

STRESS AND FATIGUE IN INTENSIVE CARE UNIT NURSES IN SOFIA

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Introduction. Intensive care unit (ICU) nurses provide constant, highly specialized and specific care for patients with acute and severe chronic conditions, which is a prerequisite for higher levels of stress.

The purpose of the study was to follow and compare the level of cortisol in saliva and the self-rated stress, sleepiness and fatigue in ICU nurses with those of nurses working in clinical wards.

Materials and methods of research. The study comprised 48 female hospital nurses of average age (49.7 ± 11.5) years, 16 from the ICU and 32 from clinical wards. 10 of the ICU nurses were studied during the day shifts and 6 during the night shifts and 16 ward nurses during the day and night shifts. Salivary cortisol levels and self-rated stress, sleepiness and fatigue were monitored at four-hour intervals. A questionnaire concerning stress symptoms was filled at the end of the day and night shifts. Statistical analysis was carried using SPSS.

Results. The cortisol retained the typical diurnal rhythm with significantly higher values and large variation during the shifts in nurses in ICU compared to clinical wards. The self-rated stress, sleepiness and fatigue increased as the shifts progressed, with no significant differences between groups and shifts. The nurses felt tense, irritated and very exhausted at the end of the shifts, they considered that the workload was high and that breaks during the shifts were insufficient.

Conclusions. The data of the study show an increased health risk in the nurses, especially in those working in the ICU.

Key words: stress, fatigue, cortisol, intensive care unit, 12-hour shifts

Introduction

Nurses work under a number of stressors in the workplace [1–4], such as time pressure, frequent interruptions, communication with patients, doctors and colleagues, shift work, long working hours etc., which contribute the prevalence of occupational stress [5–7].

Nurses working in the ICU provide constant, highly specialized and specific care for patients with acute and severe chronic conditions [8, 9]. They are constantly exposed to various stressors in the workplace, which can lead to the development of psychological syndromes and disorders such as depression, anxiety, anger, irritability and burnout syndrome [9–11]. Our study [12] conducted among nurses in 19 large hospitals in Sofia shows that ICU nurses work more often under time pressure, night shifts, 12-hour shifts compared to the ward nurses, experience a higher degree of physical and emotional exhaus-

tion and have more psychosomatic complaints.

Cortisol is a reliable stress indicator. A long lasting increase of circulating cortisol levels or changes in the circadian rhythm of the hormone lead to allostatic load and are associated with increased risk of metabolic and cardiovascular diseases, depression, etc [13].

Data on cortisol variations in nurses at work are diverse, probably associated to shift work and work tasks organization. Anjum et al. [14] found increased cortisol secretion during rotating night shifts and recovery to normal values when subjects went back to day shift, while according to another study nurses working night shifts needed at least four days to restore their circadian rhythms of cortisol secretion [15]. Our study [16] showed higher levels of cortisol in saliva in nurses compared to the reference group at some hours of the day and especially during the second half of the night shifts, accompanied by a high self-rated

stress and fatigue, indications for increased health risk. Metzenthin et al. [17] studied ICU nurses and found that self-rated stress was significantly associated with increased cortisol secretion. According to another study [18], the increase in cortisol in ICU staff does not depend on the subjective perception of stress and the professional experience does not reduce endocrine stress reactivity.

The aim of the study was to follow and compare the level of cortisol in saliva and the self-rated stress, sleepiness and fatigue in ICU nurses with those of nurses working in clinical wards.

Materials and methods of research

The study included 48 hospital female nurses, of average age (49.7 ± 11.5) years and length of service (26.8 ± 10.9) years from two University hospitals in Sofia, of which 16 work in the ICU and 32 in clinical wards. The shift system in both groups was fast rotating with 12-hour shifts and forward rotation, day shifts starting from 07:00 to 19:00 and the night shifts from 19:00 to 07:00. During the day shifts 10 of the ICU nurses were studied and 6 during the night shifts, and 16 nurses from the wards during the day and night shifts. The studied groups did not have a significant difference in age, length of service and years working night shifts (Table 1).

