

Is a Surgeon's Operative Performance Worse after a Night Shift?

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In the last 20 years sleep science has matured and ground-breaking research has unveiled metabolic and gene-level alterations associated with sleep deprivation. Studies have demonstrated epigenetic changes to tumour suppressor and circadian rhythm genes as a result of one-night of sleep deprivation [1,2] or a longer-term lack of sleep by as little as 2 hours each night.

Impact on higher function manifests as short-term ante-grade amnesia, lack of social inhibitions, a state of anxiety followed by depression and weight-gain due to impulse eating. Studies have demonstrated up to a 1.5 standard deviation lower peak performance during the state of sleep deprivation, whether chronic partial, or acute [3,4]. Motor function also deteriorates, resulting in low strength, a lack of coordination and blunted reflexes.

To quantify these effects, studies have shown the effects equivalent to intoxication at the legal alcohol limit for driving [5]. Study subjects were also unaware of this deterioration in performance, in a way similar to alcohol intoxication. Metabolic effects include epigenomic changes in lipid biosynthesis leading to hyperlipidemia, high blood glucose levels, low cortisol levels and sustained high blood pressure in response to stress. A large prospective cohort study published in 2015 [6] revealed all-cause mortality (HR 1.11 95% CI 1.06 - 1.17) and cardiovascular disease related mortality to be higher HR 1.23 95% CI 1.09 - 1.38) in nurses working night shifts for more than 5 years.

Relevant professional bodies have issued guidance acknowledging the impact sleep deprivation has on our general health and life expectancy. Guidance published on National Health Service (NHS) England website states regular poor-quality sleep puts you at risk of serious medical conditions, including obesity, diabetes and heart disease; and it shortens your life expectancy [7]. The British Medical Association (BMA) published guidance on fatigue and sleep deprivation in January 2018 [8]. It states that long work-shifts associated sleep deprivation and fatigue impacts personal safety, patient safety and in the long-term appears to increase breast, prostate, colorectal cancer and dementia.

International Agency for Research on Cancer (part of the World Health Organization) classifies carcinogens into four categories based on the strength of the scientific evidence about an agent being a cause of cancer, Group 1 (conclusive evidence), Group 2A (strong evidence but inconclusive), Group 2B (some evidence but far from conclusive) and Group 3 (no evidence of carcinogenicity to humans). "Shiftwork that involves circadian disruption" is a Group 2A carcinogen, meaning there is strong evidence it causes cancer.

It is therefore only natural to wonder how night shift working may impact a surgeon's performance. The most common shift pattern following the European Working Time Directive (EWTd) is usually a set of three or four 12-hour night shifts. This may be associated with a compounded loss of sleep and gradual deterioration in function. One of the very first studies on the subject; fatigue in surgeons performing anterior resections for colorectal cancer following a night shift, was published in American Journal of Surgery in 2008 [9]. In this study, no statistical difference was noted in recurrence rates, intra-operative, post-operative and long-term complications.

In 2009, a retrospective cohort study concluded there was an increase in postoperative complication rates when surgeons operated with less than 6 hours of sleep compared to their colleagues who had also done a night shift but managed to get more than 6 hours of sleep (6.2% vs 3.4% OR 1.72 95% CI 1.02 - 2.89) [10]. A similar study published in 2013 found no difference in outcomes when looking at daytime elective laparoscopic cholecystectomies [11]. This study measured "conversion to open procedure" as a primary outcome. The authors believed it was an aggregate marker of complications arising intra-operatively.

In 2015, an article from the New England Journal of Medicine looked at cross-specialty surgical complication rates [12]. This was a retrospective study in Canada using cost-codes to assess time worked. The authors found no statistically significant difference in 30-day complication and mortality rates. The study highlighted its limitations, with some indication that those with years of experience perform better in a state of sleep deprivation compared to those who are on the learning curve, such as trainees [13]. This could be explained by the magnitude of higher-order brain function necessary to perform unrecognized and unfamiliar procedures. This function is significantly impaired with sleep deprivation. It may highlight an experienced surgeon's self-awareness and management. They were likely to cancel activity or seek help from well-rested colleagues if they felt they were not up to task, the study stated. Yet, on sub-group analysis, they found a statistically significant increase in complication rates when surgeons had performed more than one procedure overnight, which would align with Rothchild's results of less than 6 hours of sleep impacting surgical outcomes [10].

Various studies have demonstrated varying results with sleep duration and its impact on health. A consensus statement issued by the American Academy of Sleep Medicine and Sleep Research Society state, "6 hours or less (of sleep) was inappropriate to support optimal health" and "7 to 9 hours (of sleep) was appropriate to support optimal health". "The appropriateness of 9 or more hours of sleep could not be ascertained" [14].

Arguably, reasons for sleep deprivation are not limited to work. There has been a drive from professional bodies to address mental health within the healthcare industry. It comes as data emerges about depression and suicide rates [15]. A large meta-analysis of studies focusing on the psychological impact of long shifts, stress and depression and their relation to suicide rate in the medical profession revealed that the profession "Physician" is classified "at risk" for suicide with a standardised mortality ratio (SMR) of 1.44 (1 being baseline in society), with higher risk if the physician is female (SMR 1.9) and even higher if she is either a general surgeon, an anaesthetist, a psychiatrist or a general practitioner. These SMR figures are worse than suicide rates amongst those in the armed forces in the UK [16].

Consumption of stimulants is common and may seem a necessity in light of deteriorating performance in the workplace and the psychological impact of sleep deprivation. Socially acceptable stimulants such as coffee (caffeine) and smoking (nicotine) become the mainstay drugs for self-medicating. Coffee is the world's most popular drink at present [17].

Caffeine half-life plays a major role in preventing sleep hygiene. A serum caffeine level as low as 9 mg is known to be psychoactive. Paraxanthine, a key psychoactive metabolite of caffeine, slows caffeine clearance by the kidneys and to this effect, regular consumers of caffeine have higher circulating levels of both Caffeine and Paraxanthine, placing them at a higher risk of insomnia and disrupted sleep cycles. Paraxanthine levels remain high at 8 hours post caffeine consumption. It takes approximately 30 hours to clear serum caffeine levels down to 7 mg following a large latte from named coffee vendors, containing upwards of 225 mg in each drink [18].

A better understanding of good sleep is pivotal to help improve circadian habits. Sleep researchers claim that sedation does not equal sleep [19]. The Brainstem and the frontal lobe are selectively active during sleep in comparison to propofol sedation, which exerts a global depressive effect. Functional connectivity (FC) mapping by Magnetic Resonance Imaging (MRI) identified a stronger activity, especially between the cortex and subcortical structures during sleep. This may explain memory consolidation and learning which requires active processing of information within areas of the brain. These functional connectivity's were not present in the propofol-sedated subjects.

In the 2000s, clinical sleep medicine was taken over by the concept of Sleep Hygiene, a set of environmental and behavioural changes, which lead to, improved sleep in the research and clinical setting [20]. Since, it has been widely promoted and adopted in clinical use. It appears to work effectively only when adequate support resources are available. Consequently, sleep clinicians and researchers identified sleep hygiene as a mono-therapy to tackle insomnia being largely ineffective in the community. This has led to social awareness and campaigns. Aimed at raising awareness and providing support necessary for sleep hygiene, charities have promoted campaigns like "Sleeptember" in the public sector. To conclude, sleep education is important and it should be considered in your practice and education.

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