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Review Article

How much advance notice do workers need? A review and theoretical framework for determining advance notice periods for unpredictable work

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Abstract: Regulatory guidance materials for fatigue management typically advise that employees be provided with days or weeks of advance notice of schedules/rosters. However, the scientific evidence underpinning this advice is unclear. A systematic search was performed on current peer reviewed literature addressing advance notice periods, which found three relevant studies. A subsequent search of grey literature to determine the quality of evidence for the recommendation for advance notice periods returned 37 relevant documents. This review found that fatigue management guidance materials frequently advocated advance notice for work shifts but did not provide empirical evidence to underpin the advice. Although it is logical to suggest that longer notice periods may result in increased opportunities for pre-work preparations, improved sleep, and reduced worker fatigue, the current guidance appears to be premised on this reasoning rather than empirical evidence. Paradoxically, it is possible that advance notice could be counterproductive, as too much may result in frequent alterations to the schedule, particularly where adjustments to start and end times of the work period are not uncommon (e.g., road transport, rail). To assist organisations in determining the appropriate amount of advance notice to provide, we propose a novel theoretical framework to conceptualise advance notice.

Key words: Work scheduling, Sleep, Hours of work, Predictability, On-call

Introduction

Working time arrangements that involve unpredictable scheduling of work shifts, including standby, on-call or agency-allocated work, are used in many industries, including road and rail freight, emergency services, information technology, healthcare, and essential services[1–4]. Unpredictability for the purpose of this paper refers to working time arrangements where work can be allocated/scheduled or changed at short notice (i.e., with potentially hours or a limited number of days' advance notice). Unpredictable working arrangements may include on-call work (e.g., emergency services or utilities)[5], shift changes, or any other arrangements where start times and work shifts can be altered prior to commencement[6]. Typically, unpredictable working time arrangements are used to maximise productivity by minimising 'down time', thereby ensuring operational needs are met efficiently in environments with unpredictable workloads[2, 7]. While such work schedules carry obvious organisational benefits vis-à-vis operational

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flexibility and cost, some authors have suggested that this working time arrangement has the potential to disrupt an employee's opportunity to engage in appropriate anticipatory sleep-wake behaviour and/or meet family and social obligations[8, 9]. This potential disruption results from time periods where work is possible, but not certain (i.e., time spent on-call). As a result, various industries and regulatory bodies have promulgated fatigue management regulations and guidance materials[10–12] that recommend maximising the amount of advance notice employees are provided regarding future working times with the aim of managing fatigue-related risk.

Fatigue risk management guidelines typically comprise upper limits on a range of features associated with work-rest rules. These documents generally include guiding principles for roster dimensions including shift length (typically maximums of ~10–14 h), time of day (avoid work between midnight and dawn), weekly maxima (e.g. 56h+ associated with higher likelihood of fatigue), among others[12]. Some guidelines also include direction relating to unpredictable working time arrangements. Strategies include maximum duration of standby periods[13], classification of on-call periods as part of 'work time'[14], and maximum hours post-call during standby periods[15]. Importantly, many of the guidance materials accompanying regulatory regimes focus on stipulating minimum pre-work notice periods. Pre-work notice period guidelines range from requiring a minimum of 14 d advance notice[16] to a minimum notice period of 24-h[17]. The amount of advance notice about the exact working time arrangements given to workers is likely to be a significant contributing factor as to whether work is considered 'unpredictable' or not.

While an intuitively appealing idea, the provision of extended periods of advance notice is not well supported by a strong empirical evidence base. The aim of the current review was to synthesise and evaluate the evidence-base upon which current advance notice guidance is provided. In this paper, we: conducted a search of peer reviewed studies performed on the effect of advance notice periods on worker fatigue; reviewed a selection of current fatigue management guidance materials available across a range of industries and regulatory regimes; critically assessed the evidence base supporting these recommendations.

In addition to the review components of this paper, we also present a novel theoretical framework with which to conceptualise the provision of advance notice for workers with unpredictable work schedules. This framework is based on the aforementioned review components and could be used to assist in determining an appropriate amount of advance notice to provide a given degree of certainty of future work timing and work context. Furthermore, we suggest a future research strategy to support evidence-based policy recommendations.

Methods

In line with our aims, this review was conducted in two parts:
1) a systematic search of the peer reviewed literature, and
2) a review of a selection of current industry guidance materials.

The aim of the peer reviewed literature search was to identify the available scientific evidence-base that could be used to underpin fatigue management guidance materials for organisations that address advance notice periods. The aim of the search of industry guidance materials was slightly different, and as such was conducted separately. The guidance material search was undertaken to identify what fatigue management advice is currently provided for organisations and industries where unpredictable or non-standard working arrangements are used. Ideally, the advice provided within current guidance materials would be based on the studies identified in the first search. Methods are provided for both searches.

Peer reviewed literature search

Design

This systematic search of the peer reviewed literature was conducted in line with the PRISMA guidelines[18]. This review was not registered.

Eligibility criteria

To be included, studies were peer-reviewed, published in English, and presented original data (i.e., no review articles, commentaries, etc.). No date range was used. Studies were required to address organisational fatigue management strategies for managing unpredictable working arrangements. Specifically, studies had to assess worker fatigue and/or sleep outcomes based on the amount of advance notice provided prior to shifts. Inclusion criteria aligned with the Population, Intervention, Comparator, Outcome, Study design (PICOS) framework[18].

Population: Workers who undertake shift work or other non-standard working arrangements (e.g., on-call work). All ages, genders, locations, industries, and other demographic characteristics were included.

Intervention: To be included, studies had to present a

direct comparison of outcomes based on the amount of advance notice provided to workers prior to work start times.

Comparison: No comparison group required.

Outcome: Outcomes must include fatigue or sleep.

Study design: All original study designs were included (i.e., no reviews, etc.).

Information sources

Four databases were searched to identify relevant peer-reviewed literature (PubMed, PsycINFO, IEEE Xplore Digital Library, NIOSHTIC II). The search strategy also included forwards and backwards citation tracking of included articles.

Search strategy

The search strategy was based on a recent systematic review in the area of fatigue management[19]. Search terms can be seen in Table 1.

An example search string from the search of the PsychINFO database is as follows:
(exp Fatigue/) AND ((“advance notice” or predictabil*).mp. [mp=title, abstract, heading word, table of contents, key concepts, original title, tests & measures, mesh word]) AND ((safety or productivity or health or performance or incident or accident or near miss or sleep).mp. [mp=title, abstract, heading word, table of contents, key concepts, original title, tests & measures, mesh word])

Selection process

After searching, studies were exported to Covidence (v2654, Covidence Systematic Review Software, Melbourne, Victoria) and duplicates were removed. One reviewer (MS) screened all identified studies at the title and abstract level. Studies that progressed past the title and abstract screening level had full text records retrieved, which were then screened against the specified inclusion criteria by MS.

Data items

All included studies had the following information extracted: year of publication, industry, jurisdiction, population, amount of advance notice given to workers prior to work start time, sleep or fatigue outcomes, safety and/or performance outcomes. Fatigue and sleep outcomes were compared based on the amount of advance notice given to worker populations to compare and evaluate the most appropriate amount of advance notice, for future inclusion within fatigue management guidance materials.