The exclusion criteria were as follows: (1) nurses who had received sedatives, hypnotic drugs, anti-inflammatory drugs, or hormonal

drugs (e.g., corticosteroids, melatonin, or oral contraceptives) during the 4 weeks preceding the study; and (2) nurses with metabolic, neurological or renal diseases, mental disorders or pregnancy. The study is part of a survey on risk factors for health and safety in health care. Informed consent was signed by all the subjects. The work was approved by the ethical committee of the National Center of Public Health and Analyses.

The concentration of saliva cortisol was followed on four hour intervals at the following time points: day shift – 07:00, 11:00, 15:00 and 19:00, and night shift – 19:00, 23:00, 03:00 and 07:00. The participants were instructed to avoid food and liquids and smoking for 30 minutes before these time points. Salivary cortisol was collected in polyethylene containers, stored at -20°C until sample determination. Cortisol was determined by ELISA kits (ELISA cortisol saliva EQ 6141-9601 S) of Euroimmun, Germany with an intra-serial coefficient of variation of 4.8 % and a cross-section coefficient of variation of 7.2 %. The data were matched with the reference data, provided by Euroimmun. At the above time points the participants made ratings of stress, sleepiness and fatigue in a diary. The stress scale included nine response categories [19], five included verbal anchors: 1 – very low stress (very calm and relaxed), 3 – low stress, 5 – neither low nor high stress, 7 – high stress (high tension and pressure), 9 – very high stress. The participants also rated their sleepiness during

Table 1

Age and length of service of the studied nurses

Group	Shift	n	Age, yrs. (mean \pm SD)	Length of service, yrs. (mean \pm SD)	Length of service with night shifts, yrs. (mean \pm SD)
Intensive care unit nurses	Day shift	10	48.8 ± 7.7	27.9 ± 6.1	25.6 ± 9.8
	Night shift	6	52.2 ± 8.3	24.3 ± 7.2	20.1 ± 8.3
Ward Nurses	Day shift	16	49.1 ± 11.7	27.3 ± 11.7	25.1 ± 10.5
	Night shift	16	49.8 ± 11.5	25.6 ± 9.8	24.1 ± 8.8
Total		48	49.7 ± 11.5	26.8 ± 10.9	24.2 ± 10.2

the shifts using Karolinska Sleepiness Scale (KSS) (1 – very alert, 3 – alert, 5 – neither alert nor sleepy, 7 – sleepy, 9 – very sleepy, fighting sleep, effort to stay awake), validated against physiological and behavioral measures [20]. Also during the shifts they rated on the feeling of fatigue by 9 point scale (1 – very fresh, 3 – fresh, 5 – neither fresh nor tired, 7 – tired, 9 – very tired). The Chrobach's α for the scales was 0.78.

At the end of every shift, the participants reported how their day had been in respect to different symptoms of stress, as described by Dahlgen et al. [19]. The questions were pointed towards feeling of tension, irritation, exhaustion, time pressure, difficulties in concentration (1 – not at all, 5 – to a large extent) and whether the workload was high and the rests not enough (1 – definitely enough, 5 – far from enough). The Chrobach's α for the scales was 0.66.

The data were processed with the SPSS Statistics 23.0 package. ANOVA and repeated measures effects were applied and the significance level was set at $p < 0.05$.

Research results and their discussion

Our data show that salivary cortisol retained its typical diurnal pattern ($F = 23.878$, $p = 0.0$), with high morning levels declining during the day and reaching the lowest values in the evening (Figure 1). During the day shifts, cortisol levels in ICU nurses were significantly higher than those in the clinical ward nurses ($F = 6.202$, $p = 0.027$). The variation in cortisol levels in both groups was high, especially in ICU nurses. During the night shifts, salivary cortisol also followed its circadian rhythm ($F = 5.480$, $p = 0.003$), with high variation in hormone levels in the morning, especially in ICU nurses.

