National Code of Practice

For Managing Fatigue and Shift Work in Hospital-Based Nursing

[Other logos here]

Note: We seeking input and endorsement from organisations across the sector

Contents

1. Forward

This Code of Practice is part of a new collaborative approach to managing fatigue and shift work with hospital-based nurses. It incorporates sector knowledge and experience with the latest science and international best practice in fatigue and shift work management [3-5]. The goals are to improve:

1. patient safety and the quality of care in our public hospitals;
2. the health, safety, quality of life and retention of nurses; and
3. the efficient and effective use of hospital resources, including both people and financial resources.

The Code of Practice is the product of multi-disciplinary collaboration and broad consultation with stakeholders. [Note: We are seeking input and endorsement from organisations across the sector].

1.1 Why Manage Fatigue and Shift Work?

Fatigue resulting from shift work and extended hours can degrade patient care and increase the risk of clinical error, workplace injuries to nurses, and drowsy driving accidents, as well as increasing nursing turnover and health care costs [6-17].

The US Nurses' Health Study (over 70,000 registered nurses, follow-up over 30 years) has compared nurses who work at least three night shifts per month with nurses who do not work nights. After 5 years, nurses working nights have significantly higher mortality rates from all causes and from cardiovascular disease [18]. After 15 years of night work, nurses have a higher risk of death from lung cancer [18] and ischemic stroke [19]. With increasing years of night work, there is also a linear increase in risk of type 2 diabetes that appears to be partly mediated through increasing body weight [20], a linear increase in the risk of breast cancer [21], and an increased risk of colorectal cancer risk after 15 years [22].

DEFINITION: fatigue is *a physiological state of reduced physical and mental performance capability caused by four main factors*
1) sleep loss
2) extended time awake
3) working and sleeping at suboptimal times in the circadian body clock cycle
4) workload (mental and physical).

1.2 Responsibility for Managing Fatigue and Shift Work

The Health and Safety at Work Act (HASW) (2015) identifies fatigue as a cause of workplace hazards. Hazards must be managed 'as far as is reasonably practicable'. The Act places a shared responsibility on District Health Boards (DHBs) and nurses to manage fatigue. The Act does not specifically mention shift work, but WorkSafe guidance identifies shift work as a cause of fatigue.

The Act recognises that fatigue reduces a person's ability to work efficiently and safely. Scientific advances have identified why we sometimes cannot function at our best, physically or mentally. This has led to a new definition of fatigue and the following principles for fatigue and shift work management.

In the HASW Act, hazards include *a person's behaviour where that behaviour has the potential to cause death, injury, or illness to a person.*

- Fatigue is recognised as a physiological state. This means that a person experiencing the effects of fatigue is unable to function at their best (as opposed to unwilling or unmotivated).

- Shift workers are more likely than dayworkers to experience fatigue. This is because their work patterns are more likely to produce sleep loss, extended time awake, and working and sleeping at suboptimal times in the circadian body clock cycle.
- Workplace fatigue is inevitable in 24/7 nursing services. It cannot be eliminated but must be managed.
- The traditional approach for managing fatigue and shift work – limiting maximum work hours and minimum breaks - does not adequately address all four of causes of fatigue.

In broad terms, fatigue results from:

- the physical, mental and emotional demands of all waking activities (not only work demands); and
- incomplete recovery from those demands, which (except for recovery from muscle fatigue) requires sleep.

DHBs have primary responsibility for nurses' work requirements. Nurses also have responsibility for their work requirements if they have choice over their shifts, and for their choices about how they use non-work time, including for sleep. DHBs and nurses have shared responsibility for managing the effects of fatigue when nurses are at work.

1.2 Using This Code of Practice

This Code outlines the key scientific principles for fatigue and shift work management. It then steps through the components and processes needed to build an effective, flexible fatigue and shift work management system (FSMS) for hospital-based nurses. Specific examples and tools are provided, drawn from the scientific literature, international best practice, and the findings of a 2016-2017 national survey of DHB-based nurses in 6 practice areas[1]. The Code also provides recommendations on how to implement a functioning FSMS with built-in mechanisms for continuous improvement.

The Code does not recommend absolute limits on specific aspects of nurses' work patterns, for example maximum safe shift lengths, numbers of consecutive shifts, or minimum breaks between shifts. It provides a fatigue hazard assessment matrix for evaluating weekly work patterns, based on six variables relating to work patterns and two variables relating to sleep. The matrix was developed and validated using the 2016-2017 national survey of DHB nurses and can be accessed at www.safernursing24-7.co.nz. The site calculates the hazard score associated with a weekly work pattern entered by a nurse. This enables personalised feedback on roster options for guidance when nurses have a high degree of choice over their shifts. The hazard assessment matrix can also be used for auditing of rosters across departments, practice areas, teams, etc.

The Code is supported by educational and training materials which can be accessed at [link to be inserted].

1.3 Feedback

This Code is intended to be a living document. We would very much like your input on this initial draft and ongoing feedback will be welcome once the first edition of the Code is released. Your feedback can be directed to safernursing24-7@massey.ac.nz and discussion is welcome on our forum (https://www.loomio.org/safernursing/).

[1] 2333 registered and enrolled nurses completed the survey, an estimated 32% of those eligible, based on the 2015 Nursing Council workforce survey.

Further information can be found on www.safernursing24-7.co.nz.

2. Scientific Principles for Managing Fatigue and Shift Work

The method for managing fatigue and shift work presented here is built, in part, on advances in scientific knowledge. This chapter outlines the relevant scientific principles that need to be understood to implement the remainder of the Code.

2.1 The Importance of Sleep

Sleep is essential for recovery from the energy expenditure (mental, physical and emotional) of all waking activities (not just work). It is a complex series of processes involving two alternating brain states: rapid eye movement (REM) sleep, during which active dreaming occurs, and non-REM sleep which includes deep slow-wave sleep. Many essential functions are occurring during sleep, including memory consolidation and learning, emotional regulation, repair of tissue wear-and-tear, growth, recharging of the immune system, and regulation of appetite and metabolism.

Scientific Principle: Getting enough sleep (both quantity and quality) on a regular basis is essential for restoring the brain and body.

Rostering Principle: Sleep opportunities matter, not just rest breaks. A 10-hour break from 9pm to 7 am is a much better sleep opportunity than a 10-hour break from 9am to 7pm.

Recommended sleep for people aged 18-64 years is 7-9 hours per night, although a few people may need as little as 6 hours or as much as 10-11 hours [23]. People who report regularly sleeping less than 7 hours per night are at increased risk of developing depression, obesity, type 2 diabetes, high blood pressure, and cardiovascular disease. Sleep restriction experiments lasting days to weeks in the laboratory are identifying possible mechanisms that might lead to these longer-term health effects.

People who report regularly sleeping more than 9 hours per night are also at increased risk for some of these adverse health outcomes, but the mechanisms that might cause this are not yet clear.

Sleep of DHB-Based Nurses

The 2016-17 national survey included nurses working at least 30 hours per week in six practice areas where the Safer Nursing 24/7 Advisory Group considered that fatigue levels might be high. Participants were asked how much sleep on average they usually get in a 24-h period. The percentage of nurses in each practice area who reported usual sleep less than 7 hours is shown in Figure 1.

The majority of nurses reported getting usual sleep shorter than 7 hours. On the other hand, fewer than 2% of nurses in any practice area reported usual sleep longer than 9 hours.

Participants in the national survey were also asked how often they get enough sleep and how often they wake refreshed. Figure 2 compares their responses to weighted population estimates from a 1999 national survey of New Zealanders aged 30-59 years [24].

Nurses of all ages, and nurses aged 30-59 years, were significantly more likely than the general population to report never/rarely getting enough sleep and never/rarely waking refreshed (pairwise comparisons for proportions p<0.0001 in all cases).

Sleep is a vital issue for nurses. The majority report usual sleep that is shorter than recommended for maintaining health safety, and wellbeing. They are also significantly more likely than the general population to report never/rarely getting enough sleep and never/rarely waking refreshed.

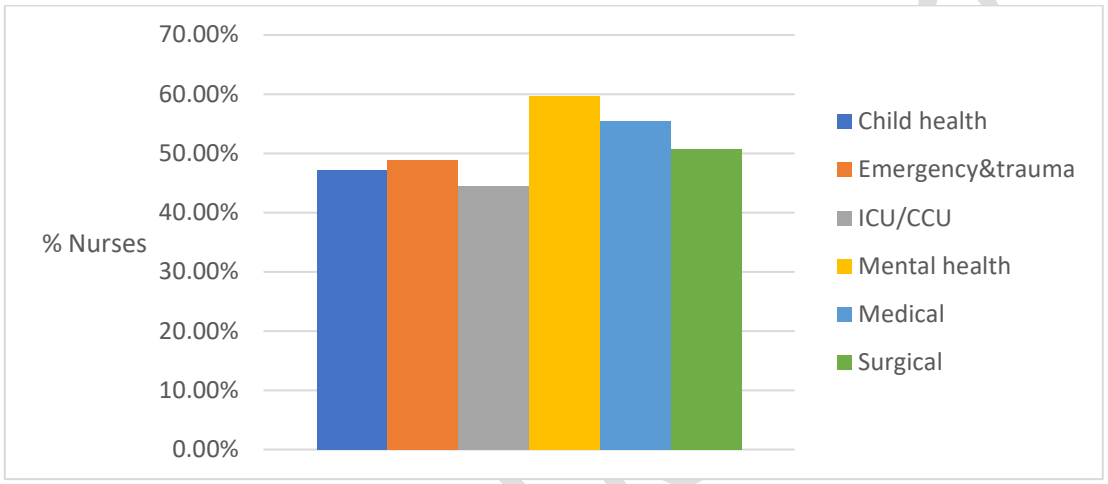

Figure 1: Percentage of Nurses in the national survey who reported usual sleep less than 7 hours

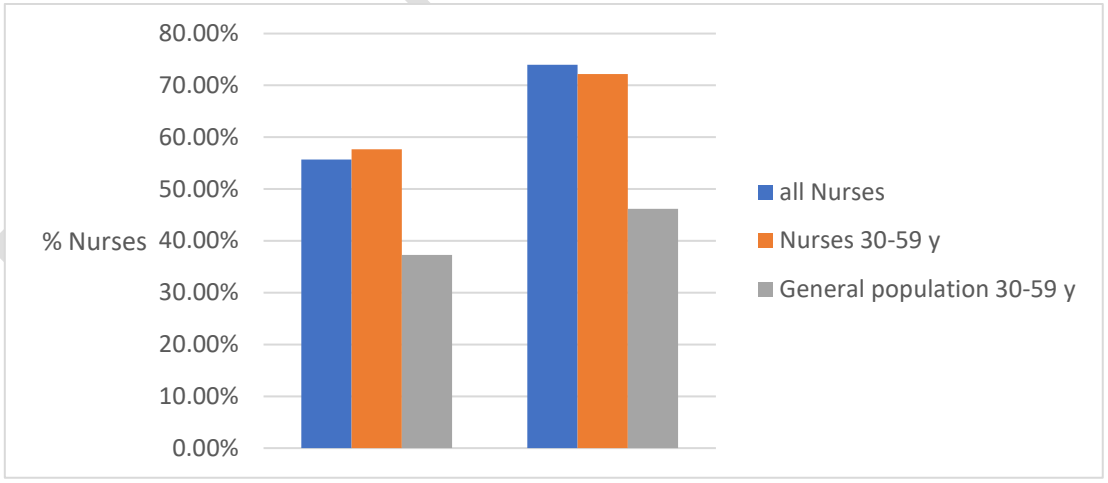

Figure 2: Percentage of Nurses in the national survey who reported never/rarely getting enough sleep and never/rarely waking refreshed

2.2 Sleep Loss and Recovery

Building Up a Sleep Debt

The pressure for sleep builds up across extended time awake and across multiple days when sleep is too short or of poor quality (cumulative sleep debt). This is accompanied, at least initially, by increasing sleepiness.