Table 1. Search terms

Population		Intervention (OR)		Outcome (OR)
Fatigue	AND	Advance notice	AND	Safety
		Predictabl*		Productivity
				Performance
				Health
				Incident
				Accident
				Near miss
				Sleep

Quality assessment

All included studies were evaluated using the Joanna Briggs Institute critical appraisal tools[20].

Guidance material search

Design

To develop an understanding of the current information provided by industry bodies on advance notice prior to shifts, a search was performed of current fatigue management guidance materials. This grey literature search was conducted in line with published strategies[21, 22]. It was not expected that all available guidance material from every jurisdiction worldwide would (or could) be sourced. Rather, the aim of this search was to evaluate common advice and regulation provided to industries that use unpredictable working arrangements.

Eligibility criteria

To be included, documents had to be English-language guidance materials provided to organisations and/or industries that use non-standard working arrangements (e.g., shift work, on-call work, etc.). These guidance materials had to include advice regarding the amount of advance notice (or predictability) that should (or would ideally) be provided to workers.

Information sources and search strategy

The search strategy was based on established strategies for sourcing grey literature[21, 22], and was based on specialist author knowledge of the area (i.e., fatigue management guidance materials). Some guidance materials were sourced from industry groups and associated webpages, in addition to the authors’ existing libraries. Further, online searches were performed using search terms such as “fatigue risk management guidance materials”, “fatigue management guidance materials”, “fatigue management guidelines”, along with countries and areas (e.g., “Europe”,

"United States", "Australia", "Canada", etc.). Google was the primary search engine used. Reference lists of guidance documents were also used as a source for additional materials. This search strategy was used as there is no current centralised repository for grey literature in the fatigue management area (i.e., traditional search strategies did not yield useful sources).

Data items

Data extracted from guidance materials included author organisation, country of origin, year of publication, title, content, access source, included references (i.e., any peer reviewed literature used to support guidance around advance notice). The authors of the present review have included a short description of the references included, to clarify what evidence is provided to support the provided guidance.

Risk of bias and quality assessment

Given that this search was focused on grey literature, no risk of bias or quality assessment processes were possible or appropriate.

Results

Peer reviewed literature search

A total of 1,162 records were returned by the search (Fig. 1). After duplicate removal, 1,005 records were screened at the title and abstract level. Of these records, 889 were excluded. The remaining 112 records were screened at the full text level. The final screening resulted in 3 studies that met the inclusion criteria.

While certain studies reviewed at the full text level would appear to meet the inclusion criteria at first glance[23–30], they did not evaluate sleep or fatigue outcomes based on the amount of prior notice provided to workers, so were excluded.

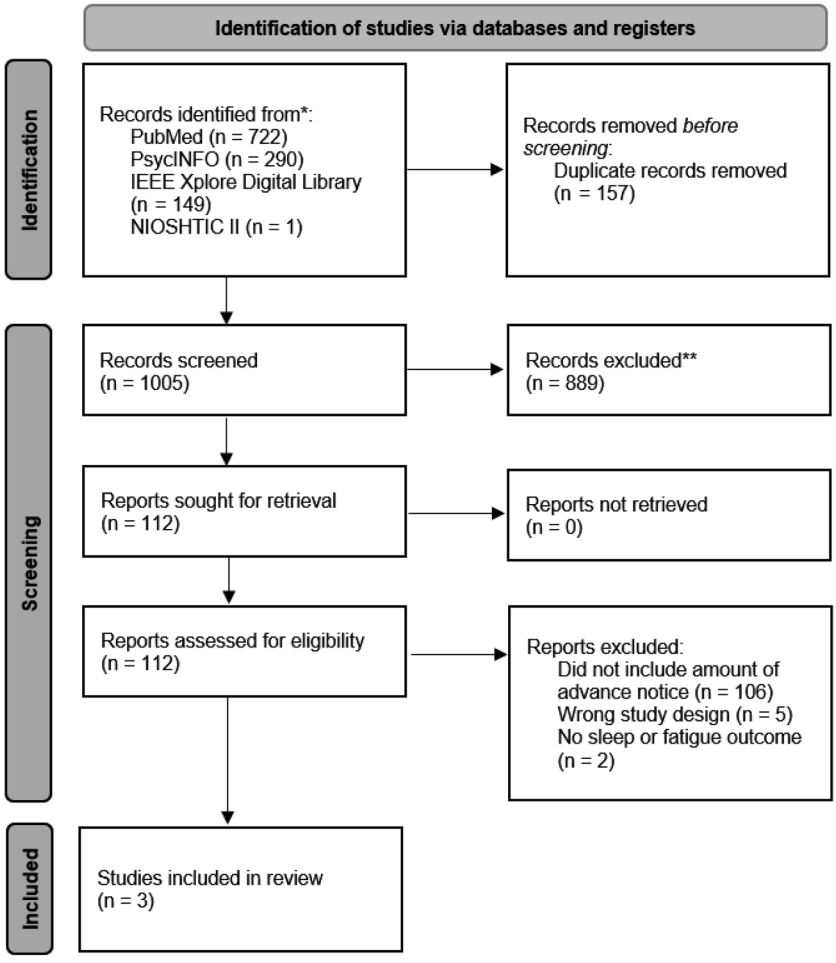

Fig. 1. PRISMA flowchart of returned records.

Study characteristics

All three included studies were undertaken by the same research group located in the United States[6, 31, 32]. Survey data was used by all three studies to investigate the sleep outcomes of varying advance notice periods in retail and food service workers. One study[31] compared sleep outcomes in workers who either were (n=754) or were not (n=5,394) included in a novel work hour ordinance, while the other two studies collected sleep and advance notice period data from one group of workers (n=27,792[32]) and (n=between 15,075 and 16,316[6]). All included studies measured sleep using non-validated scales. Additional study characteristics can be seen in Table 2.

Quality assessment

Quality assessment indicated that two of the included studies were of moderate quality[6, 32] and one was of high quality[31], based on the criteria provided by the Joanna Briggs Institute (Table 3).

Sleep and fatigue outcomes of advance notice periods

All studies indicated that greater advance notice periods were associated with improved sleep and fatigue outcomes[6, 31, 32]. This included improved sleep quality, reduced difficulty falling asleep, decreased sleep disturbance, and less fatigue upon waking[6, 31, 32]. More advance notice was typically associated with a proportionate increase in positive sleep outcomes[6, 32]. However, in one study, no difference was seen in sleep quality when >1 wk advance notice was provided, though ≤ 6 d' notice was associated with poorer sleep quality[32]. Interestingly, when an hours of work ordinance was introduced to increase notice periods to >2 wk, participants reported a 11% increase in sleep quality[31]. By comparison, workers who were not covered by this ordinance did not report any change.

Guidance material search

This section of the present review comprises a synthesis and evaluation of the guidance provided by the included documents regarding advance notice. A total of 37 documents providing fatigue management guidance were included. Documents were from Australia (n=12), the United States (n=6), Canada (n=6), the United Kingdom (n=4), New Zealand (n=3), and international regulatory bodies (n=6). The relevant information on advance notice has been extracted, as have any relevant citations supporting their claim (Supplementary Table). Most included guidelines and regulations do not provide detailed evidence to support the recommendation for extended periods of advance notice.

