

## ARTYKUŁ POGŁĄDOWY/REVIEW PAPER

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# Sleep deprivation due to long working hours: Impact on patient and provider safety

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## Summary

Anaesthesiology is a speciality with a need for on-call duty and long working hours. On-call duty is often characterised by a need for sustained vigilance, excessive work loads and a feeling of insufficiency. There is a growing amount of evidence that long periods of non-standard work or night work are associated with a deleterious influence on medical providers' performance and health. These working patterns decrease the standard of care and increase health care expenses. Beyond the effects on performance and patient safety associated with sleep deprivation, there is strong evidence linking shift work to gastrointestinal and cardiovascular diseases. Effective ways to counteract the consequences of sleep deprivation due to long working hours on an anaesthesiologist's performance include minimising night work, and defining rules on maximum hours for each work shift. *Anestezjologia i Ratownictwo 2009; 3: 20-23.*

*Keywords: anaesthesiology, fatigue, medical errors, physician health, safety, sleep deprivation*

## Introduction

The need for sleep and the circadian rhythm are genetically determined and healthy adults cannot acclimatise to disturbances in the timing of their sleep cycles. Optimal neurobehavioral performance requires circadian patterns of sleep and wakefulness [1]. Even though physicians do not often recognise it, they are negatively affected by night work or long working hours, just like any other humans. Irrespective of their career level or speciality, they are unable to maintain the same level of alertness and performance at night time or during extended work as they can during day time or during a normal working pattern. In addition to performance impairment associated with fatigue, there is increasing evidence linking extended shift work to specific health disorders (e.g. coronary artery disease and breast cancer).

## Sleep disturbance and performance changes

There is abundant evidence that fatigue caused by sleep deprivation and disruption of circadian rhythm contributes to performance decrements in discrete neurocognitive and simulated tasks. These include prolonged reaction times, reduced accuracy in repeated tasks, increased perception lapses, declining concentration, deteriorated decision making capacity and diminished fulfilment of required tasks. Also, when fatigued, the human capacity to solve unexpected situations decreases, performance variability increases, communication skills deteriorate, motivation weakens and irritability worsens with weakened empathy [2].

It is illustrative to compare impairment related to alcohol ingestion with that related to fatigue. Already, the first study to make this comparison has shown that 24 hours of sustained wakefulness reduces individual

performance by a level produced by a blood alcohol concentration of 0.8 to 1.0 ‰ [3]. Neurobehavioral impairment may be similar after acute sleeplessness and chronic sleep deprivation. Complete 24-hour sleep loss deteriorates individual performance to a level equivalent to only five hours of sleep for one week [4]. It is important to realise that humans do not properly recognise the effects of fatigue in themselves. A recent study showed that when people suffer from chronic sleep deprivation that deteriorates their performance to a level equivalent to 48 hours of wakefulness, they evaluated their own sleepiness scores mistakenly good [5].

Several studies have shown that napping is a very effective way to reduce the untoward effects of fatigue caused by a whole night's work [6]. Alertness can be improved by naps (half an hour) taken around the circadian trough during the early morning hours [7]. These work-rest schedules should be incorporated into the field of anaesthesiology in a similar way as in the safety-sensitive industry of aviation, and can be organised in the field of health care through closer collaboration between different night workers in the same profession.

### Fatigue and patient safety

Several studies show that our performance becomes significantly impaired if we work through the whole night or if we obtain fragmented sleep due to being on-call. The documentation consists of studies on both residents and specialists of various specialities: anaesthesia residents carry out endotracheal intubation slower and with more errors [8], university hospital anaesthesiologists have six times more dural punctures when performing epidurals [9], surgical residents perform laparoscopic procedures slower and with more errors [10-11], and senior cardiologists have a higher failure rate and patient mortality when they dilate coronaries in acute myocardial infarction [12], when the procedures are carried out at night or immediately after a long period on-call.

The study that helped re-shape the policy of the American Accreditation Council for Graduate Medical Education (ACGME) found that intensive care unit residents made significantly more severe medical, medication and diagnostic errors if their working schedules entailed a maximum of 34 consecutive working hours instead of 16 [13]. The ACGME has subsequently

decreased the maximum weekly working hours and the number of hours for each work shift for residents.

A recent meta-analysis showed that the clinical performance of residents is less than minus 1.5 standard deviations from normal, when they work 30 consecutive hours [14]. Normal Gaussian distribution curves clarify the result clearly: half the residents who worked excessive hours performed at a lower level normally extant only in 6% of the residents. The result also indicates that after an extended work period, half of all individuals' performance are as poor as normally only six percent of their performances would be.

These and numerous similar studies give cause to ask why we, as physicians, accept this kind of poor performance produced by lack of rest. Our patients and hospitals, as well as ourselves, expect that physicians offer safe and effective care 24 hours a day, and so we should vigorously fight to avoid fatigue and to organise night work and night duties properly [15].