As sleepiness increases, many other aspects of waking function are deteriorating including increasing irritability, degraded alertness, slower reaction times, poorer coordination, slower thinking, loss of situation awareness, and less creative problem-solving.

The effects of restricted sleep accumulate across multiple nights. They are also dose-dependent - the more sleep is cut short each night, the faster impairment builds.

Laboratory studies indicate that after the first 2-3 nights of sleep restriction, people feel increasingly sleepy. However, with additional nights of sleep restriction, they report feeling no sleepier even although on objective measures their performance is continuing to degrade [25].

Eventually, the pressure for sleep reaches a point where a person falls asleep uncontrollably. The brain slips into light sleep and stops processing visual stimuli and sounds (unless they are sudden and loud enough to wake the person up). These 'micro-sleeps' are often implicated in car crashes caused by drivers falling asleep at the wheel.

In the 2016-17 national survey, 32% of nurses reported that, since becoming a nurse, they had fallen asleep driving home from work. Nearly two thirds (65%) reported having felt close to falling asleep at the wheel in the last 12 months.

Recovering From Sleep Debt

Laboratory studies indicate that recovery from the effects of an accumulated sleep debt does not require making up all the lost hours of sleep. At least two consecutive nights of unrestricted sleep are needed for the internal structure of sleep to return to normal. Waking function may take more than 2 full nights of sleep to recover [25].

In the 2016-17 national survey:

- the median number of breaks of at least 24 hours between shifts was 1 in the last 7 days, and 1 in the week before;
- the median number of times that nurses were able to sleep between 11pm and 7 am (including days off) was 4 in each week; and
- the median number of nights when they obtained enough sleep to feel fully rested was 3 in each week.
- The survey did not ask about consecutive nights off.

Scientific principles:
The effects of sleep loss build up across multiple days (sleep debt), eventually resulting in unintended microsleeps.
As sleep debt builds up, how sleepy we feel is not a reliable indicator of how we are functioning.
At least 2 consecutive nights of unrestricted sleep are needed for recovery from sleep debt.

Rostering Principles
For recovery from sleep debt, rosters need to include regular breaks of at least 2 nights off in a row (recovery breaks). This is not the same as 48 hours off. For example, for most people 48 hours off starting at midnight allows only one night of unrestricted sleep.
How often recovery breaks are needed depends on how fast sleep debt is building up. When shifts overlap more of a nurse's usual sleep time at night, then sleep debt builds up faster.

2.3 Why We Prefer to Sleep at Night

Our ability to fall asleep and stay asleep, and our physical and mental abilities and mood while we are awake, fluctuate across the 24-hour day under the influence of a master pacemaker in the hypothalamus, the circadian body clock.

The circadian body clock functions to keep our physiology and behaviour in step with the day/night cycle. It receives light information from specialised melanopsin-containing cells in the retina that are sensitive to blue light (including from cell phones and tablet screens). Exposure to blue-rich screens in the hours before bedtime can delay the circadian body clock cycle, making it harder to fall asleep and harder to wake up next morning.

The combined effects of the circadian body clock and the pressure for sleep that builds up across time awake produce 'windows' when sleep is easier, and when sleep is more difficult.

- The circadian body clock makes us sleepiest in the early hours of the morning, when we are also least functional and most error prone. A secondary peak in sleepiness occurs in the afternoon – the 'nap window'.
- Conversely, the circadian body clock makes us most alert in the few hours before normal bedtime – the 'evening wake maintenance zone'. This makes it very difficult to fall asleep early ahead of an early shift next morning. The circadian body clock also drives an increase in alertness across the morning, making it difficult to sleep beyond about lunchtime, after a night shift.

Figure 3 visualises these patterns in terms of a drive from the circadian body clock to wake-promoting centres in the brain.

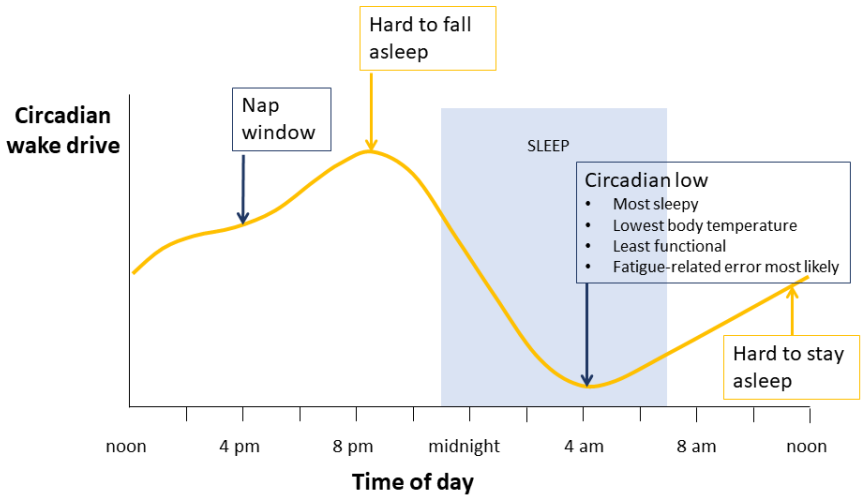

Figure 3: Diagram of how the circadian body clock influences our ability to fall asleep and stay asleep

The Challenge of Shift Work

Because the circadian body clock tracks light intensity, it does not adapt fully to shift work. Indeed, less than 3% of permanent night workers become fully-adapted to night work [26]. (Most people also like to go back to sleeping at night on their days off).

Scientific Principles

Shift work is any work pattern that requires you to be awake when you would normally be asleep if you were free to choose.

Nurses working during their usual sleep time will not be able to function at their best because the circadian body clock is trying to push their brain into sleep mode.

Nurses trying to sleep outside their usual sleep time will have more difficulty getting enough sleep because the circadian body clock is trying to push their brain into wake mode.

Rostering Principles

The timing and duration of night shifts is important. The more they overlap usual sleep time, the greater the amount of sleep restriction they are likely to cause.

Attention needs to be paid to the number of consecutive night shifts across which sleep debt is building.

Early starts and late finishes also restrict sleep, but to a lesser extent than night shifts.

The timing of 12-hour shifts needs to be carefully considered. For example, 12-hour night shifts that finish earlier will give more sleep opportunity to the night shift. However, they also mean that nurses on the day shift have to get up earlier. As shown in Figure 3, the circadian drive for wake, that peaks in the hours before usual sleep time, can make it very difficult to fall sleep earlier in anticipation of an earlier duty start time next morning.

Peripheral Circadian Clocks and the Importance of Meal Timing

Circadian rhythms exist at all levels in the body (cellular, tissue, organ, whole body). The circadian clock in the hypothalamus is the 'master clock' that is set up to ensure that our daily patterns of activity, sleep and all other functions are optimally timed with respect to the environmental cycles (physical, biological) that accompany the earth's rotation, as well as optimally timed internally with respect to each other. The master clock has outputs that drive rhythms in neuroendocrine secretion (in particular cortisol and melatonin) and in autonomic control that regulate circadian expression of the clock genes in peripheral organs [27].

In the 2016-2017 national survey, 83% of nurses indicated that they did not have access to healthy food at all hours.

In rodents, there is evidence that food intake patterns can also directly drive the rhythmicity of the clock genes in the cells of the liver, stomach, intestine, pancreas, adipose tissue and other organs including the kidney, adrenals and heart. Indeed, eating patterns can override the signals from the hypothalamic master clock, driving the peripheral clocks out of phase with it [27]. Evidence is beginning to accumulate indicating that this can also occur in humans and that it has metabolic consequences that may help explain why shift workers are at greater risk of becoming obese and developing type 2 diabetes [28, 29].

2.4 Effects of Workload

Two main mechanisms for the effects of shift work on health are being investigated. 1) Light exposure at night causes disruption to the hypothalamic master clock, as well as suppression of melatonin secretion at night. 2) Eating at inappropriate times in the master clock cycle causes internal desynchrony between circadian rhythms in different functions [2].

Mental and physical workload are considered causes of fatigue, but scientific evidence in this area is much more limited than for the other causes of fatigue. High workload, particularly without breaks, is expected to increase fatigue and may exceed the capacity of a nurse who is fatigue-impaired. On the other hand, low workload may not be stimulating enough to help nurses stay attentive when they are starting to fight sleepiness.

In the 2016-17 national survey, nurses had been able to take breaks in 73% of their shifts in the last 7 days, and 73% in the week before. However, there were significant differences between practice areas, with in-patient mental health nurses having the least opportunity to take breaks within shifts (64% of their shifts in the last 7 days, and 60% in the week before).

2.5 Fatigue Versus Safety Risk

The safety risk associated with a fatigued nurse depends 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, and the associated risks to the nurse and patient in this context are very different from those for an in-patient mental health nurse who may be responsible for multiple unpredictable patients with little backup.

Limits on shift lengths, number of consecutive shifts, breaks, etc, aim to limit the level of fatigue of nurses at work. They do not address the differences in risk associated with a fatigued nurse in different practice areas at different times.

This is also true for biomathematical models that are sometimes used to predict the average levels of fatigue generated by different rosters [1].

2.6 The Need for Different Types of Knowledge and Expertise

Advances in scientific understanding:

- have enabled new approaches to fatigue and shift work management;
- are generalisations about the causes of fatigue, the types of impairment it can create, and mitigations that can be effective in reducing fatigue levels among groups of nurses; but
- science cannot address the specific safety risk(s) represented by an individual nurse experiencing fatigue in a particular work context.

Nurses have essential knowledge and experience relevant to:

- the risks to patients, their colleagues, and themselves, that are associated with being fatigued in their particular practice and work environment(s);
- the challenges that work requirements create in relation to their other commitments outside of work; and
- the challenges that work requirements create for maintaining their own health, wellbeing, and job satisfaction.

Staff with management, health and safety, and human resources responsibilities have essential knowledge and experience relevant to:

- the DHB's expectations and constraints relating to fatigue and shift work management;
- other human resources requirements and health and safety requirements;
- impending changes in services and technology with implications for fatigue and shift work management;
- policies in other areas and sector-wide changes that have the potential to affect fatigue and shift work management; and
- prioritisation of fatigue-related risks versus other health and safety risks that the DHB must also manage.

3. Building a Fatigue and Shift Work Management System

A current US initiative describes occupational fatigue of nurses as '*an important and prevalent nurse capacity-depleting factor in healthcare systems*'. Steege et al. emphasise that addressing occupational fatigue in nursing requires *'strategic management and high-level decision-making as well as daily management through operational and tactical actions'* [3].

This Chapter works through a practical way to make fatigue and shift work management happen (Figure 4), based on the approach first implemented in the global aviation industry [4] and now expanding across a range of other sectors. It has the strength that it focuses on how to manage fatigue risk by integrating it into existing systems and processes wherever possible, rather than providing general guidance on what needs to be achieved.