The industry guidance materials included in this review typically suggest that high levels of advance notice will enable employees to better plan activities during non-work periods, and thus should be provided wherever possible. It is assumed that advanced notice will reduce fatigue-related risk and the negative psycho-social sequelae of unpredictable working time arrangements. Some guidance materials mandate specific timeframes for advance notice. For example, "if possible give drivers 24-h notice of [any] schedule change"[17], or "post work schedules at least 14 d in advance"[16]. However, most guidance materials are general (i.e., more is better) and do not prescribe what constitutes 'advance notice' or 'predictability'. That is, the precise durations of advance notice required to mitigate psycho-social or fatigue-related risk are generally not provided. Some guidance materials simply state that there is a need to "keep the timing of shifts predictable"[12], that "long range predictability is a key aspect of fatigue mitigation"[33] or, alternatively, that "irregular and unpredictable hours" are associated with higher levels of fatigue-related risk[34]. Other guidance materials describe how "planning as much of the actual hours of work as possible" is a key fatigue management strategy[35], that "rosters for shift and weekend work should be available with enough lead time to permit planning for leisure activities and sleep recovery"[36], or that "standby, reserve and on-call duties should be scheduled with as much advance notice as possible, and ideally in a predictable manner"[11]. One guidance document produced by a United States Air Force research laboratory described that "the shift worker who cannot accurately predict their work and free days will suffer from poor morale and is more likely to quit the job than the shift worker who can predict work and free days"[37]. While it could be argued that it is difficult to provide precise advice regarding ideal advance notice periods given the diversity of industries, organisations, and workgroups—the same could be said for any other industrial hazard. However, for virtually all other hazards, a general invocation would typically be considered inadequate (e.g., "try to minimise alcohol intoxication"). A lack of clear guidance around advance notice could thus be taken as indicative of a lack of consideration of fatigue as a hazard by many industries. Furthermore, difficulty in developing specific advice does not reduce the importance of providing such guidance.

Analysis of guidelines found in the search shows that very few published guidance materials provide citations or references for advice regarding predictability/advance notice (Table 4). Out of the 37 documents reviewed, just

Table 2. Characteristics of included peer reviewed studies

Authors and year	Jurisdiction	Population	Amount of advance notice given to workers prior to work start time	Sleep and/or fatigue measures	Sleep and/or fatigue outcomes
Harknett, Schneider, and Wolfe (2020)	United States	Workers employed by large retail and food service firms	"How far in advance do you usually know what days and hours you will need to work at [EMPLOYER NAME]?" Responses categorised as "less than 1 wk," "1–2 wk," "2–3 wk," "3–4 wk," and "4 or more wk"	Four self-report questions. "During the past month, how would you rate your sleep quality overall?" (1=poor, 4=very good) "During the past month, how often did you have difficulty falling asleep?" (1=never, 2=1–2 times per month, 3=weekly, 4=multiple times per week, 5=every day) "During the past month, how often did you wake up repeatedly during sleep?" (1=never, 5=every day) "During the past month, how often did you wake up feeling exhausted/ fatigued?" (1=never, 5=every day)	Significantly better sleep quality with increased advance notice (p>0.05): • <1 wk notice: ref • 0.07 point increase in sleep quality with 1–2 wk notice • 0.07 point increase in sleep quality with 1–2 wk notice • 0.10 point increase in sleep quality with 2–3 wk notice • 0.14 point increase in sleep quality with 3–4 wk notice • 0.14 point increase in sleep quality with 4+ wk notice Significantly less difficulty falling asleep with increased advance notice (p>0.05): • <1 wk notice: ref • 0.10 point decrease in difficulty falling asleep with 1–2 wk notice • 0.12 point decrease in difficulty falling asleep with 2–3 wk notice • 0.16 point decrease in difficulty falling asleep with 3–4 wk notice • 0.17 point decrease in difficulty falling asleep with 4+ wk notice Significantly less sleep disturbance with increased advance notice (p>0.05): • <1 wk notice: ref • 0.09 point decrease in sleep disturbance with 1–2 wk notice • 0.09 point decrease in sleep disturbance with 2–3 wk notice • 0.14 point decrease in sleep disturbance with 3–4 wk notice • 0.17 point decrease in sleep disturbance with 4+ wk notice Significantly less waking up feeling fatigued with increased advance notice (p>0.05): • <1 wk notice: ref • 0.08 point decrease fatigue with 1–2 wk notice • 0.14 point decrease in fatigue with 2–3 wk notice • 0.18 point decrease in fatigue with 3–4 wk notice • 0.17 point decrease in fatigue with 4+ wk notice
Harknett, Schneider, and Irwin (2021)	United States	*Seattle treatment group:* Individuals who reported working in Seattle and whose employers were of the size and type that would be covered by the Secure Scheduling ordinance. *Comparison group:* Workers employed by the exact same set of companies covered by the Seattle law but employed in other large US cities	Seattle treatment group: >2 wk advance notice Comparison group: <2 wk advance notice	Percentage of respondents who reported 'good' or 'very good' sleep quality.	11% increase in 'good' or 'very good' sleep quality for Seattle treatment group when the Secure Scheduling ordinance was introduced. No increase in sleep quality for comparison group.
Schneider and Harknett (2019)	United States	Retail and food service workers employed at 80 large companies.	Amount of advance notice given of schedule: · 0–2 d · 3–6 d · 1–2 wk · 2 wk or more	Sleep quality rated as very good, good, fair, or poor used to create a dichotomous variable (very good and good versus fair and poor).	Significantly poorer sleep when 0–2 or 3–6 d' notice given, as compared with 2 wk or more (ref). · 0.35 point decrease in sleep quality with 0–2 d' notice* · 0.27 point decrease in sleep quality with 3–6 d' notice* · 0.9 point decrease in sleep quality with 1–2 wk' notice · More than 2 wk' notice: ref

Table 3. JBI risk of bias assessment of cross-sectional studies

	First author (Year)		
	Harknett, Schneider, and Wolfe (2020)	Harknett, Schneider, and Irwin (2021)	Schneider and Harknett (2019)
Were the criteria for inclusion in the sample clearly defined?	Y	Y	Y
Were the study subjects and the setting described in detail?	Y	Y	Y
Was the exposure measured in a valid and reliable way?	N	Y	N
Were objective, standard criteria used for measurement of the condition?	N	N/A	N
Were confounding factors identified?	Y	Y	Y
Were strategies to deal with confounding factors stated?	Y	Y	Y
Were the outcomes measured in a valid and reliable way?	N	N	
Was appropriate statistical analysis used?	Y	Y	Y
Score %	62.5%	75.0%	62.5%

Cut offs ≤49% "weak", 50% to 70% "moderate", and ≥71% "strong". JBI: Joanna Briggs Institute.