The self-rated stress (Figure 2) increased with the shifts progress, with no significant differences between groups and shifts. Sleepiness increased as the shifts progressed ($F = 15.089$, $p = 0.001$), with higher values during night shifts and peak values around 03 o'clock, but without significant differences between the two groups (Figure 3). The self-rated fatigue (Figure 4) was low at the

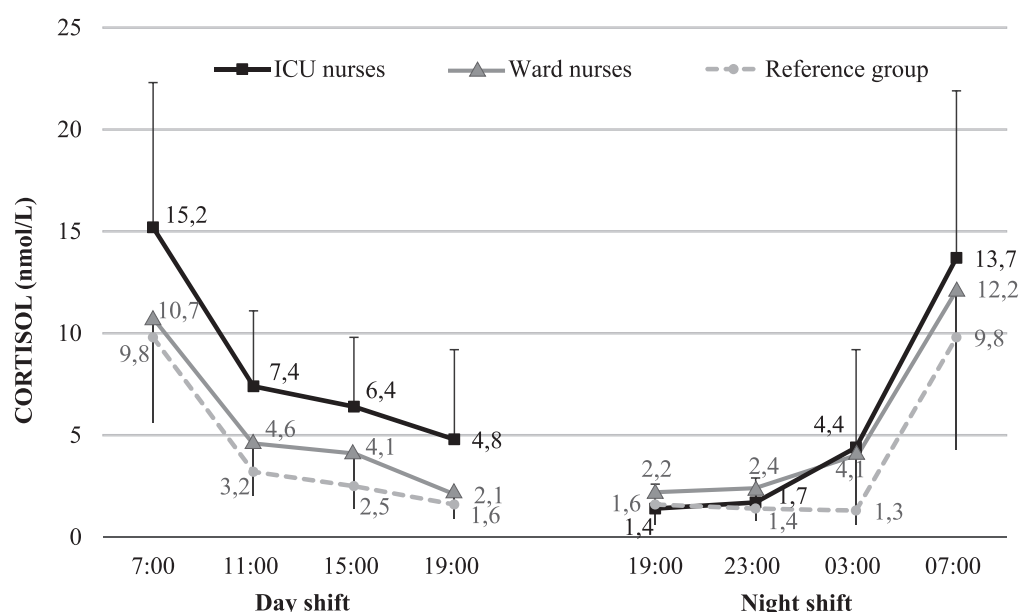


Figure 1. Time-of-day levels of salivary cortisol during day and night shift in nurses in intensive care unit (ICU) and clinical wards

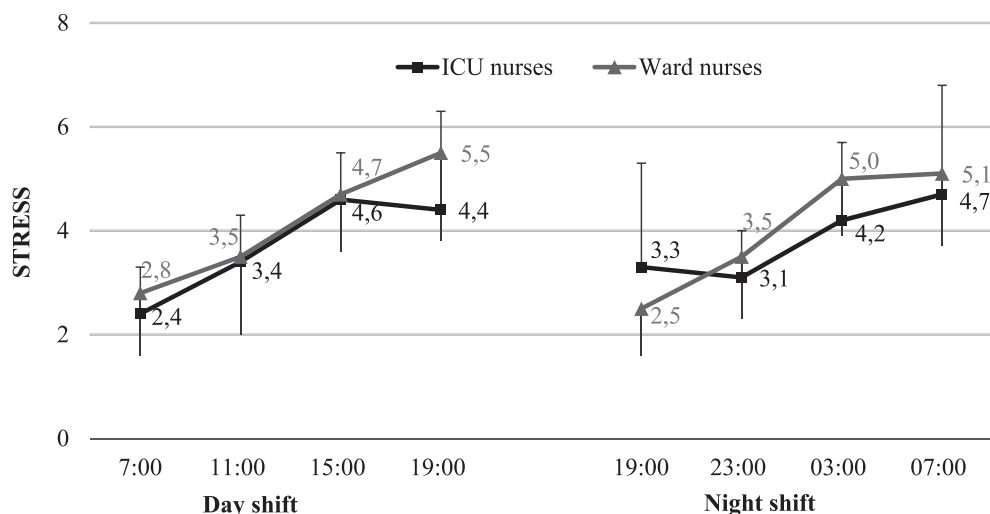


Figure 2. Self-rated stress during day and night shifts in nurses in intensive care unit (ICU) and clinical wards