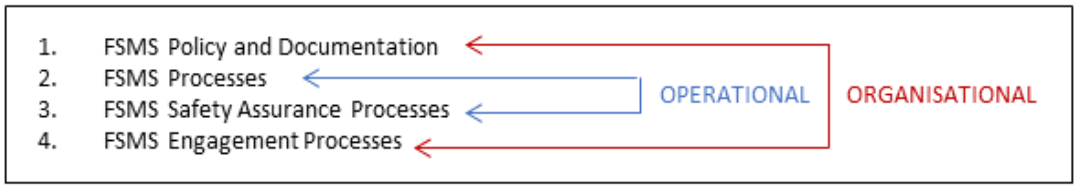

Figure 4: Essential components and processes for a fatigue and shift work management system (FSMS)

The chapter begins by working through the core activities of the FSMS (the operational components in Figure 4), as well as who is responsible for them. It then describes the organisational components and processes needed to support the functioning of the FSMS.

Fatigue Risk Management Principles

1. Fatigue is inevitable in 24/7 work. It cannot be eliminated, it must be managed.
2. Fatigue risk management must be a shared responsibility because fatigue is affected by activities outside of work as well as by work demands.
3. Fatigue risk management requires an effective safety reporting culture that clearly differentiates between: a) human error, which is a normal subset of human behaviour exacerbated by fatigue, and a safety matter; and b) intentional violation, which is a disciplinary matter.
4. The HASW Act (2015) requires all staff to report hazards, and worker engagement in fatigue and shift work management.
5. The complexity of an FSMS should be commensurate with the level of fatigue-related risk that needs to be managed.

The aim is to build fatigue and shift work management into existing systems and processes in a DHB, wherever possible. For this first edition of the Code of Practice, staff from Capital and Coast DHB have generously shared their time and expertise to develop a mapping of FSMS requirements to their existing systems and processes. This is provided as an example. It is expected that there may be differences between DHBs, but that the principles will apply to all.

3.1 FSMS Processes

The FSMS processes are a data-driven, four-step cycle that monitors and manages fatigue risk, whatever its causes, on a day-to-day basis. The cycle is summarised in Figure 5 and maps to the requirements of the HASW Act (2015) for workplace monitoring, hazard identification, risk assessment, and for taking all practicable steps to eliminate or minimise hazards (mitigation).

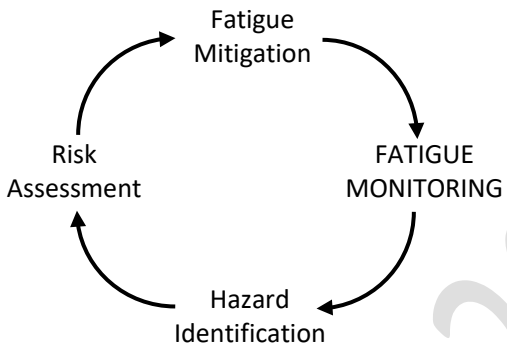

Figure 5: The FSMS processes loop

Step 1: Monitoring

Fatigue monitoring provides the data that are used to identify fatigue-related hazards. A variety of types of data can be useful and robust FSMS processes use multiple data sources [30]. Since shift work is a recognised cause of fatigue, monitoring rosters (planned and worked) is central. Fatigue levels associated with a roster can be predicted, monitored in real time, or identified by using appropriate investigation methods after an incident or accident.

The amount and complexity of data need to be commensurate with the expected levels of fatigue and the associated risk of harm to patients and/or nurses. For example, a series of fatigue reports identifying concerns with a particular roster might lead to a survey of all nurses who work the roster, to see how widespread the concerns are, and/or to a study monitoring the sleep and fatigue of nurses across the roster. Each of these additional data sources requires additional resources, both human and financial.

The aim is to have a robust set of routine data sources that can be used to trigger more intensive data gathering as required. Multiple sources of data are already available in DHBs, but additional resourcing may be required to analyse them to appropriately to identify fatigue hazards.

a) Routine Monitoring

Data for day-to-day fatigue monitoring can come from a variety of sources, including fatigue reports from nurses (and other staff who may have concerns about nurses' fatigue), data that are routinely collected about planned rosters and actual work done by nurses, and tools that can be used to estimate fatigue on different rosters.

Fatigue Reports

Fatigue reports allow nurses and others to give vital feedback on fatigue hazards where and when they occur. They identify potential hazards before these escalate into incidents or accidents. Effective fatigue reporting is therefore a key source of data for the FSMS processes.

People are encouraged to report by having an effective safety reporting culture with a clear understanding of the defining line between acceptable performance (which can include unintended errors) and unacceptable performance (such as negligence, recklessness, violations or sabotage). This provides fair protection to those who report but does not exempt them from punitive action where it is warranted. Nurses also need to be confident that reports will be acted on, which requires feedback to them, and they need to believe that the intent of the reporting process is to improve safety, not to attribute blame.

Routine Data on Rosters

Comparing planned work and actual work can provide very valuable information on likely 'fatigue hotspots'. Rostering and payroll data can be used but may not normally be compared and analysed for this purpose so additional resourcing may be required.

Roster data can also provide useful safety performance indicators (SPIs) that can be monitored over time. Examples include the number and length of unplanned shift extensions, amounts of overtime, use of call backs, exceedances of agreed maximum duty lengths or minimum breaks between shifts, frequency of two consecutive nights for recovery sleep, etc. In larger groups, patterns of sick leave use may also highlight potential fatigue hazards.

The Core Data Set within the Care Capacity and Demand Management (CCDM) system collects data that can be used for routine fatigue monitoring, for example the variance indicator score, roster gaps, overtime, extra shifts. As part of the new DHB Multi-Employer Collective Agreement (MECA), all DHBs are required to implement CCDM by 2021.

Capital and Coast DHB is in the process of implementing the CCDM system. For each shift, the variance indicator score maps patient needs (acuity, complexity, volume, etc.,) with the skill mix and number of nurse hours needed. The DHB then responds to any identified gaps, for example having an inappropriate skill mix or insufficient staff on a shift. Clearly these are both factors that can increase fatigue on the shift. The data that informs the CCDM also highlights potential mitigations, for example, providing more suitably trained staff.[2] In future, the CCDM system will also be able to forecast changes, such as the need for more staff during the flu season, because of increased use of sick leave. The NZNO has put forward a

[2] In addition to the CCDM providing data to identify fatigue hazards, there are several ways that FSMS principles might be integrated with it. For example, recognising nurses' reduced capacity to manage patient needs on the night shift (due to the circadian body clock cycle) might lead to different mitigations, for example a shorter shift and/or transfer of some tasks from the night shift to the preceding or following shifts. Nurses who have had better sleep opportunities prior to a shift will have greater capacity to manage patient needs. In addition, the criticality of many conditions varies across the circadian body clock cycle, which may need to be factored into the calculation of the variance indicator score.

proposal to document and analyse outcome data (falls, medication errors, patient outcomes, etc) alongside the CCDM dataset as it comes on line.

Capital and Coast DHB uses 'Click', a business intelligence platform where core datasets and indicators are managed, including reportable events. The aim is to develop a comprehensive matrix of factors that contribute to nurses' workload. Since workload contributes to fatigue, this platform could also be a source of data for identifying and recording fatigue hazards.

In Capital and Coast DHB, each unit has a local Data Council that owns and manages its information (plans, rosters, responses to quality or other issues, occupational health and safety risks, clinical practice issues and events, etc.) Data Councils are also charged with finding solutions and mitigating risks and vary greatly between units. This approach has the advantage that it uses each unit's expertise to identify hazards and develop targeted solutions and mitigations. However, at some level, units are competing for resources (human and financial) to manage health and safety, so decisions around resource allocation, and the ensuing responsibilities under the HASW Act, need to be carefully considered (see Section 3.3).

With rostering done at unit level, it is not presently possible at Capital and Coast DHB to get an overview of the actual work patterns of individual nurses, for example when someone is working in one unit and doing overtime in another. However, this is becoming more transparent with the implementation of the 'Trendcare' software package, which will enable a more global view. Thought needs to be given to the processes for managing individual nurses who are choosing to work excessive hours, and these processes need to be made clear to nurses in their fatigue and shift work management training.

b) Predicting Fatigue Levels

Tools that predict fatigue levels associated with different rosters can help identify likely 'fatigue hotspots', provide information on changes in fatigue levels across time, and be used to compare options when roster change is being considered as a mitigation.

The Fatigue Hazard Assessment Matrix

The fatigue hazard assessment matrix is a key output from the 2016-17 national nursing survey, and follows the approach used in the Australian Medical Association National Code of Practice – Hours of Work, Shift Work and Rostering for Hospital Doctors [5]. The matrix was derived by looking at which aspects of work patterns predicted three main fatigue-related outcomes: scoring as excessively sleepy (>10) on the Epworth Sleepiness Scale [31]; having felt close to falling asleep at the wheel in the last 12 months; and recalling a fatigue-related clinical error in the last 6 months. The matrix was developed based on the work patterns of 1885 nurses from 6 practice areas, who had worked at least 30 hours in the 7 days prior to completing the survey. The matrix is scored on work in the last 7 days and summarised in Table 1. A scoring sheet with the full question for each risk factor can be found in Appendix A. The maximum possible score is 16 (higher risk on all 8 factors).

Table 1: Fatigue hazard assessment matrix for DHB nurses

Risk factor	Lower fatigue, score 0	Significant fatigue, score 1	Higher fatigue, score 2
1. Total hours worked	≤40	40 h+ to 48 h	>48 h
2. Shift extensions ≥30 min	None	≤50% of days worked	>50% of days worked
3. Breaks <9 h between shifts	0	1	>1
4. Number of nights	0	1-2	>2
5. Number of breaks ≥24 h between shifts	≥2	1	0
6. Roster change	no	Roster change requested	Roster change not requested
7. Number of nights sleep (2300-0700)	6-7 nights	4-5 nights	0-3 nights
8. Number of nights got enough sleep to be fully rested	6-7 days	4-5 days	0-3 days

In multivariate statistical analyses that controlled for the effects of gender, ethnicity (Māori/Non-Māori), years of nursing experience, and the extent to which nurses had choice about their shifts (rated from 1=none to 5=complete), matrix scores are a better predictor of all outcome measures than the actual values of all the work factors considered together. A similar matrix derived from a 2003 national survey of Resident Medical Officers working in DHBs [32] is routinely used for evaluating their rosters (Dr Deborah Powell, personal communication).

The matrix can be used to compare likely fatigue levels associated with different rosters when roster change is being considered, or by individual nurses as a guide when making choices about their shifts.

Matrix scores can also be tracked for groups of nurses across time and used as safety performance indicators (SPIs) for defining hazards (see Step 2 below). An example might be that no practice area covered by the FSMS will have an average monthly hazard score greater than an agreed value. Average hazard scores for each practice area included in the 2016-17 survey are shown in Figure 6.