Table 4. Appropriate use of advance notice periods

Scenario	Example
Appropriate to provide high levels of advance notice	
When the likelihood of scheduling changes is low (80–90 % minimum scheduling accuracy).	*Control room operators in the utilities industry who work scheduled shifts, with last minute changes only to cover unplanned sick leave.*
When schedules are provided with the understanding that changes may be required on the day of operations.	*Drivers (i.e., truck drivers or train engineers/drivers) who are informed that they will drive specific routes regardless of any advances/delays to the day of operations schedule.*
Where downtime at work is acceptable.	*On-call fire fighters stationed in a firehouse, where downtime is acceptable due to the immediate responsiveness required in the event of a call.*
Not appropriate to provide high levels of advance notice	
Where downtime is viewed as inefficiency.	*Truck drivers and train engineers/drivers who are not required to remain at the station if there is no work to perform.*
When the person has to go to a previously unspecified location to do the job.	*Couriers who may be required to pick up/drop off items to various locations.* *Volunteer fire fighters who have other employment and/or would otherwise be at home.*
Where the likelihood of work occurring is uncertain.	*Maintenance and technical support roles, including individuals who respond to faults in information technology or utilities industries.*

seven include any citations for their guidelines on advance notice periods. While we understand that the 'grey literature' does not always claim to be evidence-based, some documents cite references in relation to predictability and advance notice[37–44]. Additionally, readers generally expect that guidance materials, even in the absence of citations, are evidence-based. However, many include reference to other guidance documents that also lack evidence for guidance about notice periods. In particular, in the guidelines provided by the Energy Institute (London)[42] and the United States ASIS Foundation[40], the citation provided is to the shift work scheduling document developed by the United States Air Force research laboratory[37]. Miller provides just one citation for the principle of predictability—a book entitled 'The 24-h business: Maximising productivity through round the clock operations', published by the American Management Association[45]. The book states that shift predictability is found to be 'a concern' for many workers but is not a peer-reviewed publication and does not include any quantitative evidence to support advance notice in scheduling. Specifically, Coleman states the following, (p. 95):

"Fourteen percent of all workers say that obtaining a more predictable schedule is their primary concern. Companies that schedule overtime at the last minute (either on days off or by extensions of workdays) create a tremendous disruption to family and social life plans, which may have been on the calendar for weeks. It's one thing for a parent to tell a child that they cannot schedule a camping trip this summer; it's another matter to postpone or cancel a planned trip one day before leaving because of a change in work schedules".

The statement appears to be the source of much of the current guidance regarding advance notice. Coleman also

describes several hypothetical scenarios and concludes with the statement that "most problems of unpredictability can be solved or reduced with better schedules that match the actual workload and the shift workers provide improved self-regulating coverage" (p. 95). Critically, no scientific evidence is provided to support this statement.

Further investigation of research into predictability and advance notice has indicated that just one peer reviewed publication prior to the Coleman book[45] notes the impact of "regularity" on worker outcomes. Knauth and Rutenfranz[46] note that:

"We are not aware of any controlled studies which have systematically compared the effects of regular and irregular shift systems. Nonetheless, we would expect regularity to facilitate the planning of activities away from work. Since this is important for sleep, non-work roles and recreation we favor regularity" (p. 362).

It is interesting to note that this 1982 paper remains uncited by all recent guideline materials, despite the concept of favouring regularity remaining consistent. It is possible that the age of this paper may render it inaccessible on current online databases. Importantly, however, the qualifying remark that regularity may be favoured *despite any controlled studies in the area*, is not present in any subsequent guidance materials. It is possible that a degree of hermeneutic distortion has occurred in the publication of books and guidance materials in the time since publication − slight changes within each iteration. This has created an orthodoxy that more advance notice/regularity is better, without an evidentiary basis. Figure 2 illustrates the progression from the original recommendations to now.

In addition to interconnectivity, guidance documents largely cite other, non-scientific guidance documents[39–41, 44], or otherwise inappropriate sources (e.g., sources that do not provide evidence for the statements which they allegedly support). For example, the ACOEM Guidance Statement[38] in discussion of notice periods refers to a conference publication that, while including key information on an algorithm used to identify fatigue-related risk within on-call operations[47], does not assess the efficacy of advance notice. Citations such as this, while informative, do not provide any scientific basis or underlying data on which to base decisions regarding the impact of advance notice periods. Furthermore, the citation provided by the Australian Medical Association[39] is for another guidance document in the Australian medical field[48], rather than scientific literature. This guidance document for the medical field produced by the Royal Australasian College of

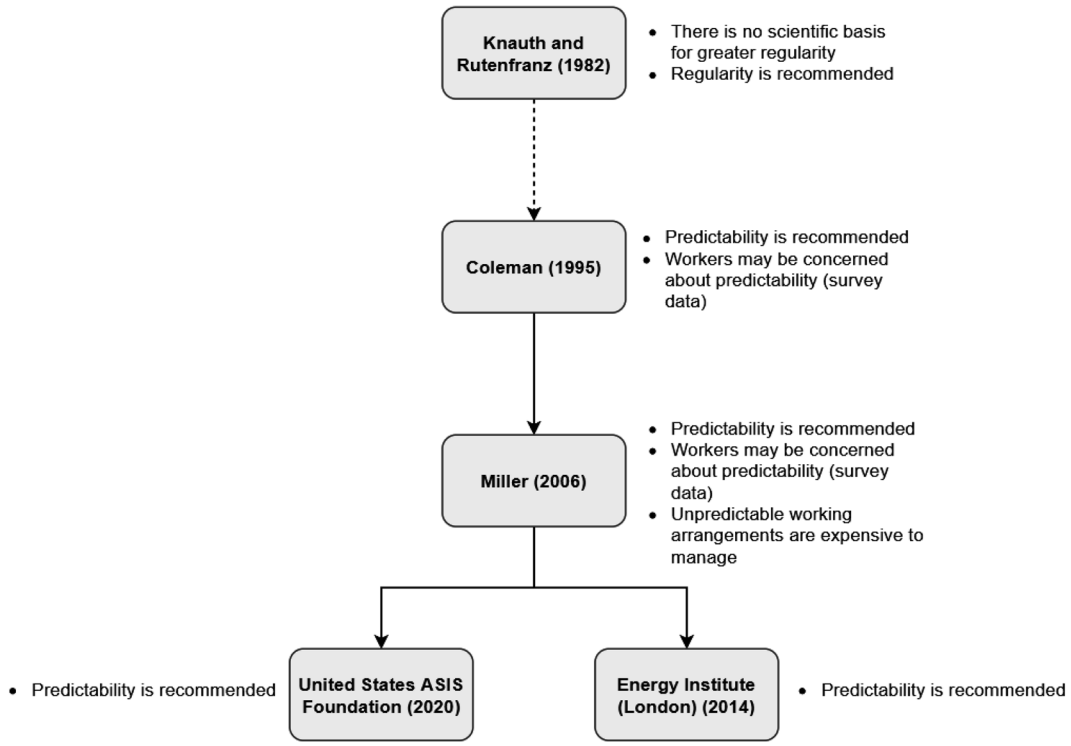

Fig. 2. Evolution of predictability recommendations. Dashed arrow indicates no direct citation, solid arrow indicates citation of previous reference.

Surgeons[48] does not include any citations. Similarly, The Canadian Standards Association[41] cites a Transportation Safety Board watchlist[49], which simply states "in the transportation industry, crews often work long and irregular schedules—sometimes crossing multiple time zones or in challenging conditions—that are not always conducive to proper restorative sleep" (p. 3) also with no supporting citation.

