



Evaluation of Nursing Workload and Efficiency of Staff Allocation in a Trauma Intensive Care Unit

Marzieh Momennasab,¹ Farzad Karimi,² Fereshte Dehghanrad,¹ and Ladan Zarshenas^{3,*}

¹Department of Nursing, School of Nursing and Midwifery, Shiraz University of Medical Sciences, Shiraz, Iran

²Student Research Committee, School of Nursing and Midwifery, Shiraz University of Medical Sciences, Shiraz, Iran

³Community Based Psychiatric Care Research Center, School of Nursing and Midwifery, Shiraz University of Medical Sciences, Shiraz, Iran

*Corresponding author: Ladan Zarshenas, School of Nursing and Midwifery, Shiraz University of Medical Sciences, Zand St, Shiraz, Iran. Tel: +98-7116474256, Fax: +98-7116474252, E-mail: zarshenas@sums.ac.ir

Received 2016 October 02; Revised 2017 April 30; Accepted 2017 June 14.

Abstract

Background: Heavy workload is one of the main problems of nurses working in intensive care units (ICUs). It not only decreases the quality and safety of patient care, but also increases human errors in health care, rate of hospitalization, and risk of mortality in patients. Workload evaluation and surveillance of patients enable authorities to allocate adequate staff to ICUs, leading to improved quality of patient care and treatment.

Objectives: The present study aimed to evaluate nurses' workload and efficiency of nursing staff allocation in a trauma ICU of Shahid Rajaei hospital, affiliated to Shiraz University of Medical Sciences.

Methods: In this cross sectional study, we evaluated nurses' workload in a trauma ICU. The evaluation was based on the nursing activities score (NAS) system and was performed in the morning, evening, and night shifts for 1 month. In this period, all nursing care activities provided for 36 patients in this unit were monitored and recorded. Additionally, the number of nurses required per shift was estimated, based on the required and available time for care. Efficiency of nursing staff allocation was evaluated accordingly.

Results: The mean age of the patients was 40.17 ± 22.30 years, and the length of ICU stay was 9.79 days on average. Based on the findings, the mean NAS score was $65.3 \pm 23.19\%$. Moreover, the number of nurses in the morning and evening shifts was less than the required number, except for days 3 and 7. On the other hand, the number of nurses in the night shifts was proportional to the required number.

Conclusions: The results indicated a heavy nursing workload in the ICU. Our findings also suggest that the quality of patient care can be improved by balanced distribution of workforce relative to workload in different shifts.

Keywords: Trauma, Intensive Care Units, Nursing Workload

1. Background

Health workforce is the main factor in providing hospital services and is the most effective element in patient survival and treatment success, as nearly 50% to 80% of costs are allocated to workforces (1). Among all medical staff in healthcare organizations, nurses are the most important and largest workforce with a vital role in the quality of care and health promotion (2). They comprise 62% of all hospital staff and account for 36% of hospital costs (3). Compared to other healthcare providers, nurses contribute to the progress of healthcare organizations more than other professionals. Accordingly, sufficient nursing workforce is essential for optimal nursing care.

Evaluation of hospital needs with respect to human resources is considered as one of the common problems in hospital settings. Overall, nursing staff shortage is one of the most challenging issues in health care worldwide

(4, 5). It not only affects patient care, but also decreases nurses' motivation and leads to forgetfulness, frustration, fatigue, excessive workload, overlapping responsibilities, stress during work shifts, and burnout (6). Therefore, a systematic process should be used while supplying and determining the required number of nurses. Nursing workload, type of disease, care requirements, and nonnursing tasks are among other important factors, which should be taken into account for determining the required number of nurses (6).

Generally, nursing workload is characterized by the time allocated to patient care, nursing activities, and skills needed for patient care (7). Research has shown that nursing workload is one of the most important indices to assess the safety and quality of care in intensive care units (ICUs) (6). Consistently, the results of a previous study revealed that heavy workload and patient-nurse ratio are sig-

nificantly related to patient mortality (8).

Moreover, inadequate number of nursing staff increases nursing workload, treatment costs, inaccurate patient assessment, and documentation errors, while reducing the standards of patient care (9). Moreover, nurses who work in ICUs and cardiac care units (CCUs) experience heavy workloads, as they should always decide about important issues associated with patients' lives (10). On the other hand, efforts to meet the needs of patients and their families expose ICU nurses to severe emotional distress and increase their workload (11).