### Health hazards of night work

In addition to safety risks and performance impairment, strong evidence suggests that night work has serious consequences for our health. For example, the incidence of duodenal ulcers is four times greater, and that of cardiovascular diseases, 40% greater among shift workers compared to day workers [16-17]. Shift work carries with it 2.3 times the risk of ischaemic heart disease than day work [18]. Finland (with five million inhabitants), has >250 annual coronary deaths due to night work [19]. Even though this death rate is close to that produced by traffic accidents, we rarely discuss the mortality rate of night work.

A meta-analysis of several large studies showed that shift workers have 1.5 times greater incidence of a breast cancer when compared to day workers [20]. It has been estimated that in Finland, more than one hundred breast cancer cases annually are caused by night work. Several health risks caused by night work are mediated via different hormonal or metabolic pathways. Breast cancer is likely caused by abnormal melatonin and oestrogen secretions [20], and cardiovascular diseases by changes in lipid metabolism and endothelial function [21] etc.

The effect of sleep deprivation on performance has special significance to anaesthetists, as we are the physicians with more night duties than any other specialists. Burnout, exhaustion and stress symptoms in anaesthe-

tists have been shown to correlate with their on-call workload [22]. Furthermore, the same study showed that a greater on-call workload was also associated with increased suicidal tendencies. Another study reported that long working hours and night duties were experienced as the second most stressful characteristics by anaesthetists in a university hospital [23].

Many other health problems have also been shown to associate with night work, extended working periods and sleep deprivation. These include diabetes, inflammations, metabolic disorders and increased overall mortality and morbidity. Night work also has serious effects on reproductive health, e.g. premature births, miscarriages and fertility. It also increases the incidence of injuries and work and traffic accidents [24-26].

### How to change current policy?

Multiple studies have shown that night work causes many significant adverse effects. However, we have to cover a certain amount of night work in many hospital specialities. Therefore, if we want to minimise the described un-toward effects on our performance and health, and on patient outcome, we should consider the design of our on-call duties, place limits on the shift lengths and reduce the amount of night work as much as possible.

Some five years ago in the department of anaesthesiology at Oulu University Hospital, the weekend on-call pattern of 24 hours was divided into shifts of 12 hours, but the number of anaesthesiologists required to cover a weekend on-call remained the same (e.g. three). Each anaesthesiologist had two 12-hour shifts with a 24-hour break between the shifts instead of having one 24-hour shift. The on-call doctor who came to work on Friday evening was off the preceding day, while the doctor who finished his on-call duty on Monday morning came back to work on Tuesday morning. This pattern began as an experiment for three months, but the anaesthesiologists were so satisfied with the system that it became established practice.

At the Hospital for Children and Adolescents of the University of Helsinki, emergency surgery is classified as either red, yellow or green (“traffic lights”) depending on the need to operate within 6, 24 or 72 hours [27-28]. Only red patients are operated on at night time, the others are operated on during the daytime. This design has decreased night time operations by over 50%. Traffic lights have also improved resident education, standardised several procedures and diminished a variety of factors, such as the annual number of appendectomies. The Traffic light system has also reduced the incidence of severe work-related exhaustion and fatigue among operating theatre staff [27].

The European working time directive may improve the safety of night workers and especially of doctors, if the European Parliament maintains a strong position in the renewal procedure of the directive. A modified working time directive may demand that the entire time the doctor has to stay in the hospital for his on-call duty be counted as work, and also require that doctors have a daily rest period of 9-11 hours. Several European medical organisations have stated that these changes would beneficially effect the safety of doctors as well as patient outcomes [29]. Possible new on-call schedules must, however, be balanced against appropriate continuity of patient care.

Even though putting limits on extended working periods would improve the quality of doctors’ lives, it would not as such reduce work done at night time. Therefore, we should seek the support of local employers for our strategies when aiming to set restrictions on night time work loads in hospitals. This reduction would clearly improve the quality of care and well-being of the whole staff, promote safety in the work environment and at the same time reduce health care expenses.