Several guidance documents do include reference to academic studies[35, 36, 50–52]. However, in these cases, scientific publications are not cited at specific locations within the document but rather are presented within an overall reference list. These reference lists are presented within guidance materials not as supporting evidence for specific elements of a guideline, but as general bibliographic source materials, or for further reading. A review of the relevant reference lists suggests that while many components of fatigue risk management guidelines are evidence-based (e.g., shift length and timing), there is no evidence on which to base guidance on desirable pre-work notice periods. This suggests that the current guidance, while intuitively appealing, is not grounded in scientific evidence. Uncomfortable as it may be, the current orthodoxy (i.e., that a greater amount of notice is always preferable) may be unfounded and thus the question remains—do workers actually use knowledge of their days off to prepare for an upcoming work schedule, and if so, how much advance notice is required to positively impact pre-work behaviour?

Discussion

Empirical support for advance notice

As can be seen from the findings of the systematic search of peer reviewed literature, just three studies are available comparing sleep and fatigue outcomes based on the amount of advance notice provided[6, 31, 32]. These studies indicated that self-reported sleep and fatigue improved when more advance notice was given. This suggests that greater notice periods may be effective in reducing worker fatigue, and likely improving safety. However, all three studies were undertaken in a sample of retail and food service workers, which may limit the applicability of these findings to other sectors. It is probable that certain characteristics of this population (e.g., economic insecurity[32]) may be strongly correlated with the unpredictable nature of these working time arrangements, such that increased advance notice periods are likely associated with increased financial stability (as upcoming earnings are known). However, when economic factors are excluded from the question (e.g., for full time rail workers and other professions who undertake on-call work under a salaried agreement[24]), the impact of advance notice is less clear. Additionally, it did not appear that night shifts were standard for these populations, despite working non-standard hours. Therefore, it is unclear what the interactive effect of advance notice periods and night shifts may be. Furthermore, advance notice was typically not the only provision designed to improve workers' ability to predict their working time arrangements in these studies, which further obscures the impact of extended advance notice periods.

There are several other papers which, while not meeting the criteria of our systematic search, can be used to support our understanding of advance notice periods. Akerstedt and Kecklund[53] present findings on the aspects of working time arrangements that negatively impact non-day workers. Short notice of a new work schedule, in this case fewer than 4 wk' notice, was the most problematic work schedule characteristic, based on self-reports. However, sleep and fatigue were not impacted by notice periods. Instead, the finding that notice periods <1 month were a significant problem for workers related to 'social difficulties' (i.e., planning future social/family activities), which the authors also linked to a lack of control or influence over time. The authors note that this negative impact *presumably* relates to 'difficulty planning life and social contacts' (p. 323). However, this study did not differentiate between notice periods of different length prior to work scheduling and was therefore not able to determine optimum notice periods and/or preparatory behaviours associated with advance notice. Similarly, another self-report study found that a higher frequency of short notice shift allocation (1–3 d in advance) resulted in poorer outcomes in nurses, as compared with less frequent short notice periods. These negative outcomes included higher rates of work/family conflict, dissatisfaction, and amount of sick leave taken[54]. While this study did not assess the relationship between different notice period durations and participant outcomes, these findings suggest that notice periods and certainty of future work time are likely to impact work and personal outcomes. Finally, one study in the rail industry found that individuals in workgroups with variable start times (i.e. less predictable) obtained fewer hours of sleep than those with regularly scheduled hours of work[55]. However, the amount of advance notice provided was not discussed.

Given the lack of clear evidence linking advance notice periods with either anticipatory pre-work behaviours or worker sleep/fatigue, it appears that current guidance

materials are limited in their evidentiary basis. This is also apparent from our review of the guidance materials themselves, which revealed few recommendations are based on clear academic evidence. While it may make logical sense that greater notice periods would result in a greater likelihood of pre-work preparations, improved sleep, and/or reduced worker fatigue, it is apparent that relevant fatigue management guidance is based simply on this logic—rather than scientific evidence.

Advance notice and certainty—are they the same?

Fatigue management guidance materials that include advice on advance notice refer to an implicit relationship—more advance notice is associated with a greater degree of certainty, and certainty will result in workers performing appropriate anticipatory behaviours (e.g., planning of sleep/wake times, social activities, etc.). The assumption is that direct causal relationships exist between each factor. The implicit relationship is graphically represented in Fig. 3.

The concept of 'certainty' in the context of work scheduling is complex. While it may be relatively straightforward to conceptualise certainty as a distinct construct in the context of advance notice periods, determining its exact nature is more challenging. Recent research has explored the related concepts of 'schedule anticipation' and 'predictability' in the context of advance notice periods[56]. Lambert and colleagues[56] employed a measure of schedule anticipation that asked workers the degree to which they agreed with the statement 'you can easily anticipate what days and times you'll be working week to week'. While the experience of anticipation is important to understand from the worker perspective, this subjective measure does not capture the probability that future work start and finish times align with a planned schedule, nor does it capture the magnitude of schedule instability. It may therefore be appropriate to conceptualise certainty as a measure of probability—the probability of a specific future shift occurring at the scheduled time. Furthermore, changes to work schedules could be evaluated based on the magnitude of the change, where substantial changes could be considered in comparison to trivial changes. For the purpose of this review, we will conceptualise 'certainty' as the probability that a planned work shift will be undertaken at the scheduled time.

The current orthodoxy, that certainty of future work time is necessary for employees to plan pre-work activities, assumes that advance notice is the same as certainty of future work time. If we are to assume that certainty results in appropriate anticipatory behaviours (discussed in detail below), then certainty would ideally be improved by working time guidelines. The requirement for advance notice may belie a key linguistic and operational flaw.

Fig. 3. Implicit relationship between advance notice, certainty, and anticipatory behaviours typically described in guidance materials.

We must also distinguish between the concept of certainty of future work time and existing models, such as the job demands-resources[57] and the job demand-control (-support)[58] models. The term 'job control' refers to the amount of control an individual feels they have over their work tasks and work activity[58]. Evidence suggests that greater job control is associated with improved wellbeing, improved physical and/or mental health, and other positive outcomes[59]. While these positive outcomes are associated with increased control over one's work (and presumably one's working time), the critical difference between job control and advance notice (and certainty—as discussed above), is that advance notice specifically refers to the notice period (i.e., hours or days) that an individual has—rather than the degree of control that individual has over their hours of work (or work tasks).

A new theoretical framework

Based on a differentiation between advance notice and certainty, we propose an alternative framework for the management of unpredictable working time arrangements within the fatigue management context. Within this framework, we propose that it is certainty, rather than advance notice, which should be managed and ideally improved. We also consider the relationship between advance notice and certainty under different conditions.

Figure 4 presents graphical representations of a series of possible working time arrangements. Each panel within the figure has axes denoting certainty (y axis) and amount of advance notice (x axis). Each function represents the degree of certainty in future work times based on the amount of advance notice that is provided. For example, a large amount of advance notice (2 wk) may be associated with either a high or low degree of certainty. High levels of certainty would occur when the worker is certain that their future work times will be static, whereas low certainty reflects the potential for work times to change (based on on-call periods, scheduling updates, etc.).