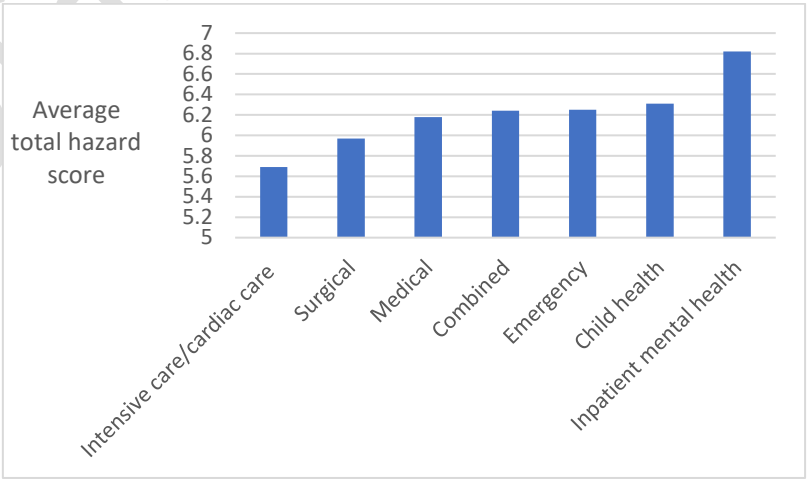

Figure 6: Average total hazard scores for the 6 practice areas in the 2016-2017 national nurses survey

Staff Knowledge and Experience

Experienced roster designers and shift workers can also predict the likely levels of fatigue in different rosters, which can be valuable when roster change is being considered as a mitigation.

Biomathematical Models

A range of biomathematical models are being marketed in New Zealand as tools for predicting the likely levels of fatigue associated with different rosters. These predictions can be used as a source of data for the FSMS process loop, but it is not recommended that biomathematical models be relied on as the only source of information on fatigue levels [1].

It is important to be aware that current models only predict group averages, not individual fatigue levels, and that they do not address the safety risk that a fatigued nurse poses in different situations. If you are considering buying a model, an important question to ask is whether it has ever been validated against fatigue measures or fatigue-related outcomes in the nursing context(s) where you want to use it.

c) Learning the Lessons from Safety Events

In the first instance, DHBs are responsible for investigating incidents relating to patient harm, staff harm, safe staffing levels, etc. The exception is cases where there is a clear concern about a nurse's fitness or competency to practise, which are referred directly to the Nursing Council. DHB staff responsible for incident investigation are likely to need upskilling in how to investigate for the role of fatigue.

At Capital and Coast DHB, morbidity and mortality meetings are currently held within units but there is an initiative to look at how these can be more integrated across the organisation and to incorporate a more multidisciplinary approach, which could include training in evaluating the role of nursing fatigue. It has also been recommended that training be provided for medico-legal lawyers who provide services to the NZNO, in relation to presenting cases to the Nursing Council and the Health and Disabilities Commission.

A method for investigating the role of fatigue is provided in Appendix B, which is recommended for the global aviation industry [4, 33] and has been accepted in New Zealand transport accident investigations and in the Courts (Philippa Gander, personal communication).

d) When More Information is Needed

When the above data sources indicate that fatigue may be an issue in a given context, but the causes or extent of the problems are not clear, then it may be appropriate to undertake a review of relevant scientific studies that have already been published and/or to collect new data with staff volunteers.

There is no single measurement that is the 'gold standard', because fatigue-related impairment affects many skills and has multiple causes. A wide variety of fatigue measures are used in scientific research, some of which are suitable for monitoring nurses in the context of FSMS [4].

New ways to measure fatigue and sleep are always being developed. For FSMS it is recommended that the measures chosen are agreed to, and accepted as being meaningful and reliable, by nurses, unions, management, relevant government agencies (WorkSafe, Ministry of Health), and scientists. This avoids the unnecessary cost and inconvenience of collecting data that is of questionable value.

Measurements can be based on staff recall (surveys) or current impressions of fatigue symptoms (rating scales in real time) or on objective measurements, such as performance tests and different types of physical monitoring. For example, a validated actigraph that measures movement can be used to track the sleep/wake cycle. Each type of measure has strengths and weaknesses, and it is important to consider the burden of data collection on participants who are expected to continue with their daily lives while being monitored. When deciding on the type(s) of data to collect, the expected level of fatigue risk

should also be a key consideration – more intensive monitoring is appropriate when fatigue risk is expected to be higher.

This is an area where it may be advisable to seek external advice in relation to selecting appropriate measures, study designs, and working through independent ethical review and approval. There are important ethical considerations to be considered when (a) staff are being monitored in their work context and study findings could potentially adversely affect their employment, and/or (b) their 24-hour sleep/wake patterns are being monitored (outside of work as well as at work).

To identify fatigue hazards and monitor the performance of the FSMS processes (see Section 3.2), data need to be analysed and evaluated regularly.

Step 2: Hazard Identification

Recall that in the HASW Act (2015), hazards include '*a person's behaviour where that behaviour has the potential to cause death, injury, or illness to a person*'. When does impairment due to fatigue reach this level? How much is too much? This depends very much on what the fatigued nurse is being asked to do and what other safety defences (including other staff) are available to support or compensate for the impaired person.

Identifying fatigue hazards thus involves identifying where nurses' fatigue levels may be of concern and considering the safety risk that fatigued nurses represents in the context in which they are working. A roster that attracts multiple fatigue reports from nurses could be considered a fatigue hazard. Failing to achieve an agreed safety performance indicator (SPI) could be considered a fatigue hazard, for example exceeding the agreed proportion of shifts that have extensions of more than 30 minutes, or not achieving an agreed minimum of two consecutive nights for recovery sleep per week.

All DHBs have hazard reporting systems, with a range of different platforms being used, including RL Solutions, Square, and Riskman. Traditionally, hazard reporting systems have focused on patient harm, but increasingly they are being designed to also capture staff harm, mostly in relation to physical and verbal assault. The expectation is that fatigue hazards can be incorporated into these systems. A field for fatigue reporting can be added to a standard hazard report form, or a separate fatigue reporting form can be used (see Appendix C for an example).

To provide reliable data, fatigue (and other hazard) reporting needs to be easy (including on-line) and the response to reports needs to be clearly understood by all parties, whether reporting one's own fatigue, or concerns about the fatigue of others. This needs to be made clear in fatigue and shift work education/training.

Step 3: Risk Assessment

Once a fatigue hazard has been identified, the level of risk that it poses must be assessed and a decision made about whether that risk needs to be mitigated. There are four basic steps in fatigue risk assessment.

1. Estimating the likelihood of nurses being fatigued. The fatigue hazard assessment matrix (Table 1) can be used to compare rosters for this purpose. Bio-mathematical model predictions can also be used, however no one tool should be used in isolation for estimating fatigue [1].
2. Estimating the likelihood of a safety incident as a result.

3. Identifying the worst possible safety outcome that could occur.
4. Calculating the risk x severity of the worst possible outcome.

Steps 2 and 3 require special expertise, as well as knowledge about the work environment where a fatigue hazard has been identified (see Section 3.3).

Fatigue is one of numerous hazards that need to be risk assessed and managed in a DHB. Appendix D shows Capital and Coast DHB's hazard reporting and risk assessment matrix. Using this same matrix to assess fatigue-related risk would enable it to be compared to other hazards. This would help prioritise where limited resources (people and financial) can be targeted for mitigations that provide the best overall safety improvement. Fatigue risk assessment may require additional training for the staff responsible for general risk assessment.[3]

Step 4: Mitigation

Varying terminology is used for mitigations, but it is useful to consider two types. 1) *Planned mitigations*' (sometimes called controls) focus on reducing the potential for nurses to be fatigued at work. 2) '*On-the-day mitigations*' are used to reduce the likelihood and/or severity of the associated health and safety risks when a nurse is fatigued at work (which is inevitable in 24/7 services). Table 2 lists some examples of each type of mitigation. Planned mitigations tend to be more generic, whereas on-the-day mitigations are often more specific to a given work context. Experienced nurses are a great source of suggestions for on-the-day mitigations that can be used in their work environment without compromising patient safety or transferring undue workload to other nurses on the shift.

The 2016-17 national nursing survey identified several effective fatigue mitigations (see Table 2). However, having had fatigue management education was not associated with reduced likelihood of fatigue-related outcomes. On the other hand, we have no information about the type of training nurses had received. A small intervention trial with nurses, that included an educational component and selected workplace strategies, resulted in increased sleep and fewer clinical errors [34].

[3] Assessing the risks associated with fatigue hazards can be challenging because fatigue can:

- diminish almost all aspects of nurses' ability to perform usual nursing tasks (see checklist 2, Appendix B);
- reduce nurses' capacity to respond to unexpected increases in task complexity, such as occur in emergency situations;
- for intermediate levels of fatigue, it is not yet clear how the different causes of fatigue should be weighted (for example, sleep debt versus trying to work when the circadian body clock is promoting sleep).

Table 2: Examples of planned and on-the-day mitigations

Planned Mitigations Reduce the likelihood of nurses being fatigued at work	**On-the-Day Mitigations** Minimise the consequences when a nurse is fatigued at work
Fatigue and shift work education/training	Workplace napping [b]
Better roster design [a] • shift choice • more nights/week with sleep 11pm to 7 am • more nights/week fully rested	Share/reduce workload • Increased workload for others?
Reduce workload • improve skill level • more staff	Finish early • consequences for others (increased workload, call-back)
Policies for • calling in too fatigued to start or continue a shift (how, consequences) • workplace napping (when, where, how) [b] • managing staff with chronic sleep problems	
Access to [a] • a rest area at work • healthy food at all times • EAP programmes	
Healthy workforce	

[a] Mitigations found to be effective in the 2016-2017 national nursing survey

[b] Appendix E gives guidelines for safe workplace napping

Rostering is the most commonly-used planned mitigation for FSMS. However, roster change can involve considerable disruption for the unit and for nurses lives outside of work. Roster change is only

Scientific Principles for Roster Design

The perfect roster is permanent day work with unrestricted sleep at night.

Better roster design focuses on:

- providing adequate sleep opportunities:
  - how fast is sleep debt building up?
  - how long since the last opportunity for 2 consecutive nights of unrestricted sleep?
- limits on continuous work (fatigue from time awake and time-on-task)
  - shift length
  - breaks during shifts
  - workplace naps
- predictable rosters (covering on-call and unplanned call-back)
  - knowing ahead of time helps nurses to arrive well-rested and fit for work
- fair distribution of weekends off
  - balance between work and non-work life matters

recommended if there is evidence that aspects of the roster are causing a fatigue hazard and the roster change is expected to reduce that hazard.

At Capital and Coast DHB, roster design is currently done at the unit level, usually by the Associate Charge Nurse, and signed off by the Charge Nurse. The only specific requirement is that rosters must adhere to the MECA guidelines. They are checked intermittently by the NZNO Delegate and subject to audit.

People with responsibility for roster design and audit should have appropriate fatigue and shift work management training to undertake these roles.

The effects of any roster change will be evident in the ongoing FSMS monitoring and should be tracked to ensure that the change has indeed been effective in reducing the fatigue hazard, and that there are no unintended negative consequences.

The effectiveness of mitigations is assessed by the ongoing monitoring of fatigue data (Step 1), thus closing the FSMS process loop

3.2 Safety Assurance Processes

Beyond the day-to-day functioning of the FSMS processes loop, there is a second set of processes in the FSMS, known as the Safety Assurance loop. This second loop takes a longer-term and broader view of fatigue and shift work management in the overall activities of the DHB and the health sector. It tracks safety performance indicators across time, to check that the FSMS processes are delivering an acceptable level of fatigue risk. This makes the Safety Assurance processes able to identify fatigue hazards that emerge more gradually or seasonally. They also identify new hazards that can arise for example due to new policies, changes in funding, new services, etc. The Safety Assurance processes help the FSMS to continuously improve and be resilient in the face of change.