beginning of the shifts and increased during work ($F = 52.123$, $p = 0.0$) with higher values during the night shifts, i.e. nurses felt more tired at night. No significant differences were found between the two groups, but the variations in values were greater in the ICU nurses.

Our data did not show significant differences between the reported stress symptoms at the end of work shifts, both when comparing day and

night shifts and the two groups. The nurses felt tense, irritated and very exhausted at the end of the shifts. They also considered that workload was high and that breaks during work are insufficient (Table 2).

Our study showed that the salivary cortisol retained its 24-hour rhythm during both day and night shift with the studied nurses, but its values were higher, especially in ICU nurses. Karhula et

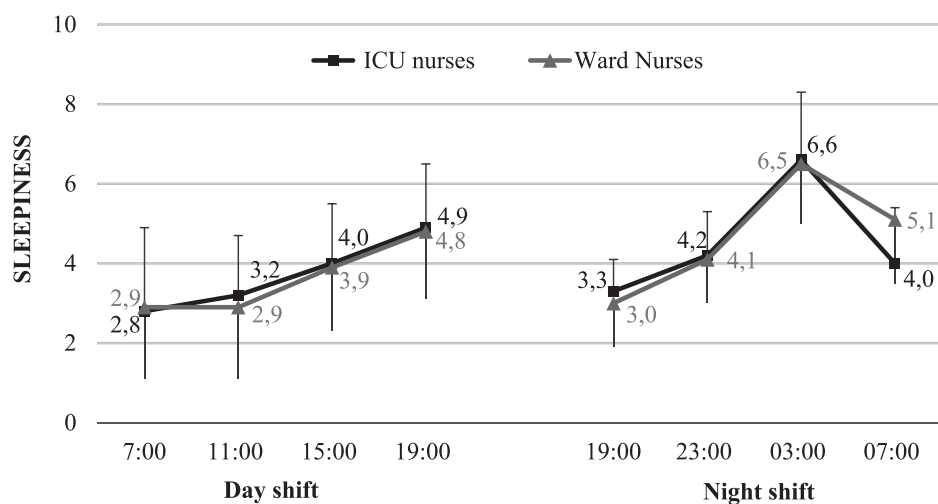


Figure 3. Self-rated sleepiness during day and night shifts in nurses in intensive care unit (ICU) and clinical wards

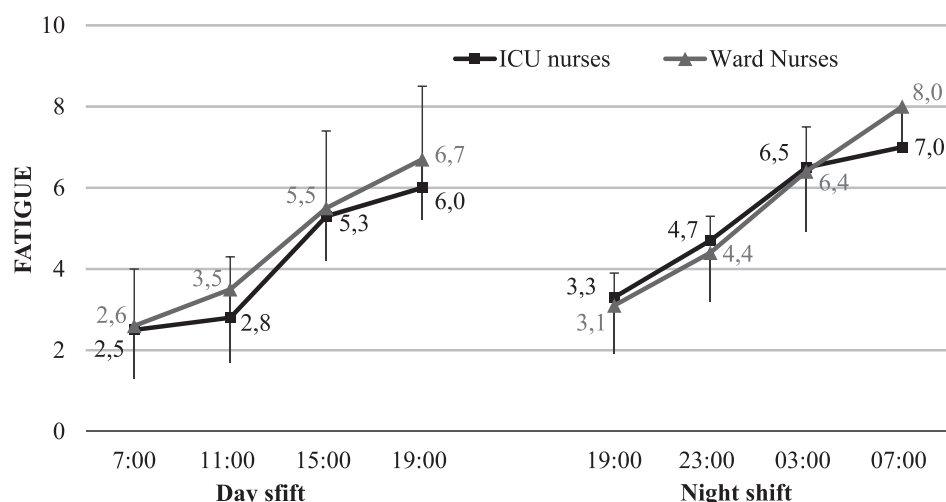


Figure 4. Self-rated fatigue during day and night shifts in nurses in intensive care unit (ICU) and clinical wards

