Sleep and the operational readiness of rural firefighters during bushfire suppression

AUTHORS

Dr Sarah Jay and Associate Professor Sally Ferguson, CQUniversity, and Dr Brad Aisbett, Deakin University. June 2013

Photo: CFA Strategic Communications

SUMMARY

Adding to the depth of knowledge of the *Operational readiness of rural firefighters during bushfire suppression* project (known as the Awake, Smoky and Hot project, or ASH), this project resource complements *Fire Note* 111 (June 2013).

It provides more information on the environmental factors that commonly contribute to sleep disturbance by discussing findings of a literature review conducted as part of the ASH project.

Particular consideration was given to factors known to be present during bushfire campaign scenarios. This project resource briefly presents the literature surrounding the impact of temperature, noise, light and smoke on sleep in general. Additionally, the current state of knowledge concerning sleep in unfamiliar, workplace settings is also summarised.

Fatigue through the lack of sleep is one of three factors that the ASH project is investigating. The effects of prolonged exposure to carbon monoxide and heat are also being investigated.

ABOUT THIS PROJECT

The ASH study is being undertaken in the *Operational readiness of rural firefighters during bushfire suppression* project, part of the Bushfire CRC *Managing the threat* program. This project is jointly coordinated by CQUniversity and Deakin University.

LITERATURE REVIEW

Sleep is divided into two distinct states; Rapid Eye Movement (REM) sleep and Non-Rapid Eye Movement sleep (NREM). NREM sleep is then sub-divided into three different stages; N1, N2, N3. A good quality sleep includes all the sleep stages in the right amounts.

A normal night time sleep is characterised by a number of approximately 90 minute cycles. During each sleep cycle a person moves through the lighter stages of sleep (N1 and N2), into deeper sleep (N3) and then into REM sleep. As the night progresses the amount of deep sleep decreases and REM sleep bouts get progressively longer. Figure 1 is a visual illustration of the night time sleep of a healthy, younger adult.

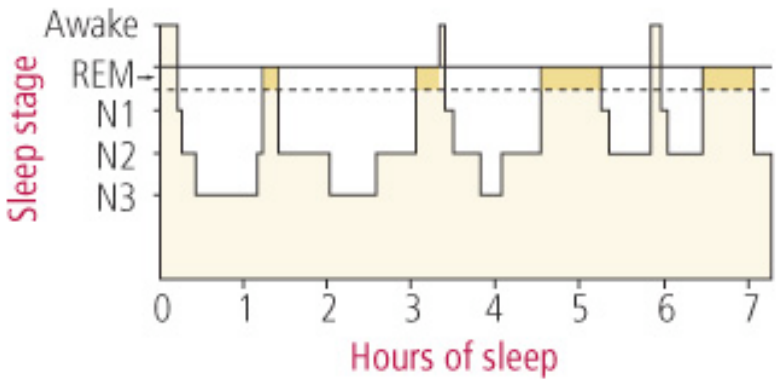

Figure 1. *Sleep Architecture – distribution of sleep stages across the night*
(Figure taken from http://www.helpguide.org/life/sleeping.htm, August 16 2012)

Temperature

Ambient temperature extremes tend to disrupt sleep. People respond to environmental temperature signals by sweating or shivering to regulate body temperature. However, a person's ability to regulate body temperature is limited when they are experiencing REM sleep. Therefore, if conditions are too hot or too cold, a person is more likely to wake up, particularly when in REM sleep. In extremely hot or cold conditions, comfort levels will be low and this can also make it difficult to get to sleep.

Noise

The World Health Organisation has developed guidelines regarding acceptable continuous noise limits and individual noise event limits during night time (i.e. normal sleeping) hours. Noise at the beginning of the sleep period can cause difficulties in initiating sleep. Once asleep, noise can disturb sleep by waking people up. However, sleep can be disturbed even in the absence of obvious awakenings. While noise may not be sufficient to completely wake someone up, it can increase time spent in a light sleep (N1 and N2), decrease deep (N3) and REM sleep and increase body movements.

Light

Light, especially sunlight, has an alerting effect. Thus, a well-lit sleeping environment can make falling asleep difficult and can prolong periods of wakefulness during the sleep period. In addition to its alerting effect, light exposure at certain times can shift the timing of a person's body clock. A person's drive to sleep is largely controlled by two main systems, one of which is the body clock, which manages the innate need to sleep at night and be awake during the day. Exposure to sunlight at the wrong time (i.e. during intended sleep periods) makes it difficult to adapt to some shift schedules, such as night shift, early morning shift or evening shift.