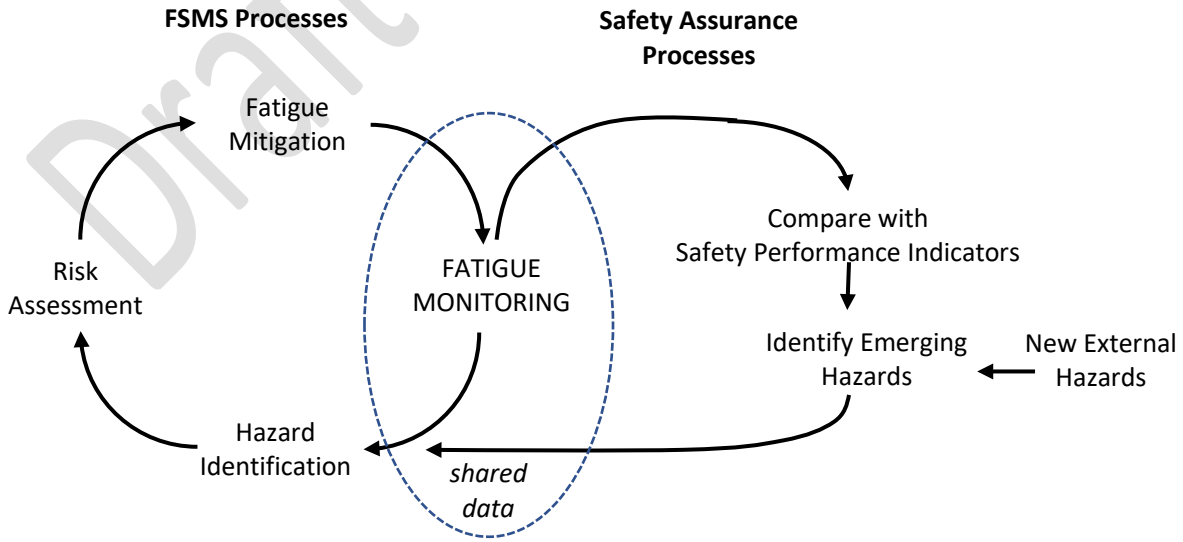

Figure 7: Showing the linkages between the FSMS Processes and the Safety Assurance Processes

Figure 7 shows the linkages between the FSMS processes and the Safety Assurance processes. They share safety performance indicators based on the fatigue monitoring data (for example, acceptable hazard assessment matrix scores, rates of overtime use, percentage of shifts extended by more than 30 minutes, regularity of two consecutive recovery nights for sleep, fatigue reports).

The Safety Assurance processes provide independent audit of the performance of the FSMS processes on a regular cycle, using agreed data provided by the Fatigue Safety Action Group (FSAG; see Section 3.3). To maintain the integrity of the audit process, members of the FSAG should not be on the audit team but are responsible for providing information as requested by it. It is important that members of the audit team have appropriate fatigue and shift work management education.

3.3 Who is Responsible for the Day-to-Day Running of the FSMS?

At Capital and Coast DHB, each unit has its own local Data Council that owns and manages its information and is charged with finding solutions and mitigating risks. The Data Councils are highly variable between units and have the advantage that they use the unit's expertise to identify hazards and develop targeted solutions and mitigations.

The John Hopkins Hospital (Baltimore) proposes a broader 6-point approach to patient safety hazard identification and management [35].

1. Identify a hazard to patient safety
2. Report the hazard in a patient safety reporting system
3. Analyse the report with a multidisciplinary team
4. Mitigate the hazard and educate practitioners
5. 'Good Catch' award for the individual (or group) who reported and helped mitigate the patient safety hazard
6. Follow up to verify sustained quality improvement

They emphasise the importance of having a designated multidisciplinary team (for example, physicians, clinical department administrators, nurses, risk managers, equipment specialists, managers of clinical operations and information technology) to review reported hazards and provide feedback to the specific clinical unit or patient care area. They also recommend:

- that the individual who reported the hazard presents the case, which recognises the importance of timely feedback to nurses who report and that their input is valued; and
- participation of everyone who is familiar with the event context and can help to tease out the various human and organisational factors involved.

Another unique feature of this approach is the 'Good Catch' awards, which reinforce that reports are appreciated as a contribution to safety.

The John Hopkins approach is very similar to recommended practice for fatigue risk management systems in commercial aviation, which is to establish a Fatigue Safety Action Group (FSAG) with responsibility for coordinating all fatigue risk management activities [36].

The FSAG should include representatives of all stakeholder groups, with input from other individuals as needed, to ensure that it has appropriate access to scientific, statistical, and medical expertise. Inclusion of all stakeholders is an important strategy for promoting engagement with the FSMS.

The principal functions of the FSAG are to:

- assist in the development of the FSMS;
- lead FSMS implementation;
- oversee the ongoing operation of the FSMS processes;
- contribute as appropriate to the FSMS safety assurance processes (Section 3.2);
- maintain the FSMS documentation (Section 3.4); and
- be responsible for ongoing FSMS training and communications (Section 3.5).

An example of terms of reference for an FSAG can be found in Appendix F.

At Capital and Coast DHB, the role of the FSAG is proposed to fit into the current responsibilities of the Health and Safety Team, which covers the whole DHB. This model will require careful consideration of communications, and distribution of responsibilities for fatigue and shift work management, between Data Councils in each unit and the Health and Safety Team.

The Health and Safety Team has a chain of escalation up to the DHB Board. Those people with responsibilities at each level may need appropriate fatigue and shift work management education to enable them to assume their roles and responsibilities in this context.

Thought needs to be given to how the FSMS safety assurance processes would work in this model. Who would provide independent audit of the Health and Safety Team on a regular cycle, to ensure the effectiveness and ongoing improvement of its FSMS activities?

3.4 FSMS Policy and Documentation

Policy

The FSMS policy defines principles, responsibilities, and safety performance indicators (SPIs) for fatigue and shift work management and records the commitment of the DHB to providing adequate resourcing to achieve those SPIs.

In discussions with the NZNO and Capital and Coast DHB, there was consensus that there should be a national policy for fatigue and shift work management in DHBs, since they have the same responsibilities, unions and MECA. Based on this input and practice in other industries, is recommended that the national FSMS policy addresses the following areas.

1. The DHBs recognise the following.
    1.1 Fatigue is a physiological state of reduced physical and mental performance capability caused by sleep loss, extended time awake, working and sleeping at sub-optimal times in the circadian body clock cycle, and workload.

1.2 Fatigue impairs nursing performance and can degrade patient care, increase the risk of injury to patients and nurses, and affect the health, wellbeing, and retention of nurses.
1.3 Shift work is a cause of fatigue, which cannot be eliminated in 24/7 services and must be managed.
1.4 Managing fatigue and shift work is a shared responsibility of management, health and safety representatives, nursing staff, and other staff whose decisions can affect nurses' fatigue and its impact on patient safety and nurses themselves.

2. The DHBs commit to the following.
   2.1 Adequate resourcing will be provided to develop and maintain an effective fatigue and shift work management system (FSMS).
   2.2 The FSMS has defined safety objectives and a list of agreed safety performance indicators to measure how well it is achieving those objectives. These can be updated as part of the continuous improvement of the FSMS.
   2.3 There are clear lines of accountability for all aspects of the FSMS.
   2.4 The aims and activities of the FSMS are communicated to all the relevant areas and levels of the organisation.
   2.5 Nurses and all other staff involved in the FSMS will receive appropriate education and training to enable them to fulfil their roles in the FSMS.
   2.6 This policy will be reviewed periodically to ensure that it remains relevant and appropriate.

The FSMS is relevant to, and should be integrated with union agreements, safe staffing initiatives, and other health, safety and wellness programmes. There are three pillars of health and wellness: diet, exercise and sleep.

Documentation

The Documentation provides a record of what the FSMS is and does (whereas the Policy describes its principles and objectives). It brings together in one place all the information needed for auditing the FSMS, including the following.

a. The FSMS policy.
b. A full description of the FSMS processes and procedures (what needs to be done on a regular basis), and who is responsible for them (who does what).
c. FSAG activities and outputs, including findings from collected data, recommendations, and actions taken.
d. The data tracking agreed safety performance indicators.
e. The FSMS engagement processes, including education and training programs with their attendance records.

Documentation is a routine activity for Health and Safety Teams.

3.3 FSMS Engagement Processes

Fatigue and shift work management training is vital to the success of FSMS. Everyone whose role in the DHB can influence the FSMS needs to have an appropriate level of training. This includes nurses, roster designers, those involved in the operation of the FSMS processes and safety assurance processes, and the people responsible for overall risk assessment and resource allocation in the DHB. It also includes senior management, in particular the executive accountable for the FSMS, and decision-makers in health and

safety and human resources. Training in fatigue and shift work management is also recommended for NZNO and PSA delegates.

The content of training programs should be adapted to make sure that each group has the knowledge and skills they need for their role in the FSMS.

As part of the Safer Nursing 24/7 project a range of on-line training materials are being developed. This will include materials for training for all nurses (and to be included as a part of orientation for new staff) that can be credited towards the 60 hours of professional development training required by the Nursing Council. Core components of the training will include responsibilities under the HASW Act in relation to managing fatigue and their role in the FSMS, the basic science of shift work and fatigue, risks associated with shift work, and personal strategies for managing shift work and fatigue. The training will be developed iteratively and will stem from on-going discussions with DHBs to determine the needs of different groups. Future iterations of the training will incorporate information on the Code of Practice and fatigue risk management in nursing, as it is implemented.

Good communications are also vital to the success of FSMS. It is recommended that DHBs have an FSMS communications plan that keeps all staff informed about their responsibilities in the FSMS, the activities of the FSAG, and where they can access reliable additional information if they are interested. The FSMS training programs are clearly an important part of the communication plan. However, training generally occurs at fairly long intervals (for example annually). There also needs to be ongoing communication with nurses and other involved staff to keep fatigue and shift work issues 'on the radar' and to encourage their continuing commitment. Maintaining the communications is normally a responsibility of the FSAG.

Having a range of communication channels is recommended, including electronic media (websites, on-line forums, e-mail), newsletters, bulletins, seminars, periodic poster campaigns in strategic locations, etc. Cooperation between DHBs and unions in the development and dissemination of communications is strongly recommended.

4. Implementation

4.1 Planning

Implementing an FSMS requires an investment in staff time. People are required who have appropriate organisational knowledge, fatigue and shift work expertise, and understanding of the hazards and risks in each working environment. Given the HASW Act requirements for engagement with workers (Part 3 s 60) and the role of collective employment agreements and other health, safety and wellbeing initiatives in FSMS, union(s) should be represented. A different mix of expertise may be needed to design the FSMS than is needed to implement it and run the FSMS processes (tasks of the FSAG).

When deciding to implement an FSMS, the first step is to clearly identify its scope, i.e., the group(s) of nurses, and possibly other staff, to whom it applies. The next step is to undertake a 'gaps analysis' to identify:

1) elements of the FSMS that are already available in existing DHB systems and processes;
2) existing systems and processes that could be modified to meet the needs of the FSMS (to minimise 're-inventing the wheel'); and
3) where new systems and processes are needed for the FSMS.