Evaluation of nursing staff workload is a prerequisite for proper allocation of staff to ICUs, while an unjustified increase in the number of nurses imposes a huge economic burden on healthcare systems. On the other hand, an insufficient number of nursing staff may reduce the quality of care, lead to prolonged hospital stay, and increase the risk of potential complications and healthcare costs (12, 13).

Several trauma victims are admitted to ICUs due to the severity of damages and necessity of complex monitoring and treatment. In fact, specialized care for such patients directly affects the nursing workload (14). Failure to manage health care provision by appropriate staff allocation may reduce the quality of care. It can consequently increase the length of stay (LOS) and complicate the conditions due to the limited number of trauma ICUs. Therefore, precise estimation of nursing workload and proper allocation of nursing staff are important in the management of trauma ICUs.

Moreover, previous studies have shown that a sufficient number of nurses can ultimately lead to increased professional satisfaction (15). However, in Iran, allocation of nursing staff is based on the number of beds rather than nursing workload (16). Over the past 30 years, many efforts have been made in different countries to measure and adjust the actual workload of nurses in different hospital units, including ICUs.

Accordingly, measures were first developed for regulating the nursing workload based on medical scales (indirect measurement). Using these scales, nursing workload was assessed based on a series of therapeutic interventions for patients (13). These measures had some limitations and could evaluate nursing care activities, which were not directly related to therapeutic interventions. Therefore, Nursing Activities Score (NAS) was developed to resolve this problem. This index includes various nursing activities and is composed of 23 items, evaluating activities and care services provided by nurses for critical patients (17). In fact, NAS indicates the percentage of time spent for direct patient care by a nurse during a work shift in the ICU. Therefore, the total score indicates a nurse's activity during a work shift (17).

The results of different studies have demonstrated different NAS scores in various hospital ICUs. For instance, according to a study in Brazil, nurses' workload in a trauma ICU was estimated at 71.3%, based on the NAS scores (12). Another study also reported a workload of 63.7% in the ICU setting (11). Moreover, in a heart surgery ICU in Iran, NAS was reported to be 82% (18). Comparison of the results of mentioned studies revealed greater NAS scores in Iran, which could be due to the higher nurse-patient ratio, longer LOS, and characteristics of hospital wards (19).

Generally, evaluation of nursing workload (especially in ICUs) is an important factor in the allocation of adequate nursing staff to hospital units. In addition, proper planning can effectively improve care quality and reduce costs, work pressure, and problems arising from increased workload. However, this index has not been used for the evaluation of workload and nursing staff allocation in ICUs of Iran.

2. Objectives

In this study, we aimed to evaluate nursing workload in a trauma ICU, using NAS and determine the efficiency of nursing staff allocation according to the workload.

3. Methods

This cross sectional study was performed in the trauma ICU of Shahid Rajaei hospital of Shiraz, Southwest of Iran during 1 month (August 2015). This hospital, which is the first-ranked trauma hospital in South of Iran, is affiliated to Shiraz University of Medical Sciences. Currently, it has 4 ICUs, and the present study was performed in the adult trauma ICU (9 beds).

This study was carried out during 1 month since the morning shift on August 1 until the end of the night shift on August 31. During this period, 36 patients were hospitalized. The type and amount of care provided for the patients were monitored and recorded based on the NAS scale. The patients' demographic data (e.g., age, sex, and type of disease) were recorded by the researchers. Then, NAS was used to gather information about the workload.

In the present study, we applied NAS, which was developed by Miranda et al. (2003) using the therapeutic intervention scoring system (TISS-28) (17). In this study, we used the Persian version of NAS with confirmed content and face validity and reliability (Cronbach's alpha, 0.7) (18). This 23-item scale measures basic activities, respiratory, cardiovascular, renal, neurological, and metabolic support, as well as specific interventions. Each item is scored to indicate the percentage of time spent by a nurse on a particular activity. Therefore, the sum of scores indicates the average

NAS score for each patient and shows the percentage of time a nurse spends on care activities during a shift. The total scores in NAS range from 0% to 177% (13, 20).

In this study, the data were collected by the researchers in the morning, evening, and night shifts. Accordingly, NAS was measured for each patient in every shift, and then, the average NAS score was calculated in every work shift. Since a NAS score of 100% is equivalent to a work shift, we calculated the time required for the care of each patient by multiplying the patient's NAS score by working hours per shift and dividing the result by 100.

Moreover, the number of nurses needed per shift was calculated based on nursing workload. In our study, 5 nurses worked in the morning, evening, and night shifts constantly. They were available for 6 hours in the morning and evening shifts (30 hours in total) and 10 hours in the night shift (50 hours in total). It should be noted that the night shift lasts for 12 hours, although nurses normally rest for 2 hours during the shifts and are available for 10 hours. The difference between the nurses' total working hours and the time required for care indicated the efficiency of nursing staff allocation in every shift.