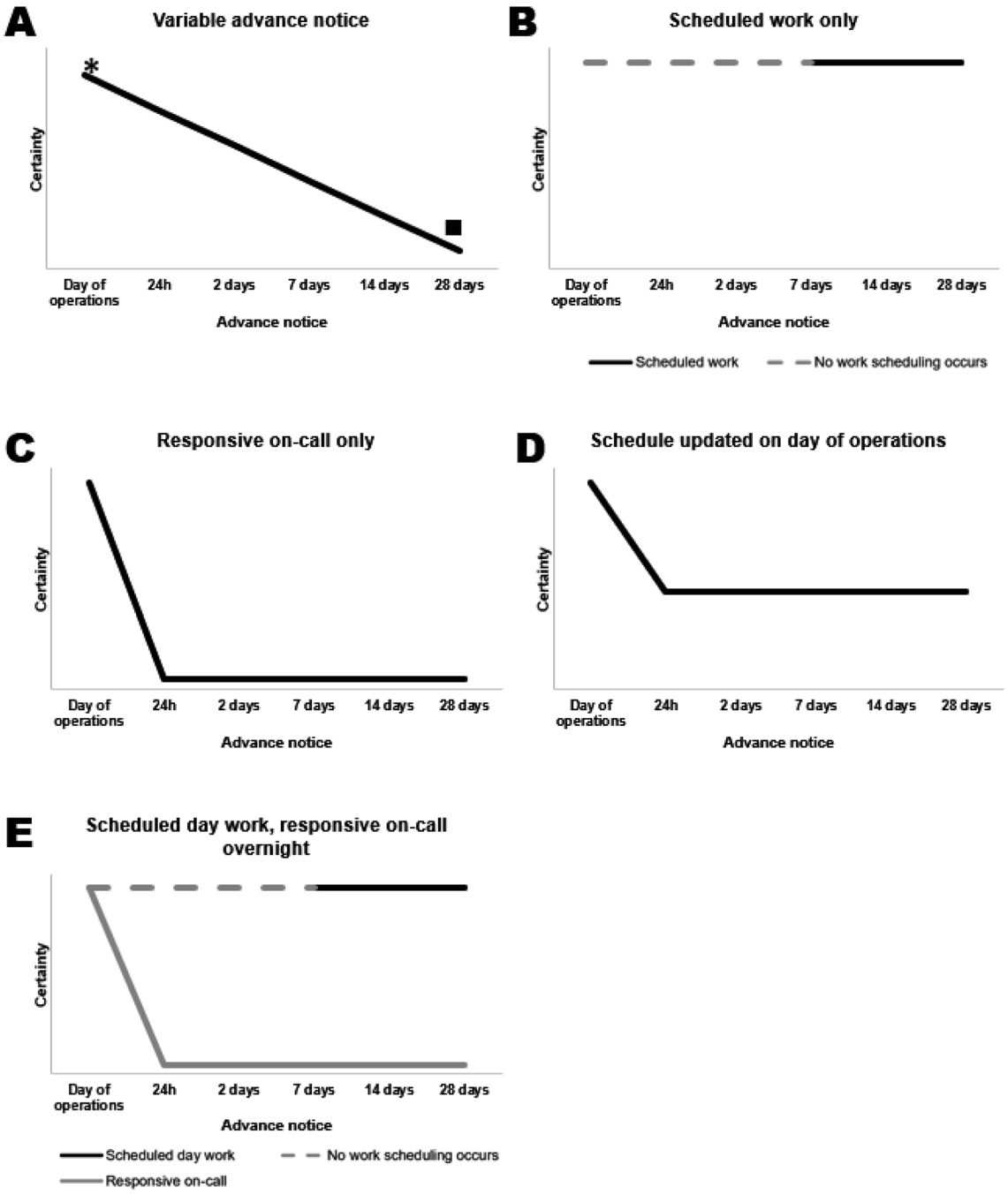

Fig. 4. Theoretical relationship between certainty of work time and advance notice for differing working arrangements. Each panel represents a different working time arrangement. Axes denote certainty (y axes) and amount of advance notice (x axes). Functions represent certainty of future work time based on the amount of advance notice provided. Solid black lines represent scheduled day work, solid grey lines represent responsive on-call, and broken grey lines represent no work scheduling occurring.

In Fig. 4, panel A, we can see that certainty of future work time is associated with the amount of advance notice that is provided in a variable on-call environment. Less advance notice is likely to be associated with a higher degree of certainty of future work times. That is, if an employee were to receive a call to attend to a job with no notice (denoted by the asterisk in Fig. 4, panel A), they would have a very high degree of certainty that they would be commencing work at that time. One example of this may be in an emergency situation—if a volunteer firefighter were to receive a call to attend to a bush fire, they would be extremely certain that the work would commence as

soon as they could make it to the scene.

Conversely, a greater amount of advance notice may be associated with less certainty of future work time. While a worker may be told via a rostering system that they would be working at a certain time on a future date, the closer that date is, the more certainty they can have about their work time. For example, the volunteer fire fighter may have a scheduled burn planned a week in advance. While they have some awareness of their potential shift start time on that date, it is possible in the summer months that a number of factors could impact this work time (e.g., a fire starts in their local area, etc.). Therefore, while a high level of advance notice may give the illusion of providing prior planning capacity, the worker is far less certain of their future work schedule than had less notice been provided. This scenario is denoted in Fig. 4, panel A by the square.

In considering the relationship between advance notice and certainty, we must consider a variety of different working arrangements. In particular, it is likely that the relationship between certainty and advance notice will differ between industries and different organisations or even work groups. In many industries, scheduled work time does not include any on-call or unpredictable components (shift work or standard work). As such, predictability is high for all planned shifts, regardless of the amount of advance notice, and it would be rare for schedules to be made without at least 1−2 wk of notice. This can be seen in panel B of Fig. 4. Conversely, some roles do not include any scheduled work time, and operate on a responsive on-call basis (i.e., work only occurs following unplanned calls). As such, there would be little capacity for certainty prior to a given day, but a high level of certainty after being called (Fig. 4, panel C). Another possible working arrangement is the use of planned schedules that are refined on the day of operations. This is often seen in the rail industry, where drivers are scheduled to specific trains, which may depart up to two hours earlier/later than expected on any given day. These individuals therefore have a moderate level of certainty prior to the day of operations (they know they will be driving a specific train on that day), but there is a four-hour potential window for their start time (Fig. 4, panel D). Figure 4, panel E demonstrates the theoretical certainty of a worker who performs scheduled day shifts (high certainty, no short notice) in addition to overnight responsive on-call (low certainty until the night of operations).

Based on this theoretical conceptualisation, we can consider specific workgroups and industries that are likely to have significantly different relationships between certainty and advance notice. Operators must consider how much certainty could be reasonably expected based on the amount of advance notice that is provided (or desired). If there is a low certainty associated with high levels of advance notice, the advance notice may have the opposite effect than what is desired. That is, greater advance notice may be associated with *reduced* certainty. For example, a notice period of two weeks may be helpful in a situation where there is a high degree of certainty. However, if the individual's work schedule were to change two days in advance of their shift, this would indicate a) a low degree of certainty for the longer notice period, and b) a higher degree of certainty for the shorter notice period. In this case, we may consider whether it is better for the worker to avoid the longer period of uncertainty, and only be presented with the shorter notice period—and a higher degree of certainty. However, the acceptable degree of certainty may differ between individuals and workplaces. See Table 4 for an overview of industrial and operational requirements that may impact the appropriateness of long advance notice periods.

