Health effects of sleep deprivation on nurses working shifts

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Summary
Introduction. Atypical work schedules cause reduced sleep, leading to drowsiness, fatigue, decline of cognitive performance and health problems among the members of the nursing staff. The study was aimed at reviewing current knowledge and attitudes concerning the impact of sleep disorders on health and cognitive functions among the members of the nursing staff. Sleep and Interpersonal Relations in Modern Society. The modern 24-hour society involves more and more employees (health services, police departments, public transport) in non-standard forms of work. In European Union countries, over 50% of the nursing staff work night shifts, while in the United States of America 55% of nursing staff work more than 40 hours a week, and 30-70% of nurses sleep less than six hours before their shift. Cognitive Effects of Sleep Deprivation. Sleep deprivation impairs the performance of tasks that require intensive and prolonged attention which increases the number of errors in patients care, and nurses are subject to increased risk of traffic accidents. Sleep Deprivation and Health Disorders. Sleep deprived members of the nursing staff are at risk of obesity, diabetes, gastrointestinal disorders and cardiovascular disease. The risk factors for breast cancer are increased by 1.79 times, and there is a significantly higher risk for colorectal carcinoma. Conclusion. Too long or repeated shifts reduce the opportunity for sleep, shorten recovery time in nurses, thus endangering their safety and health as well as the quality of care and patients’ safety. Bearing in mind the significance of the problem it is necessary to conduct the surveys of sleep quality and patients’ health among the members of the nursing staff. The study was aimed at reviewing current knowledge and attitudes concerning the impact of sleep disorders on health and cognitive functions among the members of the nursing staff. The modern 24-hour society involves more and more employees (health services, police departments, public transport) in non-standard forms of work. In European Union countries, over 50% of the nursing staff work night shifts, while in the United States of America 55% of nursing staff work more than 40 hours a week, and 30-70% of nurses sleep less than six hours before their shift. Cognitive Effects of Sleep Deprivation. Sleep deprivation impairs the performance of tasks that require intensive and prolonged attention which increases the number of errors in patients care, and nurses are subject to increased risk of traffic accidents. Sleep Deprivation and Health Disorders. Sleep deprived members of the nursing staff are at risk of obesity, diabetes, gastrointestinal disorders and cardiovascular disease. The risk factors for breast cancer are increased by 1.79 times, and there is a significantly higher risk for colorectal carcinoma. Conclusion. Too long or repeated shifts reduce the opportunity for sleep, shorten recovery time in nurses, thus endangering their safety and health as well as the quality of care and patients’ safety. Bearing in mind the significance of the problem it is necessary to conduct the surveys of sleep quality and health of nurses in the Republic of Serbia as well in order to tackle this issue which is insufficiently recognized.

Key words: Nursing Staff, Hospital; Nurses; Sleep Deprivation; Sleep Disorders, Circadian Rhythm; Burnout, Professional; Workload; Cognition; Attention; Arousal; Risk Factors; Obesity; Diabetes Mellitus; Neoplasms; Quality of Health Care

Sažetak

Ključne reči: bolničko osoblje; medicinske sestre; nedostatak sna; poremećaji sna; obitelj; profesionalna izgiranje; preopterećenost poslovom; kognicija; pažnja; budnost; faktori rizika; gojaznost; dijabetes melitus; karcinomi; kvalitet zdravstvene nege

Introduction
Sleep is a biological necessity essential for life and our optimal health. We are capable of altering most of our habits significantly, but we cannot give up sleep for longer than short periods of time. Nowadays, there are professions and vocations across the world whose specific duties oblige their members to follow reverse work-sleep schedule, sleeping during daylight hours and being awake during the night. However, poor sleep quality, insufficient amounts of sleep, and wrongly adjusted sleep cycle may negatively affect mental and physical functioning in the waking state [1].

Nurses in healthcare systems play a central role in patients’ care and health care teams by performing
countless tasks critically associated with risks for a patient’s safety [2], as well as managing a number of dynamic work processes under conditions of extreme workload, and multiple time pressure [3]. Although nurses are known for their commitment to health promotion, the irony is that they are, more than any other profession, at risk from exposure to many serious health disorders and disturbed mental and social well-being, resulting in a reduction of job performances which can affect both the quality of care and patients’ safety because of the nature of their work and work schedules. Night shift work is preconditioned by the need to provide 24-hour care and may result in reduced sleep due to desynchronization in the regulation of endogenous circadian rhythms, leading to accumulated “sleep debt”, sleepiness and fatigue, which, in turn, results in increased physical and psychological health problems in nurses [4].