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## Piśmiennictwo

1. Dijk DJ, Lockley SW. Integration of human sleep-wake regulation and circadian rhythmicity. *J Appl Physiol* 2002; 92: 852-62.
2. Howard SK, Rosekind MR, Katz JD, Berry AJ. Fatigue in anesthesia. Implications and strategies for patient and provider safety. *Anesthesiology* 2002; 97: 1281-94.
3. Dawson D, Reid K. Fatigue, alcohol and performance impairment. *Nature* 1997; 388: 235.
4. Dinges DF, Pack F, Williams K, Gillen KA, Powell JW, Ott GE, Aptowicz C, Pack AI. Cumulative sleepiness, mood disturbance, and psychomotor vigilance performance decrements during a week of sleep restricted to 4-5 hours per night. *Sleep* 1997; 20: 267-77.
5. Lockley SW, Landrigan CP, Barger LK, Czeisler CA. When policy meets physiology. The challenge of reducing resident work hours. *Clin Orthop Rel Res* 2007; 449: 116-27.
6. Driskell JE, Mullen B. The efficacy of naps as a fatigue countermeasure: a meta-analytic integration. *Hum Factors* 2005; 47: 360-77.
7. Sallinen M, Härmä M, Akerstedt T, Rosa R, Lillqvist O. Promoting alertness with a short nap during a night shift. *J Sleep Res.* 1998; 7: 240-7.
8. Smith-Coggins R, Rosekind MR, Buccino KR, Dinges DF, Moser RP. Rotating shiftwork schedules: can we enhance physician adaptation to night shifts? *Acad Emerg Med* 1997; 4: 951-61.
9. Aya AG, Mangin R, Robert C, Ferrer JM, Eledjam JJ. Increased risk of unintentional dural puncture in night-time obstetric epidural anesthesia. *Can J Anaesth* 1999; 46: 665-9.
10. Taffinder NJ, McManus IC, Gul Y, Russell RC, Darzi A. Effect of sleep deprivation on surgeons' dexterity on laparoscopy simulator. *Lancet* 1998; 352: 1191-2.
11. Grantcharov TP, Bardram L, Funch-Jensen P, Rosenberg J. Laparoscopic performance after one night on call in a surgical department: prospective study. *BMJ* 2001; 323: 1222-3.
12. Henriques JP, Haasdijk AP, Zijlstra F, Zwolle Myocardial Infarction Study Group. Outcome of primary angioplasty for acute myocardial infarction during routine duty hours versus during off-hours. *J Am Coll Cardiol* 2003; 41: 2138-42.
13. Landrigan CP, Rothschild JM, Cronin JW, Kaushal R, Burdick E, Katz JT, Lilly CM, Stone PH, Lockley SW, Bates DW, Czeisler CA. Effect of reducing interns' work hours on serious medical errors in intensive care units. *NEJM* 2004; 351: 1838-48.
14. Philbert I. Sleep loss and performance in residents and nonphysicians: a meta-analytic examination. *Sleep* 2005; 28: 1392-402.
15. Iglehart JK. Revisiting duty hour limits – IOM recommendations for patient safety and resident education. *NEJM* 2008; 359: 2633-5.
16. Pietroiusti A, Forlini A, Magrini A, Galante A, Coppeta L, Gemma G, Romeo E, Bergamaschi A. Shift work increases the frequency of duodenal ulcer in H pylori infected workers. *Occup Environ Med* 2006; 63: 773-5.
17. Boggild H, Knutsson A. Shift work, risk factors and cardiovascular disease. *Scand J Work Environ Health* 1999; 25: 85-99.
18. Fujino Y, Iso H, Tamakoshi A, Inaba Y, Koizumi A, Kubo T, Yoshimura T, Japanese Collaborative Cohort Study Group. A prospective cohort study of shift work and risk of ischemic heart disease in Japanese male workers. *Am J Epidemiol* 2006; 164: 128-35.
19. Tenkanen L, Sjoblom T, Kalimo R, Alikoski T, Harma M. Shift work, occupation and coronary heart disease over 6 years of follow-up in the Helsinki Heart Study. *Scand J Work Environ Health* 1997; 23: 257-65.
20. Megdal SP, Kroenke CH, Laden F, Pukkala E, Schernhammer ES. Night work and breast cancer risk: a systematic review and meta-analysis. *Eur J Cancer* 2005; 41: 2023-32.
21. Mullington JM, Haack M, Toth M, Serrador JM, Meier-Ewert HK. Cardiovascular, inflammatory, and metabolic consequences of sleep deprivation. *Progr Cardiovasc Dis* 2009; 51: 294-302.
22. Lindfors PM, Nurmi KE, Meretoja OA, Luukkonen RA, Viljanen AM, Leino TJ, Harma MI. On-call stress among Finnish anaesthetists. *Anaesthesia* 2006; 61: 856-66.
23. Kinzl JK, Traweger C, Trefalt E, Riccabona U, Lederer W. Work stress and gender-dependent coping strategies in anesthesiologists at a university hospital. *J Clin Anesth* 2007; 19: 334-8.
24. Barger LK, Cade BE, Ayas NT, Cronin JW, Rosner B, Speizer FE, Czeisler CA, Harvard Work Hours, Health, and Safety Group. Extended work shifts and the risk of motor vehicle crashes among interns. *NEJM* 2005; 352: 125-34.
25. Folkard S, Lombardi DA. Modeling the impact of the components of long work hours on injuries and "accidents". *Am J Industrial Med* 2006; 49: 953-63.
26. Folkard S. Shift work, safety, and aging. *Chronobiol Internat* 2008; 25: 183-98.
27. Kallio P, Meretoja O, Salminen P, Arjatsalo C Liikennevalo-ohjaus tehostaa päivystysleikkaustoimintaa ja parantaa henkilökunnan työhyvinvointia (Traffic-light guidance of emergency operations). *Suom Lääkäril* 2006; 48: 5075-81.
28. Meretoja OA. We should work less at night. *Acta Anaesthesiol Scand* 2009; 53: 277-9.
29. [http://cpme.dyndns.org:591/adopted/2008/CPME\\_AD\\_Brd\\_140608\\_141\\_EN.pdf](http://cpme.dyndns.org:591/adopted/2008/CPME_AD_Brd_140608_141_EN.pdf)