A case study in Australian and North American rail

To illustrate the challenge of providing fatigue management guidelines for unpredictable working arrangements, we will use the rail industry as an example. Passenger and freight train schedules in Australia are often highly scheduled. That is, the organisations know when trains are scheduled to depart/arrive and can plan worker shifts accordingly. However, trains are delayed on a semi-frequent basis for many rail depots[60]. A delay can result in altered shift times for workers, often with little or no notice and a degree of uncertainty. This stands in opposition to the rail industry in North America. Most freight train operations in North America are unscheduled and operate via a board or pool model[24]. This model includes a rotating 'board' of drivers/engineers[1], where the individual at the top of the board is allocated the next train to arrive. Similarly, there is a 'board' of trains where the next scheduled train is at the top. Drivers/engineers progress toward the top of their board as drivers and trains are 'paired' (Fig. 5). This model typically gives workers a minimum 2 h formal warning prior to shift start time, giving a high degree of certainty with a short notice period—within already scheduled 'on' days. The board model has been described as resulting in "duty-rest schedules [being] irregular and unpredictable, which makes sleep planning very difficult"[38].

[1]'Driver' is the standard term in Australia, while 'engineer' is the preferred term in North America.

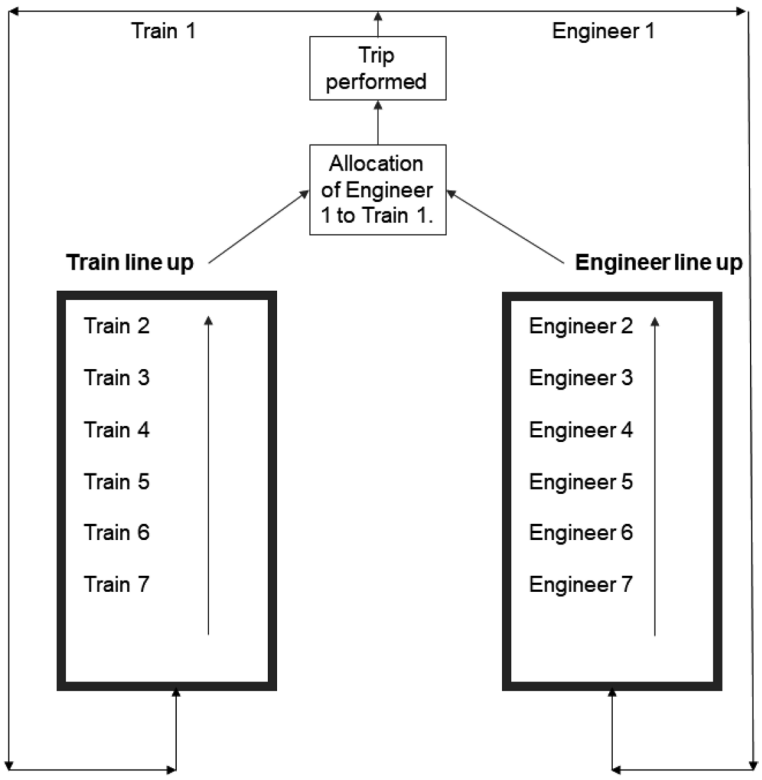

Fig. 5. The board model of train and engineer allocation. Trains and engineers are allocated to a 'board' where the engineer and train at the top of each board are allocated to one another. The trip is performed, and each engineer and train returns to the bottom of the board. As other engineers and trains are allocated to jobs, they then progress back to the top of the board for another allocation.

If we are to assume that a greater amount of prior notice results in better outcomes, it would stand to reason that scheduled rail operations would be preferred. However, when scheduled trains are delayed in the Australian model, notice periods are often shorter than in the North American model (i.e., <2 h). Furthermore, an entire workgroup's roster may be impacted by delays. This is particularly relevant where fatigue management systems are highly regulated, as they are in the Australian rail industry[61]. Fatigue management systems in the Australian rail sector require certain breaks between shifts (e.g., "the 10-h rule"), which can result in significant flow-on effects for workers or workgroups. The board system in the North American model, can easily adapt to scheduling changes. However, there is the possibility for seniority to take precedence for 'desirable' shifts, rather than the board. Under rail regulations in the United States this is described as a seniority move[62], and can be a form of delegation. Anecdotal reports indicate that in some workgroups, certain workers will allocate out undesirable jobs to others, waiting at the top of the board for preferred routes or jobs.

Conversely, many rail workers in North America object to these short (though certain) notice periods—as they may be unable to plan their pre-work preparatory behaviours appropriately and may experience a high level of stress[63, 64], anxiety[65], and/or fatigue[63, 66] due to being on-call over extended periods of time. The potential problems associated with this working time arrangement are reflected in the recent United States industrial disputes regarding current rail scheduling policies. For example, the use of 'precision scheduled railroading' has been used in certain areas of North America to attempt to increase certainty of train schedules. Unfortunately, many workers report that this type of scheduling has resulted in a reduction in employee numbers, and as a result, an increase in schedule variability and/or fatigue[67].

Both the North American and Australian models present potential problems in terms of advance notice periods. The Australian model may have more notice, which would be preferred under most fatigue risk management system guidelines, but also has a lower level of certainty. Conversely, the North American model has little

advance notice, but high degree of certainty. See Fig. 6 for a graphical representation of the advance notice and certainty associated with these models. We propose an approach that considers both advance notice periods and the associated certainty: finding the middle ground between these approaches that may give drivers on the board model more notice and reduce the uncertainty of scheduled rail working time.

How does certainty impact anticipatory behaviours?

In considering the implicit relationship described in Fig. 2 (advance notice → certainty → anticipatory behaviours), it is important also to understand how certainty impacts anticipatory behaviours. To our knowledge, no research has been performed on this relationship. However, it is logical to assume greater certainty is associated with the *opportunity* to perform anticipatory behaviours. That is, if future work times are known, workers *could* perform anticipatory behaviours. However, we do not know 1) whether workers do perform anticipatory behaviours when certain of future work times, 2) what type of anticipatory behaviours occur (or are most likely), or 3) whether anticipatory behaviours result in improved outcomes (e.g., a lower likelihood of fatigue). Additionally, we do not currently understand the impact of certainty/uncertainty on family/social disruption, though this is outside the scope of the current review.

The type of anticipatory behaviours performed when workers are certain of future work times may include preplanning sleep/wake times, social activities, and other personal responsibilities. However, little is known about specific behaviours. For example, while it is logical to assume that workers may alter their sleep based on certainty/uncertainty, we do not currently know what changes are made. It is possible that a greedy heuristic would be in play when workers are uncertain of future work times, with workers obtaining as much sleep as is possible, as soon as possible. It may be fair to hypothesise that when certain, workers take prophylactic naps or adjust their bed or wake times, rather than relying on this heuristic. However, there is little evidence to support this notion at present. Furthermore, there is no evidence to suggest that these behaviour changes are effective. That is, we do not know if anticipatory behaviours result in lower likelihood of fatigue. We also do not know whether anticipatory behaviours are helpful (or harmful) in other areas—such as personal/family life, or the management of other responsibilities. Not only this, but we do not yet understand the differential impact of certainty on anticipatory behaviours within groups of workers, including between industries, workgroups, and based on demographics (e.g., gender) or individual differences. As a result, we propose that future research aim to understand how certainty impacts anticipatory behaviours—including both strategies and efficacy.