The FSMS is not intended to function in isolation. Working through the gaps analysis is also a good time to consider how the FSMS will be integrated with the DHB's other safety management systems, how it may impact on other parts of the organisation, and for identifying the lines of accountability. Examples include:

- Who does the FSAG report to?
- Where does responsibility lie for risk assessment and selection of mitigations?

  Factors to be considered are how to deal with hazards requiring immediate attention, those expected to be high risk, those requiring more complex or expensive mitigations, and those for which the mitigations will have flow-on effects for other parts of the organisation. Regardless, the FSAG should be recognised as a major fatigue and shift work management resource for the DHB.

- Who is responsible for setting the fatigue safety performance indicators and for auditing the activities of the FSAG?

By the end of the planning phase, there should be a detailed proposal for how the FSMS will work. This describes all the components, procedures, and linkages into other systems within the DHB and includes a draft of the FSMS Policy and the FSAG terms of reference.

Approval of the proposal and allocation of funding lead to the next stage, which is the initial implementation of the FSMS.

4.2 Implementing the Initial Version of the FSMS

The approval of the required resources (people and financial) launches this stage. The FSAG is established, with appropriate training as required, and responsibility for actioning the agreed FSMS proposal is transferred to it (progressively if appropriate).

This is sometimes viewed as an FSMS trial, in that unforeseen issues may necessitate some modification of the initial proposal. The procedure for dealing with any changes needs to be clear. The FSAG may need to consult with the individual(s) to whom they are directly accountable and major changes with cost implications may require approval further up the chain of escalation.

Education/training needs to commence as soon as possible to ensure that all involved staff are aware of their roles in FSMS and have appropriate knowledge to succeed in those roles. An essential part of this initial training, and all initial FSMS communications to staff, is raising the awareness of the importance of fatigue, and improving the fatigue safety reporting culture of the DHB.

Once the FSMS processes and the Safety Assurance Processes are operational, the effectiveness of the FSMS can be evaluated and improved on an ongoing basis. At this point the FSMS can be considered fully functional. There should be an agreed timeframe for achieving full implementation.

4.3 Generating Culture Change

The current US initiative by Steege et al. [3] undertook an exploratory interview study with 22 nurses working in intensive care and medical-surgical units in a large academic medical centre in the Midwest, to explore facilitators and barriers to nurse coping and fatigue [16]. They identified a new construct defined as '*supernurse*' with subthemes that include: extraordinary powers used for good; cloak of invulnerability; no sidekick; Kryptonite, and an alter ego. They argue that these values, beliefs, and behaviours define specific aspects of nursing professional culture that can act as barriers to fatigue risk management systems and to achieving safety culture in hospitals.

In a second study, the same US group conducted semi-structured interviews with 10 nurse managers from 2 hospitals and 11 nurse executives from hospitals across a Midwestern State, to evaluate current implementation of fatigue risk management systems in nursing [17]. They concluded that the adoption of evidence-based policies is both limited and variable (depending on the policy). While nurse leaders rate nurse fatigue as an important issue that has negative consequences, the social norms around fatigue have hindered '*elevation of this topic to trigger sweeping organisational change*'. The authors identify raising the visibility of fatigue across an organisation as a critical first step. This work highlights the vital role of the FSMS communications strategy from the very beginning of FSMS implementation.

The 2016-17 national nurses survey included two free text fields where nurses could add their written comments about issues to do with fatigue and shift work. At the time of writing of this draft version of the Code of Practice, analysis of these comments is ongoing. They are expected to provide context around some of the cultural issues relevant to implementation of FSMS in DHBs.

4.4 Concluding Remarks

Fatigue is inevitable in hospital nursing, because shift work is required to provide 24/7 cover. There are well-documented adverse effects of fatigue and shift work on patient safety and quality of care, as well as on the health, safety, and retention of nurses. Advances in scientific knowledge and safety management systems can be used to reduce these adverse effects. The approach described here is designed to help DHBs and nurses meet their obligation under the HASW Act to reduce fatigue as a cause of hazards 'as far as is reasonably practicable'. It is anticipated that details of FSMS will be adapted to best suit local conditions in different DHBs, but that the overarching principles are common to all.

5. Acknowledgments

The following people had a key role in the 2016-17 survey and developing the Code of Practice:

Safer Nursing 24/7 Project Research Team

- Professor Philippa Gander, Sleep/Wake Research Centre, Massey University
- Dr Karyn O'Keeffe, Sleep/Wake Research Centre, Massey University
- Professor Annette Huntington, School of Nursing, Massey University
- Adjunct Associate Professor Léonie Walker, School of Health Sciences, Massey University
- Dr Jinny Willis, New Zealand Nurses Organisation

Safer Nursing 24/7 Project Advisory Group

- Andrea McCance, Director of Nursing and Midwifery, Capital & Coast DHB.
- Belinda Bennett, Operations Manager, Surgery, Women & Children, Capital & Coast DHB.
- Toni Dal Din, Director of Nursing, Mental Health & Intellectual Disability Service, 3DHB.
- Pamela Doole, Manager, Strategic Policy, Nursing Council of New Zealand.
- Michele Halford, Executive Leader Nursing, Wairarapa DHB.
- Lynley Mulrine, Industrial Services Lead Organiser, Southern Region, NZNO.
- Shannon Lake, Te Rūnanga Auckland Representative; Registered Nurse, Counties Manukau DHB.
- Monina Hernandez, President of the Filipino Nurses Association of New Zealand.
- Trish Walton, After Hours Duty Nurse Manager, Southern DHB.
- Sally Houliston, Nurse Consultant, Workforce Development, Hawkes Bay DHB.
- Jeroen Douwes , Director, Centre for Public Health Research, Massey University
- Jill Dorrian, Associate Professor/Co-Director, Behaviour-Brain-Body Research Centre, University of South Australia
- Valerie O'Keeffe, Senior Consultant, Work, Health and Safety, University of South Australia

Funding for the Safer Nursing 24/7 project was provided by the Health Research Council (HRC 16/133), with additional funding from the New Zealand Lottery Grants Board (R-LHR-2016-25977), the McCutchan Trust, and the Massey University Research Fund.

6. Appendix A: Full Scoring Sheet for the Fatigue Hazard Assessment Matrix

These questions apply to the last 7 days	**Scores**			**Your score**
	1	2	3	
How many hours in total did you work?	≤40	40+ to 48	>48	
How many times did you work at least 30 minutes longer than your usual shift length?	none	≤50% of shifts	>50% of shifts	
How many times did you have a break shorter than 9 hours between two duty shift periods? *Include periods when you were on call, but were not called in, as duty time.*	0	1	>1	
How often did you work a night shift? *Include shifts of any length between 11pm and 7am and shifts that ended after 11pm.*	0	1-2	>2	
How many times did you have at least a 24-hour break between duty shift periods?	>2	1	0	
Were changes made to your roster? *Through work beyond rostered hours, additional duties (overtime) or call-back etc.* If yes, were these changes requested by you?	no	Roster change requested	Roster change not requested	
On how many nights (including days off) were you able to sleep between 11pm and 7am?	6-7 nights	4-5 nights	0-3 nights	
On how many nights did you get enough sleep to be fully rested?	6-7 nights	4-5 nights	0-3 nights	
			Add up your total score	

7. Appendix B: Analysing the Role of Fatigue in Safety Events

The primary aim of investigating the role of fatigue in safety events is to identify how its occurrence or effects could have been mitigated, in order to reduce the likelihood of similar events in the future. There is no simple formula for evaluating the contribution of fatigue to a safety event. To establish that fatigue was a contributing factor, it has to be shown that;

- the person was in a fatigued state; and
- the person took particular actions or decisions that were causal in what went wrong; and
- those actions or decisions are consistent with the type of behaviour expected of a fatigued person.

Basic information can be collected for all fatigue reports and safety events, with more in-depth analyses reserved for events where it is more likely that fatigue was an important factor and/or where the outcomes were more severe.

7.1 Basic Information

To establish whether a person was likely to have been fatigued at the time of an event, four pieces of information are needed.

1. The time of day that the event took place. If it was in the window of circadian low (WOCL, 0200-0600), then fatigue may have been a factor.
2. Whether the person's normal circadian rhythm was disrupted (for example, if in the last 72 hours they worked at night).
3. How many hours the person had been awake at the time of the occurrence. (It may be more reliable to ask 'what time did you wake up from your last sleep period before the event?'). If this is more than 16 hours, then sleepiness may have been a factor.
4. Whether the 72-hour sleep history suggests a sleep debt. As a rough guide, if the average adult requires 7-8 hours of sleep per 24 hours, then a person who has had less than 21 hours sleep in the last 72 hours was probably experiencing the effects of a sleep debt. If information on sleep history is not available, duty history can provide information on sleep opportunities.

7.2 Investigating Fatigue in Depth

If answers to the four questions above suggest that the person was fatigued at the time of the event, then more in-depth investigation requires looking at whether they took particular actions or decisions that were causal in what went wrong, and whether those actions or decisions are consistent with the type of behaviour expected of a fatigued person. The following two checklists provide one example of how this can be done

Checklist 1 is designed to establish whether the person was in a fatigued state, based on a series of questions or probes that address key aspects of fatigue. The answer to each question is compared to the best-case response, in order to build an overall picture of the fatigue hazard. Any departure from the best-case response indicates increased risk of fatigue

Checklist 2 is designed to establish whether the unsafe action(s) or decision(s) were consistent with the type of behaviour expected of a fatigued person.

Checklist 1: Establishing the Fatigued State

Questions	Best Case Responses	Investigator's Notes
Quantity of Sleep establish whether or not there was a sleep debt		
How long was last consolidated sleep period?	7.5 to 8.5 hours	
Start time?	Normal circadian rhythm, late evening	
Awake Time?	Normal circadian rhythm, early morning	
Was your sleep interrupted (for how long)?	No	
Any naps since your last consolidated sleep?	yes	
Duration of naps?	Had opportunity for restorative (1.5-2 hrs) or strategic (20 min) nap prior to start of late shift	
Describe your sleep patterns in the last 72 hours. (Apply sleep credit system)	2 credits for each hour of sleep; loss of one credit for each hour awake - should be a positive value	
Quality of Sleep establish whether or not sleep was restorative		
How did the sleep period relate to the individual normal sleep cycle i.e., start/finish time?	Normal circadian rhythm, late evening/early morning	
Sleep disruptions?	No awakenings	
Sleep environment?	Proper environmental conditions (quiet, comfortable temperature, fresh air, own bed, dark room)	
Sleep pathologies (disorders)	None	
Work History establish whether hours worked and type of activities involved had an impact on sleep quantity and quality		
Hours on shift and/or on call prior to the occurrence?	Situation dependent - hours on shift and/or on call and type of work that ensure appropriate level of alertness for the task	
Work history in preceding week?	Number of hours on shift and/or on call and type of work that do not lead to a cumulative fatigue	

Checklist 1: Establishing the Fatigued State (continued)