The data reported in the literature have shown that sleep disorders, and related health problems, are at least as prevalent in nurses as in other professional groups that are traditionally considered risky. Despite the fact that nurses in Serbia comprise one of the largest segments of professionals working in the healthcare system, the literature review for our country reveals that there is no indication of addressing adequately the adverse effects of sleep deprivation on health and cognitive functioning in nurses. Thus, this study was aimed at determining the current knowledge and attitudes about sleep deprivation and its effects on nurses’ health and cognitive functioning.

Sleep and Modern Society Relationships

Throughout the development of civilization, humans mainly worked and lived modulating their everyday activities to day/night cycle. The emergence of modern industrial society with its socio-cultural and technological evolution contributed to the disruption of this natural rhythm, whereas the introduction of artificial light, continuous technological processes and shift work have established preconditions for developing sleep disorders [3]. The society, therefore, as a result of social changes, economic and technological progress and globalization of markets, is moving ever closer towards a “24-hour society“. Due to these changes more and more of the working population is involved in some of the non-standard working patterns (shift work, night shift work, readiness shifts etc.). This is primarily related to those working in service sector (health, police and transport), for whom there is an expectation, as well as an actual need of constant availability in the course of 24 hours [5]. Although public services that are at disposal 24 hours a day may benefit society, shift work might have adverse effects on the workers themselves (poor health, family/social issues), as well as on the society as a whole (accidents and performance errors) [6]. In European Union (EU) countries, shift work is most common in the health care sector, with about one-third engaged in shift work [5].

Sleep and Atypical Patterns of Work as a Phenomenon of Professional Nursing Practice

Atypical work schedules of nurses in hospital sector were arranged as a result of two conflicting problems: the growing demands for higher quality patients’ care and the global phenomenon of health-systems financial constraints that require “maximum effective work with a minimum staffing”. Thus, extended work shifts of twelve hours, or longer, which began towards the end of the 80’s, have now become omnipresent within nursing [7], creating over-demanding work environment for nurses. They have to provide care for a large number of patients, often with no breaks, or a rest during working hours, as well as without sufficient hours of rest between shifts [8]. Consequently, nursing staff are often fatigued and uncertain about whether they are able to make sound judgments to provide adequate care for patients, prompting them to leave nursing profession. All remaining nurses are forced into working overtime, and workload increases due to staff shortage, thus completing what has been described as the vicious cycle [9].

Secondary analysis of data collected from eight countries, as a part of longitudinal NEXT study, has revealed that over 50% of nurses work night shifts, whereby in France most nurses (15.6%) work a permanent night shift, whereas the highest number of nurses working rotating night shifts has been found in Slovakia (70.8%) and Poland (68.4%) [10]. According to data survey conducted by the American Nurses Association (ANA), 53% of nurses work unplanned overtime, 55% work more than 40 hours per week [11], while 9% work more than 60 hours per week [9]. Despite recommendations and even legal provisions in certain countries (the United States of America) limiting the shift length to 12 hours and prohibiting overtime except in emergency situations, they are used very flexibly, depending on the approval of the hospital or the decisions made by the nurses themselves, regarding their overtime work [12]. Nurse mandatory overtime regulations do not limit nurses’ voluntary overtime work hours [9]. Their 12-hour shift is actually more than 13 hours in length- either to complete documentation, admit a new patient, report shift handover, assist a colleague, to increase their income, or to accumulate more days off in a row [7].

Regardless of whether nurses are motivated by altruism, a sense of responsibility, fear of job loss, or monetary gain, they risk their health and safety when they are sleep-deprived and chronically tired. Data analysis from a study done by Geiger-Brown et al. showed that daily sleep time for day- and night-shift nurses was 5.7/5.2 hours following a first 12-hour shift, and 7.7/5.5 hours following a second
Mechanisms of Sleep Regulation

The cycle of sleep-wakefulness is a natural part of human life, which includes sleep through the night and wakefulness during the day [18]. Our sleep pattern is governed by two basic physiological processes: a) homeostatic sleep pressure is referred to the pressure of sleep after consecutive hours of wakefulness and makes us more wakeful as the day progresses; b) the circadian body clock promotes wakefulness at usual times for everyday activities, as well as sleepiness at the usual bedtime [19]. Thus, the homeostatic system tends to make us sleepier as time goes on, whereas circadian wake-promoting signal prevents us from falling asleep.