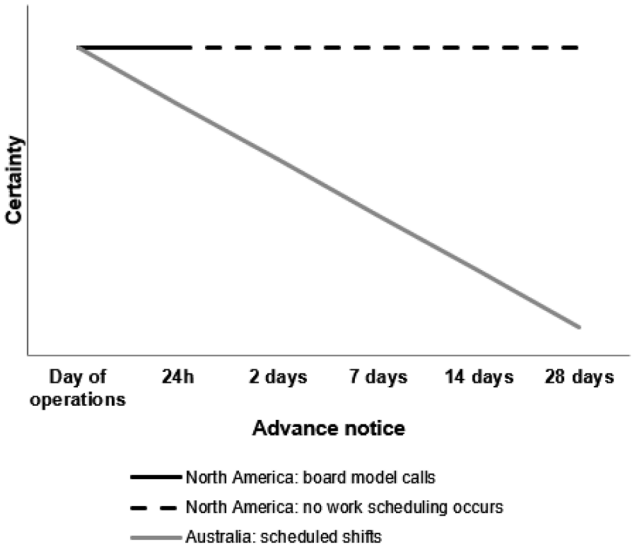

Fig. 6. Advance notice and certainty of work time within Australian and North American rail models. The solid black line representing the North American board model indicates that scheduling is done within 24 h of work start times, and as such has a high degree of certainty. Conversely, the grey line representing the Australian model indicates that as there is the potential for shift change (due to delays, etc.) up until the shift start time, certainty increases as time to shift decreases.

Recommendations for future guidance materials

Until fatigue management guidelines can be developed based on a scientific understanding of the relationship between certainty of future work time and anticipatory behaviours, we suggest the following interim principles:

Until there is evidence to suggest otherwise, organisations should try to provide as much certainty as possible, while also providing the maximum possible advance notice period. Organisations should use roster data to determine the likelihood that planned shifts will be altered based on the amount of notice that is provided. Using the 'Goldilocks' principle[68], a 'sweet spot' could be identified, where advance notice is maximised, while ensuring that workers have a high level of certainty.

Remove blanket mandatory advance notice periods from industry fatigue management guidance materials in situations where advance notice is associated with a low level of certainty. Guidelines that require high levels of

advance notice *may have the unintended consequence of reducing certainty* (Fig. 4, panel A). Frequent uncertainty surrounding work hours is likely to reduce employee confidence in standard schedules, which may then decrease planning capacity of the individual employee (including planning sleep periods— "why should I sleep now, when I know my scheduled shift is probably going to change").

Organisations should be vigilant in monitoring and evaluating working arrangements with unpredictable components. This will ensure that organisations are aware of employee and contractor work hours (in Australia, this aligns with minimum legislative obligations)[69]. These data can be used to determine certainty based on advanced notice, and to monitor any changes to scheduling predictability.

We propose the use of real time technological solutions to monitor scheduling requirements. For example, North American rail operators using the board model may opt to update rail operations data in real time on an employee portal, to maximise driver awareness of operations. This would improve the degree of certainty and advance notice drivers have.

Where a high level of certainty is not possible, fatigue-related risk should be managed in line with the principles of a Fatigue Risk Management System (FRMS). FRMS is a risk-based approach to fatigue management, where periods of work that may result in a higher likelihood of fatigue can be dynamically assessed, so appropriate control measures can be implemented[70, 71]. For example, industries that use standard shifts, such as Australian rail, could adopt a dynamic fatigue risk assessment process in response to any last-minute schedule changes. That is, assessing the likelihood of fatigue, and the potential consequences of a fatigue-related error whenever a worker is required to commence unplanned work. This approach would not only address the safety and performance of workers but would minimise the need for extended notice periods prior to schedule changes.

Where to from here?

While it is logical to assume that longer advance notice periods may be associated with a greater capacity for workers to plan sleep and other non-work activities (potentially reducing fatigue), there is a lack of scientific evidence supporting current fatigue management guidance. We therefore propose a research agenda focusing on the role of advance warning and certainty of future work times on pre-work time management, sleep, and subsequent fatigue. This is supported by the proposition by Åkerstedt and Kecklund[53] that future research should include experimental control of notice periods to determine acceptability—from both a fatigue and social perspective. We suggest that this should also include the impact of systems of work on differing levels of advance notice and certainty (i.e., in different industries and workgroups). Additionally, future research is needed to understand the relationship between certainty and anticipatory behaviours. We recommend that this should include different types of anticipatory behaviours and their efficacy—to ensure that future guidelines promote positive worker outcomes. Furthermore, industry groups and individual workplaces should develop guidance materials that consider the optimum convergence of advance notice and certainty of future work time, rather than including one-size-fits-all advance warning requirements.

Limitations

There are several limitations of the current review that must be noted. While every effort was made to identify available peer reviewed studies addressing advance notice prior to shifts, it is possible that as in any review, some studies were missed. Furthermore, a traditional systematic search of current guidance materials was not possible, due to the lack of a repository for fatigue management regulatory and guidance documents. As such, it is possible (and indeed likely) that additional guidance materials (particularly those used within organisations and not made publicly available) were not included in the current review. However, the available guidance materials presented a highly consistent view, suggesting that saturation was reached (Supplementary Table).

A note on the practicality of advance notice periods

This review has identified that the current advice provided regarding notice periods (i.e., that more notice is better under all circumstances) is not based on a strong body of evidence. As such, we cannot definitively determine whether longer advance notice periods are 'better' (i.e., result in increased preparatory behaviours, increased pre-work sleep, improved work performance, etc.). However, we must note that under some circumstances, extended notice periods may be impractical. For example, under emergency circumstances in some industries (e.g., utilities, healthcare), extended advance notice may not be possible (and as such would fit into the 'short advance notice/high certainty' category of the proposed theoretical model—Fig. 4, Panel C). Importantly, the aim of the current review is not to state that all industries must provide

extended advance notice periods. Quite the opposite—it is clear from the lack of literature in the area that we simply do not know what the optimum level of advance notice is at this time.

Conclusion

The current review of both the peer reviewed literature and current industry guidance materials addressing advance notice periods suggests that while it is a widely held belief that more advance notice is better from a fatigue management standpoint, there is limited scientific evidence underpinning this claim. It appears that much of the regulatory guidance materials developed for industry, while making intuitive sense, are not yet based on scientific evidence. We therefore propose a theoretical model to address both advance notice and certainty of work time—to help organisations and industries to conceptualise their working time arrangements. This framework can be used as a first step in identifying what an appropriate amount of prior notice may be. However, future research is necessary to understand the impact of differing advance notice periods on worker outcomes—including preparatory behaviours, sleep, fatigue, and safety.

Conflict of Interest

None.

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