Questions	Best Case Responses	Investigator's Notes
Irregular Schedules **establish whether the scheduling was problematic with regards to its impact on quantity and quality of sleep**		
Was the person a shift worker (working through usual sleep times)?	No (The circadian body clocks and sleep of shift workers do not adapt fully)	
If yes, was it a permanent shift?	Yes -days	
If no, was it rotating (vs irregular) shift work?	Yes - Rotating clockwise, rotation slow (1 day for each hour delayed), night shift shorter, and at the end of cycle	
How are overtime or double shifts scheduled?	Scheduled when people are in the most alert parts of the circadian body clock cycle (late morning, mid-evening)	
Scheduling of critical safety tasks?	Scheduled when people are in the most alert parts of the circadian body clock cycle (late morning, mid-evening)	
Has the person had training on personal fatigue mitigation strategies?	Yes	

Checklist 2: Establishing the Link between Fatigue and the Unsafe Act(s)/Decision(s)

Performance Indicators	Investigator's Notes
Attention	
Overlooked sequential task element	
Incorrectly ordered sequential task element	
Preoccupied with single tasks or elements	
Exhibited lack of awareness of poor performance	
Reverted to old habits	
Focused on a minor problem despite risk of major one	
Did not appreciate gravity of situation	
Did not anticipate danger	
Displayed decreased vigilance	
Did not observe warning signs	
Memory	
Forgot a task or elements of a task	
Forgot the sequence of task or task elements	
Inaccurately recalled operational events	
Alertness	
Succumbed to uncontrollable sleep in form of micro-sleep, nap, or long sleep episode	
Displayed automatic behaviour syndrome	
Reaction Time	
Responded slowly to normal, abnormal or emergency stimuli	
Failed to respond altogether to normal, abnormal or emergency stimuli	
Problem-Solving Ability	
Displayed flawed logic	
Displayed problems with arithmetic, geometric or other cognitive processing tasks	
Applied inappropriate corrective action	
Did not accurately interpret situation	
Displayed poor judgment of distance, speed, and/or time	

8. Appendix C: Example of a Fatigue Reporting Form

Confidential Fatigue Report Form

NAME

WHEN DID IT HAPPEN? Date Time

Describe the roster on which the event happened

Describe the shift on which the event happened (rostered, actual)

WHAT HAPPENED?

Describe how you felt (or what you observed)

Please circle how you felt

1	Fully alert, wide awake	5	Moderately let down, tired
2	Very lively, somewhat responsive, but not at peak		
3	OK, somewhat fresh	6	Extremely tired, very difficult to concentrate
4	A little tired, less than fresh	7	Completely exhausted

WHY DID IT HAPPEN?

Fatigue prior to duty	Yes / No	How long had you been awake when the event happened?	hrs mins
Home	Yes / No		
Shift itself	Yes / No	How much sleep did you have in the 24 hrs before the event?	hrs mins
Personal	Yes / No		
		How much sleep did you have in the 72 hrs before the event?	hrs mins

Other comments

WHAT DID YOU DO? Actions taken to manage or reduce fatigue

WHAT COULD BE DONE? Suggested corrective actions

8. Appendix D: Capital and Coast DHB's Hazard Reporting and Risk Assessment Matrix

Capital & Coast District Health Board
Ūpoko ki te Uru Hauora

Hazard Reporting and Risk Assessment Matrix

(The hazard identifies potential damage, harm or loss that is then risk rated)

Instructions for Use

1. **Consequence / Severity Scores** (C) - Using table 1 choose the most appropriate domain for the identified risk from the left hand side of the table. Then work along the columns in same row with the examples of descriptors to assist in identifying a consequence / severity score, on the scale of 1 to 5, which is the number given at the top of the column.
2. **Likelihood Score** (L) - Using table 2 assess the likelihood of the consequence occurring/re-occurring, which is also given a score of 1 to 5, the higher the number the more likely it is the consequence will occur.
3. **Risk Score** - Using table 3, calculate the risk score by multiplying the consequence by the likelihood: = C (consequence) x L (likelihood) = R (risk score)
4. **Risk Rating Index** – Having identified your risk score refer to table 4 to determine the appropriate level of risk and timescales for actions

Table 1 - Consequence Score (Severity Levels) and Examples of Descriptors
Choose the most appropriate domain for the identified risk from the left hand side of the table. Then work along the columns in same row to assess the severity of the risk on the scale of 1 to 5 to determine the consequence score, which is the number given at the top of the column.

Risk Category	1 Negligible	2 Minor	3 Moderate	4 Major	5 Catastrophic
Patient Care	Could potentially lead to: Minimal patient injuries resulting in in convenience or delayed discharge that is relate to the process of healthcare and differs from the expected outcome. Temporary minor loss of function Medication error with no harm	Could potentially lead to: Permanent minor or temporary moderate loss of function that is related to the process of health care and differs from the expected outcome of that care. Wrong consumer or wrong procedure with risk of or actual minor harm Additional monitoring, investigations or minor interventions as a result of the incident i.e. first aid required	Could potentially lead to: Permanent moderate or temporary major loss of function that is related to the process of healthcare and differs from the expected outcome of that care. Wrong consumer or wrong procedure with risk of or actual moderate harm Fall resulting in fracture Any of the following as a result of the incident: Transfer to higher level of care, including hospitalisation Increased length of stay (>one day) Surgical or other significant intervention required	Could potentially lead to: Permanent major or temporary severe loss of function that is related to the process of healthcare and differed from the expected outcome of that care. That indicates a system failure requiring independent enquiry Wrong consumer or wrong procedure with risk of or actual major harm Retained item with immediate removal Misadministration of radioactive materials Unanticipated cardio-pulmonary resuscitation resulting from the process of health care Community suicide by current mental health consumer within 28 days of contact with service Missing person with a risk of serious harm to self or others	Could potentially lead to: Death or permanent severe loss of function that is related to the process of health care and differs from the expected outcome of that care. That indicates a system failure that may result in external enquiry Wrong consumer or wrong procedure with risk of or actual severe harm Suicide as inpatient Blood component given to wrong consumer Retained item with delayed removal Child/infant abduction or discharge to the wrong family Failure of essential service with risk of severe consumer consequences Wrong consumer or wrong procedure with risk of or actual severe harm
Health & Safety	Could potentially lead to: Minimal injury requiring no/minimal intervention or treatment	Could potentially lead to: Minor injury or illness, requiring minor intervention Time off work for less than 3 days	Could potentially lead to: Moderate injury requiring professional intervention Time off work for 4-14 days Notifiable Event reportable to WorkSafe	Could potentially lead to: Major injury leading to long-term incapacity/ disability Time off work for more than 14 days Notifiable Event reportable to WorkSafe	Could potentially lead to: Multiple permanent injuries or incident leading to death Notifiable Event reportable to WorkSafe
Service	Could potentially lead to: Minimal effect on service delivery. Minimal effect on infrastructure, records, IT systems or communication and minimal or no disruption to service delivery.	Could potentially lead to: Unplanned service delivery or programme delays localised to a department or community service. Localised damage to property, assets or records and restricted access to IT systems or communication.	Could potentially lead to: Unplanned restrictions to services and programmes. Temporary suspension of work due to damage to property, assets, records or access to IT or communication systems.	Could potentially lead to: Unplanned cessation of a service or programme availability with a possible flow on effect to other services. Restriction or damage of or prolonged service disruption to some property, utilities, records, IT data systems & communications.	Could potentially lead to: Unplanned cessation of a critical programme or service. Loss or permanent damage of property, major utilities, records, IT data systems and communications resulting in prolonged suspension of service delivery.

Table 1 - Consequence Score (Severity Levels) and Examples of Descriptors
Choose the most appropriate domain for the identified risk from the left hand side of the table. Then work along the columns in same row to assess the severity of the risk on the scale of 1 to 5 to determine the consequence score, which is the number given at the top of the column.

Risk Category	1 Negligible	2 Minor	3 Moderate	4 Major	5 Catastrophic
Reputational	Could potentially lead to: Low level publicity as a result of poor performance (such as targets or release of National SSE report). Ward / team level review	Could potentially lead to: Adverse publicity as a result of poor performance (such as targets or release of National SSE report). Internal inquiry undertaken at service level or organisation-wide level.	Could potentially lead to: Loss of public confidence at service level threatening service delivery. Internal serious event review conducted using external agency / personnel to assist.	Could potentially lead to: Service disruption Loss of staff confidence resulting in adverse publicity/union action.	Could potentially lead to: Major adverse publicity affecting service delivery and/or loss of public confidence. Political perception/intervention.
Legal	Could potentially lead to: A legal obligation will be breached and possibility that a compliant or claim will be made.	Could potentially lead to: A legal obligation will be breached and some possibility that a claim be made.	Could potentially lead to: A significant legal obligation will be breached and potential that a claim be made. Internal inquiry	Could potentially lead to: A significant legal will be obligation breached and potential for legal actions to be taken. Internal review assisted by external agency or personnel	Could potentially lead to: A significant legal will be obligation breached resulting in legal action by a third party. (e.g. Failure to meet DAP strategic objectives) Major enquiry by external agency
Financial	Could potentially lead to: Cost over-run or reduction in revenue >$0.1m. Temporary loss of or unplanned expenditure related to individual program/project but no net impact on budget.	Could potentially lead to: Cost over-run or reduction in revenue >$0.5m	Could potentially lead to: Cost over-run or reduction in revenue the lower of: >$1m or >4-7%	Could potentially lead to: Cost over-run or reduction in revenue the lower of: >$2m or >7-10% Unable to pay creditors. A fraud impacts on service delivery.	Could potentially lead to: Cost over-run or reduction in revenue the lower of: >$3m or >10% Unable to pay staff or finance critical services. Fraud impacts on service delivery.
Governance	Could potentially lead to: Board decision has potential to be unlawful or be challenged or not meet statutory obligations but there is opportunity to address the risk. Occasional adverse local publicity	Could potentially lead to: Failure to meet a strategic objective Periodic loss of public support Board decisions could be unlawful and could be challenged or there is potential that it will not meet its statutory obligations.	Could potentially lead to: Failure to meet a number of strategic objectives. Broadening adverse publicity at a local level , loss of consumer confidence Board is unlikely to meet its statutory obligations.	Could potentially lead to: Failure to meet a significant number of DAP strategic objectives. Sustained adverse publicity at a national level leading to external intervention Board decisions are unlawful or would be challenged (e.g. due to conflicts of interests).	Could potentially lead to: Failure to meet critical DAP strategic objectives Significant loss of public and minister confidence , and loss of reputation leading to external intervention

Table 2 - Likelihood Score
– What is the likelihood of the consequence occurring (re-occurring) / How often might it / does it happen

Likelihood	Incidence	Chance	Narrative
5 - Almost Certain	Weekly	90%	Is certain to occur, possibly frequently
4 - Likely	Monthly	75%	Is likely to occur in most circumstances
3 - Possible	Six-Monthly	50%	Will occur at some time
2 - Unlikely	Yearly	25%	May occur at some time
1 - Rare	3 Yearly	5%	Will occur only in exceptional circumstances

Table 3 - Risk Score & Grading = Consequence (Table 1) **X Likelihood** (Table 2)

Likelihood	5 Catastrophic	4 Major	3 Moderate	2 Minor	1 Negligible
5 - Almost Certain	25	20	15	10	5
4 - Likely	20	16	12	8	4
3 - Possible	15	12	9	6	3
2 - Unlikely	10	8	6	4	2
1 - Rare	5	4	3	2	1

Table 4 – Risk Rating Index

Risk Score	Grade	Timescales for Review of Risk Assessments (All risks are to be reviewed and the risk register updated monthly)
1 – 3	Low Risk	Quick, easy measures implemented immediately and further action planned for when resources permit. **Review risk assessment no later than six months**.
4 - 6	Medium Risk	Actions implemented **as soon as possible** but **no later than a year**. **Review risk assessment no later than three months.**
8 – 12	High Risk	Actions implemented as soon as possible and **no later than six months**. **Review risk assessment no later than two months**.
15 – 25	Extreme Risk	Requires **urgent action** where possible and where the score is **20 or 25 the Board is made aware of the risk. Review risk assessment no later than one month**.