al. [21] studied alpha amylase and cortisol in saliva in healthcare workers, dividing participants into two groups – low and high stress at work. The authors found higher values of the two biomarkers in the group of healthcare workers working under high stress. These data are consistent with our findings of higher cortisol levels in ICU nurses, taking care for patients with acute and severe health conditions with responsibility to prevent or detect complications and, in their case, to act immediately and effectively [22].

The subjective perception of stress increased with the progress of the shifts, but did not show significant differences between the groups and the

shifts in contrast to the levels of salivary cortisol, an objective indicator of stress. Thus, the subjective perception of stress does not correspond to the endocrine response, which confirms the data of Fischer et al. [18], but it should be noted that our findings showed high stress both while using objective and subjective methods in both groups – nurses in the ICU and in clinical wards. The differences in cortisol levels were significant during the day shifts, and at the end of the work day ICU nurses reported that they had more work than the nurses in the wards, while after the night shifts the ratings did not differ but after both shifts showed very high workload and insufficient time for rest.

Table 2

Stress symptoms ($\bar{x} \pm SD$) at the end of the day and night shifts in nurses in intensive care unit and clinical wards

Stress symptoms	Intensive care unit nurses		Ward nurses	
	Day shift $\bar{x} \pm SD$	Night shift $\bar{x} \pm SD$	Day shift $\bar{x} \pm SD$	Day shift $\bar{x} \pm SD$
Tense (max 5)	3.3 \pm 1.2	3.8 \pm 0.4	3.5 \pm 1.0	3.5 \pm 1.0
Irritated (max 5)	3.0 \pm 0.9	3.0 \pm 1.2	3.2 \pm 0.7	3.2 \pm 1.1
Exhausted (max 5)	3.5 \pm 1.0	3.0 \pm 0.9	3.6 \pm 1.1	3.6 \pm 0.9
Time pressure (max 5)	2.0 \pm 0.9	2.2 \pm 0.8	2.5 \pm 0.7	2.5 \pm 1.1
Difficulty in concentration (max 5)	1.9 \pm 0.7	2.6 \pm 0.5	2.2 \pm 0.6	2.5 \pm 0.7
A lot of work (max 5)	4.1 \pm 0.9	3.8 \pm 0.4	3.9 \pm 0.6	3.8 \pm 0.6
Insufficient rests (max 5)	4.2 \pm 1.0	3.8 \pm 1.1	4.3 \pm 1.5	3.8 \pm 1.1

Our data showed that subjective perception of sleepiness and fatigue increased with the progress of the shifts and were higher during the night shifts, which is consistent with results of Di Muzio et al. [23], who found that night shifts were associated with significantly greater sleepiness and fatigue in nurses. Our data showed peak values of sleepiness in both groups around 03 o'clock, which corresponds to the diurnal rhythm of the indicator. The subjective feeling of fatigue had the highest values at the end of the shifts, and the nurses felt tense, irritable and very exhausted. They worked on schedules with extended 12-hour shifts, another prerequisite for higher levels of fatigue. Thompson [24], using objective methods such as reaction time, distraction and muscle strength found that the advancing fatigue in nurses at the end of 12-hour shifts negatively affected their work.

Our study also has some limitations, such as studying different nurses during the day and night shifts, but the evening values of cortisol during day

and night shifts in both groups of nurses were close and give us reason to assume that the study design does not have a significant effect on the results. Secondly, nurses were examined in the conditions of 12-hour shifts and our results may not be relevant to other shifts. Third, but not least, cortisol samples were collected from participants, so their motivation and professional responsibilities might have affected the accuracy of the time range for collecting biological samples.