Smoke

The most highly toxic constituent of smoke is carbon monoxide (CO). The National Occupational Health and Safety Commission specifies limits surrounding both the daily average and maximum exposure concentrations for CO, which should never be exceeded. These limits are 30 parts per million and 400 parts per million respectively. In terms of the concentrations of CO that firefighters are likely to encounter, air sampling during a series of prescribed burns found that apart from 2% of cases recorded, the daily average exposure was within the prescribed limit of 30 parts per million (Reisen *et al.,* 2007).

Photo: CFA Strategic Communications

Given the noxious nature of the constituents of smoke (namely CO) little research has been undertaken into its effects during sleep. Light, noise and temperature can be safely manipulated in the laboratory (and field settings, albeit less easily), but there are ethical considerations surrounding exposure to CO above a certain level. A 1982 study showed increases in deep sleep (N3) and decreases in REM sleep in younger adults during exposure to CO over an eight hour period of 100 parts per million (Groll-Knapp *et al.,* 1982). Results of this study showed that the day following exposure, memory consolidation was impaired, with a tendency toward a more depressed mood. However, there is insufficient data to be conclusive about the impact of CO on sleep.

Unfamiliar surroundings

Some industries require workers to sleep away from their home on a regular basis. Examples include fly-in fly-out miners living onsite, a doctor sleeping in the hospital when on call or airline pilots in hotels between in and outbound flights. Similarly, firefighters live in temporary accommodation during campaign bushfires.

There are benefits to keeping workers near to or at work, whether this work is at a hospital, airport or fireground. Staying onsite significantly reduces commute times or may even eliminate the commute altogether. This is important, as driving at night or after an extended shift puts workers at an increased risk of an accident. From a workplace performance perspective, if workers are nearby they can respond and take action more quickly than if they have to travel from home.

Anecdotally, it is reported that people do not sleep as well when they are away from their home environment. Even when conditions are close to ideal (in terms of both timing of sleep and environmental factors such as temperature, light and noise), the quality of sleep is not as good. There is limited data comparing sleeping at home with sleeping in other locations that are not influenced by work schedules. However, one study compared sleep obtained by marine pilots both at and away from home (e.g. pilot houses or similar) (Ferguson *et al.,* 2005). Data revealed that total sleep was about 30 minutes longer at home (6.9 hours compared to 6.3 hours). In addition, subjective sleep quality ratings were lower when sleeping away from home. Importantly, work schedules did not influence the timing of sleeping away from home (most away sleeps occurred between 10pm and 7am) and pilots were not on call. The pilot houses where sleep occurred were designed for sleeping and thus the environment is not thought to have had adverse effects on sleep.

These data suggest that simply being away from home and away from familiar surrounds can negatively affect sleep quality.

At home but still working

Being at home, but on call for work can result in sleep disruption. Going to sleep, knowing there is potential to be woken up, may result in a degree of stress and/or anxiety. While there are very few field studies that demonstrate this, there are general links between stress and/or anxiety symptoms and the perception of poorer sleep quality. Similarly, anticipation caused by thoughts of having to wake early or being woken when on call have been shown to disrupt sleep, with one study showing a decrease in

deep sleep when on call, even when no calls occurred during the night. (Torsvall, 1988)

Tips to improve onsite sleep environment

1. Use earplugs to block out noise, or use 'white noise', such as a fan or a specific 'white noise' CD to help block other noises.
2. Situate sleeping quarters as far as practicable from other sections of the staging site (meal, management areas) to reduce noise for those trying to sleep (in particular where vehicles are moving around).
3. Where possible, have people sleep in individual rooms or smaller groups to minimise disturbance.
4. Have day crews sleep in one area and night crews in another area rather than mixing them up.
5. Keep the sleeping environment dark by using eye masks and/or blinds.
6. Wear dark glasses after a night shift to minimise the alerting impact of sunlight just prior to sleep.
7. Turn off mobile phones and pagers when it is not essential to have them on.
8. Keep the sleeping environment comfortable, but slightly cool (around 16 to 20°C).
9. Formalise or improve handover processes. If workers have confidence in their team members, work-related stress and anxiety can be reduced when not working.

More information on sleep and sleep health can be found via the Australasian Sleep Association, www.sleep.org.au, and the Sleep Health Foundation, www.sleephealthfoundation.org.au

References

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