9. Appendix E: Guidelines for Safe Workplace Napping

Workplace napping is an effective way of temporarily reducing fatigue and it can provide improved alertness and performance for several hours. It should not be required or used as a routine strategy for coping with work demands. Rather, it should be used as needed in response to unanticipated fatigue experienced at work.

- A nurse who needs to nap to stay safe at work is encouraged to submit a fatigue report so the FSAG can decide whether this is a one-off event or an indication that high fatigue levels are common and additional mitigations are needed.
- Workplace napping is not a tool for enabling extended shifts on a routine basis.
- Napping should occur during a nurse's break or after they have cleared it with the shift supervisor, to be sure that the nurse's absence does not increase fatigue risk for others on the shift.
- The shift supervisor should be informed when and where a nurse plans to nap.
- No more than 40 minutes should be spent trying to nap. It is the responsibility of the nurse to have a reliable method for waking up (e.g., a cell phone) at least 10 minutes prior to returning to work. This is to allow time from recovery from sleep inertia – the grogginess and disorientation that sometimes happens before someone is fully awake.
- If the nap is not during a scheduled break, the nurse should notify the shift supervisor when they are returning to work.
- Procedures for napping safely at work should be covered in fatigue management training.

Consideration should be given to providing a suitable place for nurses to nap prior to driving home after a shift, if they are concerned about driving fatigued.

In the 2016-17 national survey, 32.4% of nurses answered 'yes' to the question 'since becoming a nurse, have you ever fallen asleep while driving home from work'. 64.6% answered 'yes' to the question 'in the last 12 months, have you ever felt close to falling asleep at the wheel'.

10. Appendix F: Example of Terms of Reference for a Fatigue Safety Action Group (FSAG)

Purpose

The Fatigue Safety Action Group (FSAG) is responsible for coordinating all fatigue risk management activities at [insert DHB name]. This includes responsibility for gathering, analysing, and reporting on data that measures fatigue among nurses. The FSAG is also responsible for ensuring that the FSMS meets the safety objectives and safety performance indicators (SPIs) defined in the FSMS Policy, and that it meets regulatory requirements. The FSAG exists to improve safety and does not get involved in industrial issues.

Terms of Reference

The FSAG is directly responsible to [named manager] and reports through [specified channels]. Its membership will include at least one representative of each of the following groups: management, rostering, health and safety, and nurses, with other specialists as required.

The tasks of the FSAG are to:

- develop, implement, and monitor processes for the identification of fatigue hazards;
- ensure that comprehensive risk assessment is undertaken for fatigue hazards;
- develop, implement, and monitor controls and mitigations as needed to manage identified fatigue hazards;
- develop, implement, and monitor effective FSMS performance metrics;
- cooperate with the [appropriate parts of the organisation] to develop, implement and monitor FSMS safety assurance processes, based on agreed SPIs and targets;
- be responsible for the design, analysis, and reporting of studies that measure nurses' fatigue, when such studies are needed for the identification of hazards, or for monitoring the effectiveness of controls and mitigations (such studies may be contracted out but the FSAG is responsible for ensuring that they are conducted with the highest ethical standards, meet the requirements of the FSMS, and are cost-effective);
- be responsible for the development, updating, and delivery of FSMS education and training materials (these activities may be contracted out but the FSAG is responsible for ensuring that they meet the requirements of the FSMS and are cost-effective);
- ensure that all relevant personnel receive appropriate FSMS education and training, and that training records are kept as part of the FSMS documentation;
- develop and maintain strategies for effective communication with all stakeholders;
- ensure that nurses and others receive responses to their fatigue reports;
- communicate fatigue risks and the performance of the FSMS to senior management;
- develop and maintain the FSMS intranet site;
- develop and maintain the FSMS documentation;
- ensure that it has adequate access to scientific and medical expertise as needed, and that it documents recommendations made by these specialist advisors and the corresponding actions taken;
- keeps informed of scientific and practical advances in fatigue risk management principles and practice;
- manage effectively and be accountable for FSMS resources.

The FSAG will meet monthly. Minutes will be taken during meetings and distributed within 10 working days after each meeting. The FSAG will present an annual budget request in [designated part of the financial cycle] and an annual report of all expenditures.

Note: there may be other requirements in relation to the Health Practitioners Competency Assurance Act that the FSAG needs to take into account.

11. References

1. Australian Civil Aviation Safety Authority, *Biomathematical Fatigue Models: Guidance Document* 2014.
2. Oster H, et al., *The functional and clinical significance of the 24-hour rhythm of circulating glucocorticoids.* Endocrine Reviews, 2017. **38**(1): p. 3-45.
3. Steege L and Pinekenstein B, *Addressing occupational fatigue in nurses: a risk management model for nurse executives.* The Journal of Nursing Administration, 2016. **46**(4): p. 193-200.
4. International Air Transport Association, International Civil Aviation Organisation, and International Federation of Airline Pilots' Associations, *Fatigue Management Guide for Airline Operators. Second Edition 2015*. 2015, International Air Transport Association: Montreal.
5. Association, A.M., *National Code of Practice- Hours of Work, Shiftwork and Rostering for Hospital Doctors*. 2016.
6. Gold DR, et al., *Rotating shift work, sleep, and accidents related to sleepiness in hospital nurses.* American Journal of Public Health, 1992. **82**(7): p. 1011-1014.
7. Scott LD, et al., *Effects of critical care nurses' work hours on vigilance and patients' safety.* American Journal of Critical Care, 2006. **15**(1): p. 30-37.
8. Rogers AE, et al., *The working hours of hospital staff nurses and patient safety.* Health Affiars (Millwood), 2004. **23**(4): p. 202-212.
9. Trinkoff AM, et al., *Nurses' work schedule characteristics, nurse staffing, and patient mortality.* Nursing Research, 2011. **60**(1): p. 1-8.
10. Olds DM and Clarke SP, *The effect of work hours on adverse events and errors in health care.* Journal of Safety Research, 2010. **41**(2): p. 153-162.
11. Trinkoff AM, et al., *Work schedule, needle use, and needlestick injuries among registered nurses.* Infection Control and Hospital Epidemiology, 2007. **28**(2): p. 156-164.
12. Lipscomb JA, et al., *Work-schedule characteristics and reported musculoskeletal disorders of registered nurses.* Scandanavian Journal of Work, Environment and Health, 2002. **28**(6): p. 394-401.
13. Stimpfel AW and Aiken LH, *Hospital staff nurses' shift length associated with safety and quality of care.* Journal of Nursing Care Quality, 2013. **28**(2): p. 122-129.
14. Griffiths P, et al., *Nurses' shift length and overtime working in 12 European countries: the association with perceived quality of care and patient safety.* Medical Care, 2014. **52**(11): p. 975-981.
15. Scott LD, et al., *The relationship between nurse work schedules, sleep duration, and drowsy driving.* Sleep, 2007. **30**(12): p. 1081-1087.
16. Steege LM, et al., *Adressing occupational fatigue in nurses: Current state of fatigue risk management in hospitals, Part 1.* The Journal of Nursing Administration, 2017. **47**(9): p. 426-433.
17. Steege LM, et al., *Adressing occupational fatigue in nurses: Current state of fatigue risk management in hospitals, Part 2.* The Journal of Nursing Administration, 2017. **47**(10): p. 484-490.
18. Gu F, et al., *Total and cause-specific mortality of U.S. nurses working rotating night shifts.* American Journal of Preventive Medicine, 2015. **48**(3): p. 241–252.
19. Brown DL, et al., *Rotating nght shift work and the risk of ischemic stroke.* American Journal of Epidemiology, 2009. **169**(11): p. 1370-1377.
20. Pan A, et al., *Rotating night shift work and risk of type 2 diabetes: two prospective cohort studies in women. .* PLoS Medicine / Public Library of Science, 2011. **8**(12): p. e1001141.
21. Schernhammer ES, et al., *Rotating night Sshifts and risk of breast cancer in women participating in the Nurses' Health Study.* Journal of the National Cancer Institute, 2001. **93**(20): p. 1563-1568.
22. Schernhammer ES, et al., *Night-shift work and risk of colorectal cancer in the Nurses' Health Study.* Journal of the National Cancer Institute, 2003. **95**(11): p. 825-828.
23. Hirshkowitz M, et al., *National Sleep Foundation's sleep time duration recommendations: methodology and results summary.* Sleep Health, 2015. **1**(1): p. 40-43.

24. Mihaere KM, et al., *Obstructive sleep apnea in New Zealand adults: prevalence and risk factors among Maori and non-Maori.* Sleep, 2009. **32**(7): p. 949-56.
25. Belenky, G., et al., *Patterns of performance degradation and restoration during sleep restriction and subsequent recovery: a sleep dose-response study.* J. Sleep Res., 2003. **12**(1): p. 1-12.
26. Folkhard S, *Do permanent night workers show circadian adjustment? A review based on the endogenous melatonin rhythm.* Chrolobiology International, 2008. **25**: p. 215-224.
27. Buijs R, et al., *Peripheral circadian oscillators: timing and food*, in *Chronobiology: Biological Timing in Health and Disease*, G. MU, Editor. 2013, Elsevier: Oxford, UK. p. 83-103.
28. Abbott SM, Malkani RG, and Zee PC, *Circadian dysregulation in mental and physical health*, in *Principles and Practice of Sleep Medicine*, R.T. Kyger M, Dement WC,, Editor. 2017, Elsevier: Philadelphia, PA. p. 405-413.
29. Knutsson A and Kemp A, *Shift work and diabetes – A systematic review.* Chronobiology International, 2014. **31**: p. 1146-1151.
30. International Civil Aviation Organisation, *Fatigue Management-related excerpts from Annex 6 to the Convention on International Civil Aviation.* 2011: Montreal, Canada.
31. Johns MW, *A new method for measuring daytime sleepiness: the Epworth sleepiness scale.* Sleep, 1991. **14**: p. 540-545.
32. Gander PH, et al., *Work patterns and fatigue-related risk among junior doctors* Occupational and Environmental Medicine, 2007. **64**: p. 733-738
33. International Civil Aviation Organisation, *Fatigue Risk Management Systems - Manual for Regulators*. 2012: Montreal.
34. Scott LD, et al., *An interventional approach for patient and nurse safety: a fatigue countermeasures feasibility study.* Nursing Research, 2010. **59**(4): p. 250-258.
35. Herzer KR, et al., *Patient safety reporting systems: sustained quality improvement using a multidisciplinary team and "good catch" awards.* Journal on Quality and Patient Safety, 2012. **38**(8): p. 339-347.
36. International Civil Aviation Organisation, *Manual for the Oversight of Fatigue Management Approaches, 2nd Edition*. 2016, International Civil Aviation Organisation: Montreal.