In conclusion, the results of the study showed that cortisol maintained its diurnal rhythm, but with higher values in the nurses, especially in those working in the ICU, which is consistent with their ratings of high workload and insufficient rest time. The subjective perception of stress, sleepiness and fatigue increased as the shifts progress, especially at night, and at the end of the shifts the nurses felt tense, irritable and very exhausted. The data of the study show an increased health risk in the nurses, especially in those working in the intensive care units.

References

1. Lin, P. C., Chen, C. H., Pan, S. M. et al. (2012), «Atypical work schedules are associated with poor sleep quality and mental health in Taiwan female nurses», *International Archives of Occupational and Environmental Health*, No. 85, pp. 877–884. <https://doi.org/10.1007/s00420-011-0730-8>.
2. Hoffman, A. J., Scott, L. D. (2003), «Role stress and career satisfaction among registered nurses by work shift patterns», *Journal of Nursing Administration*, No. 33, pp. 337–342. <https://doi.org/10.1097/00005110-200306000-00006>.
3. Ettorre, G., Greco, M. (2015), «Healthcare Work and Organizational Interventions to Prevent Work-related Stress in Brindisi, Italy», *Safety and Health at Work*, Vol. 6, No. 1, pp. 35–38. <https://doi.org/10.1016/j.shaw.2014.10.003>.
4. Lothschuetz, M. K., Geiger-Brown, J. (2010), «Is it time to pull the plug on 12-hour shifts? Part 2. Barriers to change and executive leadership strategies», *J Nurs Adm*, Vol. 40, No. 4, pp. 147–149. <https://doi.org/10.1097/NNA.0b013e3181d40e63>.
5. Khamisa, N., Peltzer, K., Dragan, I. D. et al. (2016), «Work related stress, burnout, job satisfaction and general health of nurses: A follow-up study», *Int J Nursing Practice*, Vol. 22, No. 6, pp. 538–545. <https://doi.org/10.1111/ijn.12455>.
6. Freimann, T., Merisalu, E. (2015), «Work-related psychosocial risk factors and mental health problems amongst nurses at a university hospital in Estonia: A cross-sectional study», *Scand J Publ Health*, No. 43, pp. 447–452. <https://doi.org/10.1177/1403494815579477>.
7. Jones, G., Hocine, M., Salomon, J. et al. (2015), «Demographic and occupational predictors of stress and fatigue in French intensive-care registered nurses and nurses' aides: A cross-sectional study», *International Journal of Nursing Studies*, No. 52, pp. 250–259. <https://doi.org/10.1016/j.ijnurstu.2014.07.015>.
8. Lakanmaa, R. L., Suominenb, T., Perttilä, J. et al. (2010), «Competence requirements in intensive and critical care nursing – Still in need of definition? A Delphi study», *Intensive Crit Care Nurs*, No. 28, pp. 329–336. <https://doi.org/10.1016/j.iccn.2012.03.002>.