Circadian modulation of sleep pressure, or circadian variations in susceptibility to sleep, primarily depend on the signal from the circadian pacemaker located in the hypothalamic suprachiasmatic nuclei, which is in the close interaction with various environmental and social markers [20]. Suprachiasmatic nuclei receive light intensity-dependent signals [21], interpret them, then pass on signals to the pineal gland, which in response secretes more or less of the hormone melatonin [22]. Inhibition of suprachiasmatic nuclei released in the dark phase leads to increased secretion of melatonin, which, in turn, promotes transition to sleep and sleep onset [23]. Light stimulates the suprachiasmatic nuclei via the suppression of melatonin production, and in response to hypothalamic-pituitary-adrenal axis activation stimulates increased cortisol levels, helping to wake up in the morning [24]. The circadian wake-promoting signals decrease during the evening hours with an increase of homeostatic sleep pressure, resulting in the onset of sleep [20].

Therefore, altered levels of melatonin due to prolonged exposure to light result in desynchronization between the internal hormonal environment and external environment, explaining poor sleep quality of nurses working night shifts [23]. Consequently, nurses experience misalignment of their circadian rhythms in relation to their rotating schedules, particularly at night, attempting to work and sleep at the “wrong circadian phase”. Their homeostatic and circadian sleep systems no longer act synergistically to maintain the adequate sleep-wake relationship and they have to fight to stay awake during the night, faced with the increase in homeostatic sleep pressure and absence of wake-promoting signal from suprachiasmatic nuclei [22]. Only a small number of nurses are able to adjust their circadian rhythm with a sleep/wake ratio as required by their profession, while the majority of them in different ways deal with the problems that result from shift work by experiencing various inconveniences and disturbances. Getting enough rest after a night shift can help to alleviate sleep disorders in nurses working rotating shifts [23]. However, short breaks between shifts can accumulate sleep deprivation over several consecutive nights resulting in sleep debt mounting. Thus, further increasing fatigue and sleepiness involve decline in performance and increased risk of accidents and errors [20].

Effects of Acute and Chronic Sleep Deprivation on Cognitive Performance

Failure to satisfy the needs for both adequate and appropriately timed sleep can result in a noticeably reduced ability to learn, remember, use sound judgment, focus effectively and perform tasks safely [11], particularly those that require intensive, or prolonged attention [25].

Sleep loss changes the activity of the prefrontal cortex involved in higher-order cognitive processing, such as decision-making. Consequently, sleepy nurses can be prone to use inadequate algorithms for decision making [26] and routinely solving a problem, and they can fail to identify available alternatives clearly, which increase the likelihood of risky decisions and adverse outcomes for patients [19, 25, 26]. Communication skills decrease as sleep deprivation increases. The nurse may have trouble finding the right word, or properly interpret what others have said, or written. This can lead to nurses’ misjudgment of situation, and result in avoiding communication, or communicating inadequately [25].

Overworked nurses tend to make mistakes in judgment thus causing medication errors, negligent patients’ care and accidents [26]. Studies have shown that nurses who work 12-hour shifts when compared to those who work 8-hour shifts nearly triple the chance of making an error [25]. Bjørnevået et al., [18] by referring to Scott et al. study of inen-
sive care unit nurses, conducted in the United States, suggest that during the 28-day study period errors were reported in 27% of nurses, “almost error” in 38% and 20% of nurses fell asleep at least once during that period. Alertness, concentration and caution, crucially important to provide safe and high-quality care, have been lowered in sleep-deprived and overworked nurses.

A study conducted in Norway shows that unintended sleep episodes at work occur eight times more frequently in nurses working in intensive care than in women from a Norwegian general population sample [18]. Additionally, sleep deprivation and fatigue in nurses is an important public health issue. Due to their demanding work schedules, sleep-deprived nurse fatigue becomes a potential hazard to nurses themselves, and other road users [25]. Eanes [11], citing a study by Scott et al., conducted in the United States, said that during the four-week study period, 67% of nurses in night shifts reported at least one episode of drowsy driving home, and 2.4% reported having experienced drowsy driving after every shift. According to the results of a Swedish study, 25% of the night shift nurses were sleepy while they were getting themselves ready to drive home [7].

