.5% vs 33.8%).

The collective employment agreement also specified a minimum of two breaks of at least 24 h per week which were to be consecutive 'except in the case of emergencies or by agreement'. Neither practice area achieved this (the means are below 2 in Fig. 1, for both weeks). The questionnaire did not ask about consecutive breaks of at least 24 h.

4. Discussion

This survey provides the first comprehensive overview of the work patterns of nurses working in New Zealand public hospitals and the aspects of those work patterns that are associated with fatigue-related outcomes (chronic sleep problems, excessive sleepiness, having felt sleepy at the wheel in the last year, and recalling a fatigue-related clinical error in the last 6 months). In the absence of other nationwide data, we selected a two-week timeframe for the questions relating to work patterns. This was based on the assumptions that recall of more recent work would be more reliable, and that a large enough sample would capture representative information across longer roster cycles. The lack of other nationwide data means we are unable to comment on the representativeness of the work patterns reported by the participating nurses.

With regard to the representativeness of the participants, the survey had an overall response rate of 42.6% across the 6 targeted practice areas. In all 6, response rates were highest among the youngest nurses (younger than 25 years) and lowest among the oldest nurses (65+ years). The use of an on-line survey may have contributed to this. Eight percent of participating nurses identified as being Māori, compared to 6.9% in the 6 target practice areas in the 2015 Nursing Council Workforce Survey (Te Kaunihera Tapuhi o Aotearoa Nursing Council of New Zealand, 2015). Among the practice areas, the lowest response rate was from in-patient mental health nurses (18.2%), possibly because a significant number are not members of the NZNO which conducted targeted recruitment of its members for the survey (in-patient mental health nurses generally belong to a different union). In-patient mental health also had the highest proportion of Māori nurses (12.8%) and male nurses (24.7%).

As this was a survey study, all the outcome measures were self-assessed. Nurses identified the clinical errors that they considered were due to fatigue, and their subjective evaluation of the causes of errors, together with the prompt inherent in the question, mean that the reliability of this measure cannot be independently validated. On the other hand, for managing safety, nurses' perceptions provide important data because they are informed by their expertise and influence their use of mitigation strategies.

The prevalence of reporting sleep problems and excessive sleepiness was higher among the nurses than in the general population of New Zealand adults (for a sleep problem lasting more than 6 months, 38.13% versus 25.09% for adults aged 20–59 years (Paine et al., 2005); for excessive sleepiness, 33.75% versus 14.9% for adults aged 30–59 years (Gander et al., 2005a); in both cases, pairwise comparisons for proportions $p < 0.0001$). This is consistent with the higher prevalence of sleep problems among shift workers (Drake et al., 2004; Flo et al., 2013).

A similar proportion of nurses recalled making a fatigue-related clinical error in the last 6 months (30.8%) compared to registrars (35.5% in a 2003 survey) (Gander et al., 2005c; Gander et al., 2007) and anaesthetists (32.0% in a 1997 survey) (Gander et al., 2000). In contrast, the younger and less experienced house officers in the 2003 survey (in their first two years of clinical practice) were more likely to recall a fatigue-related error in the last 6 months (50.4%). This is consistent with the finding in the present study that older and more experienced nurses were less likely to recall a fatigue-related error in the last 6 months.

The registrars and house officers were also asked the same question about sleepy driving. A similar proportion of nurses (64.50%) and registrars (62.3%) reported having felt sleepy at the wheel in the last 12 months, compared to 72.6% of house officers.

The associations in Table 3 highlight the importance of sleep opportunities across a roster, with increased likelihood of fatigue-related outcomes associated with more night shifts, and decreased likelihood associated with more opportunities for sleep between 11 p.m. and 7 a.m., and more nights with enough sleep to feel fully rested. This is consistent with the role of the circadian body clock in regulating sleep timing and quality, and with sleep restriction and circadian disruption causing fatigue-related impairment (Chellappa et al., 2019; International Civil Aviation Organisation, 2016).

At least two consecutive nights of unrestricted sleep are generally recommended for recovery from the cumulative effects of multiple days of insufficient sleep (Banks et al., 2010; Belenky et al., 2003; International Civil Aviation Organisation, 2016; Van

Dongen et al., 2003). The collective agreement under which these nurses worked required at least two consecutive breaks of at least 24 h per week. The median reported in the survey was one per week. However, care must be taken interpreting this finding because of the way that the question was asked. For example, one break of 48 h would still only be counted as one break. The timing of shifts resulted in nurses having (on average) at least 2 nights per week on which they were able to sleep between 11 p.m. and 7 a.m. and/or to obtain enough sleep to feel fully rested (Table 2, Fig. 1). However, it is not known whether these were consecutive nights.

Breaks of at least 24 h also provide vital time for maintaining commitments and activities outside of work. The findings (Table 3) also highlight three factors potentially linked to managing work/non-work commitments that are consistently associated with fatigue-related outcomes, namely shift extensions, roster changes and shift choice.

In addition to lack of two breaks of at least 24 h per week, the work patterns of in-patient mental health nurses also indicate that, in practice, the 40-h work week limit prescribed in the collective agreement is not necessarily respected. While in-patient mental health nurses may have been rostered for five 8-h shifts (40 h) per week, shift extensions and lack of 24-h breaks contributed to the 40-h limit being exceeded. These findings are consistent with the overall shortage of mental health nurses (Cassie, 2018; New Zealand Ministry of Health, 2018).

The issue of shift length is often hotly debated internationally in industrial negotiations. Nurses who work 12-h shifts work fewer shifts per week than nurses who work 8-h shifts, and therefore have less opportunity to work unplanned shift extensions and more opportunity to obtain sleep between 11 p.m. and 7 a.m.. The associations in Table 3 suggests that this would reduce the likelihood of having fatigued nurses on the ward. However, this should not be assumed to support the argument that 12-h shifts are preferable in all practice areas (Dall Ora et al., 2016).

The safety risk for patients and nurses that is associated with a fatigued nurse depends on what she/he is being asked to do, the other hazards present, and the other safety defenses present. For example, an intensive care nurse may have responsibility for only one patient and works supported by technology in a highly proceduralised environment with support close at hand. In contrast, an in-patient mental health nurse may be responsible for multiple unpredictable patients with little backup. Extending in-patient mental health shifts to 12 h would increase the accumulation of time-on-task fatigue across the shift in this higher-risk environment and these nurses are already the group least able to take scheduled breaks during their shifts. If the high level of extended hours and inability to take breaks in in-patient mental health is due to insufficient staffing, this would not be relieved by moving to 12-h shifts.

We conclude that the survey findings support the need for more flexible and effective fatigue and shift work management for hospital nurses (Steege and Pinekenstein, 2016; Steege et al., 2017a,b). The variability seen in work patterns between practice areas probably reflects a combination of tradition, nursing expertise and the nature of the work, and a range of constraints that may be local or national. Examples include the health and socioeconomic profile of the community served by each hospital, the hospital's services and facilities, staff preferences, staffing levels, overall shortages of qualified nurses, and the level of government funding. We advocate an approach to fatigue and shift work management that integrates safety management and scientific principles with nursing and management expertise. It should be data-driven, risk-focused, adaptable, and resilient in the face of changes in the services required, the resources available, and the overall goals of the healthcare system (International Civil Aviation Organisation, 2016; Steege and Pinekenstein, 2016; Steege et al., 2017a,b).

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