9. Ceballos-Vásquez, P., Rolo-González, G., Hernández-Fernaud, E. et al. (2015), «Psychosocial factors and mental work load: a reality perceived by nurses in intensive care units», *Revista latino-americana de enfermagem*, Vol. 23, No. 2, pp. 315–322. <https://doi.org/10.1590/0104-1169.0044.2557>.
10. Mealer, M., Jones, J., Newman, J. et al. (2012), «The presence of resilience is associated with a healthier psychological profile in intensive care unit (ICU) nurses: Results of a national survey», *International Journal of Nursing Studies*, No. 49, pp. 292–299. <https://doi.org/10.1016/j.ijnurstu.2011.09.015>.
11. Myhren, H., Ekeberg, Ø., Stokland, O. (2013), «Job Satisfaction and Burnout among Intensive Care Unit Nurses and Physicians», *Critical Care Research and Practice*. Volume, Article ID 786176. <https://doi.org/10.1155/2013/786176>.
12. Vangelova, K., Dimitrova, I., Cekova, I., Stoyanova, R. (2021), «The effect of work-related risk factors on health symptoms of hospital nurses», *Acta Medica Bulgarica*, Vol. 58, No. 1, pp. 81–87. <https://doi.org/10.2478/amb-2021-0013>.
13. Kivimäki, M., Kawachi, I. (2015), «Work Stress as a Risk Factor for Cardiovascular Disease», *Current cardiology reports*, Vol. 17, No. 9, p. 74. <https://doi.org/10.1007/s11886-015-0630-8>.
14. Anjum, B., Verma, N. S., Tiwari, S. et al. (2014), «Altered Circadian Secretion of Salivary Cortisol during Night Shift», *IJHSR*, Vol. 4, No. 2, pp. 46–52.
15. Niu, S. F., Chung, M. H., Chu, H. et al. (2015), «Differences in cortisol profiles and circadian adjustment time between nurses working night shifts and regular day shifts: A prospective longitudinal study», *International Journal of Nursing Studies*, Vol. 52 No. 7, pp. 1193–1201. <https://doi.org/10.1016/j.ijnurstu.2015.04.001>.
16. Cekova, Ir., Stoyanova, R., Vangelova, K. (2018), «Ekskretsiya na melatonin i kortizol v slyunka na bolnichni meditsinski sestri po vreme na 12-chasovi smeni», *B'lg. spisanie po obschestveno zdrave*, No. 10 (4), pp. 46–55.
17. Metzenthin, P., Helfricht, S., Loerbroks, A. et al. (2009), «A one-item subjective work stress assessment tool is associated with cortisol secretion levels in critical care nurses», *Prev Med*, Vol. 48, No. 5, pp. 462–466. <https://doi.org/10.1016/j.ypmed.2009.02.001>.
18. Fischer, J. E., Calame, A., Dettling, A. C. et al. (2000), «Experience and endocrine stress responses in neonatal and pediatric critical care nurses and physicians», *Critical Care Medicine*, Vol. 28, No. 9, pp. 3281–3288. <https://doi.org/10.1097/00003246-200009000-00027>.
19. Dahlgren, A., Kecklund, G., Åkerstedt, T. (2005), «Different levels of work-related stress and the effects on sleep, fatigue and cortisol», *Scand J Work Environ Health*, Vol. 31, No. 4, pp. 277–285. <https://doi.org/10.5271/sjweh.883>.
20. Åkerstedt, T., Gillbert, M. (1990), «Subjective and objective sleepiness in active individual», *Int J Neurosci*, No. 52, pp. 29–37. <https://doi.org/10.3109/00207459008994241>.
21. Karhula, K., Härmä, M., Sallinen, M. et al. (2016), «Association of Job Strain with Cortisol and Alpha-Amylase Among Shift-Working Health Care Professionals in Laboratory and Field», *Biological Research for Nursing*, Vol. 18, No. 1, pp. 101–112. <https://doi.org/10.1177/1099800415577801>.
22. Viana, R., Vargas, M., Carmagnani, M. et al. (2014), «Profile of an intensive care nurse in different regions of Brazil», *Texto & Contexto – Enfermagem*, Vol. 23, No. 1, pp. 151–159. <https://doi.org/10.1590/S0104-07072014000100018>.
23. Di Muzio, M., Reda, F., Diella, G. et al. (2019), «Not only a Problem of Fatigue and Sleepiness: Changes in Psychomotor Performance in Italian Nurses across 8-h Rapidly Rotating Shifts», *Journal of Clinical Medicine*, Vol. 8, No. 1, pp. 47. <https://doi.org/10.3390/jcm8010047>.
24. Thompson, B. J. (2019), «Does work-induced fatigue accumulate across three compressed 12 hour shifts in hospital nurses and aides?», *PLoS One*, Vol. 14, No. 2, e0211715. <https://doi.org/10.1371/journal.pone.0211715>.

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