**Sleep Loss and Health Related Disorders in Nurses**

**Sleep Loss and Obesity**

In addition to poor dietary habits, increased caloric intake and lack of exercise, sleep loss is considered to be a potential risk factor for obesity. Those who consistently sleep less than 6 hours in a 24-hour period are significantly more likely to have a higher body mass index (BMI) [11]. The data of cross-sectional study of 2,103 nurses, conducted in the United States, suggested that irregular shifts, working extended hours, poor eating habits and sleep insufficiency were related to obesity in nurses [27]. Low levels of hormone leptin (appetite-suppressing hormone) and high levels of ghrelin (appetite stimulant) in the serum of individuals have been associated with sleeping less than seven hours a day, which may explain an increased hunger and intake of calorie-dense foods and obesity in those with insufficient sleep [11].

**Sleep Loss and Diabetes**

Researchers believe that chronic, partially reduced sleep may increase the risk of diabetes independent of changes in BMI [11]. Twenty years of research which included the 177,000 nurses within the Nurses’ Health Study showed that the major risk factor for type 2 diabetes increased with the number of years of shift work. Nurses with 1-2 years of shift work had a 5% higher risk than those who did not work in shifts, while the risk was 60% higher in nurses with more than 20 years of shift work [28]. Chronic sleep loss may lead to persistent insulin resistance and hyperinsulinemia, resulting in excess plasma glucose, which ultimately increases the risk of diabetes [29]. In addition, short sleep duration alters the secretion of growth hormone, elevate the cortisol level and increase the sympathetic tone, all of which affect the activity and release of insulin [11].

**Sleep Loss and Disorders of the Gastrointestinal Tract**

Chronic disruption of biological rhythms due to shift work has been associated with the development of serious gastrointestinal disease. The results of a study conducted in Michigan showed significantly higher prevalence of inflammatory bowel disease in nurses working rotating night shifts than in day shift nurses [30]. In addition, nurses who work the night shift have a higher incidence of peptic ulcers and disorders, such as constipation and diarrhea [29].

**Sleep Loss and Cardiovascular Problems**

The onset of arterial hypertension due to disturbed circadian rhythm of blood pressure and diabetogenic profile potentiates atherosclerosis and can cause a cardiovascular disease (CVD) [31]. Studies have shown that prolonged sleep deprivation increases the risk of developing CVD and induces insulin resistance by augmenting proinflammatory cytokine production (interleukin-6) [32, 33]. In addition, higher rates of obesity and cigarette smoking may contribute to increasing the risk of CVD in the shift worker population [29]. In a Brazilian study which included 620 nurses, the prevalence of CVD was 18% and 21% of nurses who worked only day shift and those who worked only night shift, respectively. The presence of nocturnal sleep disorders increased the probability of occurrence of CVD 2.79-fold, while the presence of the nocturnal and diurnal sleep disturbances increased this probability 3.07-fold [34].

**Sleep Loss and Risk of Malignant Diseases**

According to the data from the Nurses’ Health Study showed that the nurses who had been working at least three rotating night shifts a month for 15 years, or more, had a significantly greater risk of developing colorectal cancer as compared with nurses who did not report working rotating night shifts [30]. The nurses who reported more than 20 years of rotating night shift work were 1.79 times more likely to have an increased risk of breast cancer than nurses who never worked shifts [29]. It has been accepted that the risk of cancer increases as a result of the reduced levels of melatonin production at night [11, 29, 33–35]. The decline in melatonin secretion levels leads to immunosuppression including the reduced natural killer cells activity (NK), which can also be one of the variables affecting the increased cancer risks in the studied population [35].

**Conclusion**

Long or more frequent shifts reduce the chances for nurses to get enough sleep and decrease the length of recovery time between shifts. Despite speci-
fic recommendations that nurses working shifts in any day do not exceed 12 hours, these recommendations, as well as legal provisions, are being slowly adopted and flexibly interpreted. These data are worrisome since the degree of sleep loss is associated with significant adverse effects on the overall safety, health and well-being of nurses, as well as neurocognitive dysfunction which may have negative implications for patients’ safety and can have adverse consequences on the quality of care delivered as well.

Numerous studies have shown a high prevalence of sleep disorders among shift working nurses, but on the other hand, in our country, it has been an under-recognized and underestimated problem both from a research and a clinical point of view. Thus, further research is required to assess the association between the sleep quality and health related quality of life in nurses in order to clarify the observed problem.

References