The NAS checklist was completed for each patient by the researcher with the help of ICU nurses since admission until discharge. During the study, 777 checklists related to 36 patients were completed. Finally, the data were analyzed using SPSS version 19. Descriptive and nonparametric statistics were calculated for statistical analysis.

3.1. Ethical Considerations

This study was approved by the ethics committee of Shiraz University of Medical Sciences (IR.SUMS.REC.1394.S140). The study methods and objectives were explained to the patients and nurses. Written informed consents were obtained from all the participants. Anonymity and confidentiality of the data were guaranteed.

4. Results

In this study, the majority of the patients were male (80.6%). The mean age of the participants was 22.30 ± 40.17 years (range, 18 - 87 years). Based on the findings, the majority of the subjects (94.4%) were hospitalized due to traumatic events with traffic accidents accounting for the majority (82.3%). The mean LOS was 9.82 ± 9.94 days (range, 1 - 46 days), with a median of 7 days; it should be mentioned that 1 (2.8%) patient died during the study. The mean bed occupancy was 8.35 ± 0.855 out of 9 beds. Among 29 nurses working in the ward, 86.2% (n, 25) were women, 96.55% (n, 28) had a Bachelor's degree in nursing, and 55.17% had more than 5 years of work experience.

4.1. Nursing Workload

Based on NAS, the mean nursing workload was $65.32 \pm 3.19\%$. In the 6-hour morning shifts, the mean NAS score was reported to be $65.8 \pm 3.61\%$, and the mean time required for patient care was 33.25 hours. In the evening shifts, the mean NAS score was $65.1 \pm 2.89\%$, and the mean time needed to provide care for all the patients was 32.34 hours. However, the mean NAS score in the night shifts was reported to be $64.9 \pm 3.07\%$, with an average of 48.7 hours needed for nursing care. The results of the study showed no significant relationship between the average workload score and type of disease, age, or sex. Nevertheless, we observed a positive correlation between LOS and average workload based on NAS ($P < 0.05$).

4.2. Efficiency of Nursing Staff Allocation

Comparison of the required time and 30 hours of care activities in the morning shifts indicated that the mean number of available nurses in the morning shifts was 0.54 (range, 0.7 - 1.93) less than the required number, except for days 19, 25, and 26 (Figure 1). In the evening shifts, the time needed to provide care was less than the available time, except for days 4, 5, 8, 24, 25, 26, and 27.

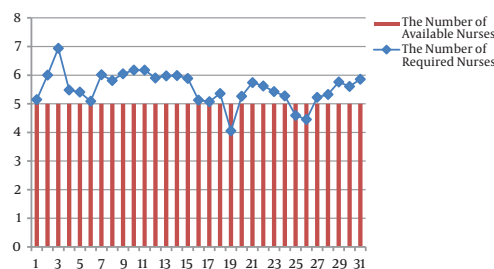


Figure 1. The Number of Required and Available Nurses in the Morning Shifts

The number of required nurses based on workload (determined through NAS) also revealed that the number of required nurses was 0.39 (range, 0.08 - 1.2) less than the number of nurses available in the evening shift, except on the aforementioned days (Figure 2). The results showed no significant difference between the number of required nurses and the number of available nurses in the night shifts. Accordingly, 4.87 nurses were needed per shift on average, and 5 nurses were constantly working in night shifts (Figure 3).

5. Discussion

This study was conducted in a trauma ICU. The patients' demographic characteristics (such as age and sex) were

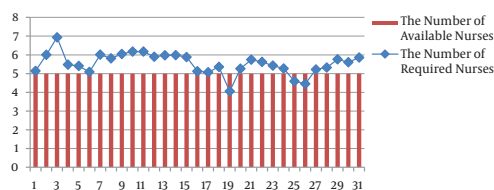


Figure 2. The Number of Required and Available Nurses in the Evening Shifts

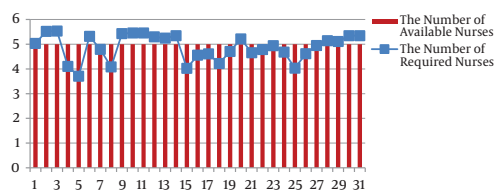


Figure 3. The Number of Required and Available Nurses in the Night Shifts

consistent with those reported in a study by Nogueira et al. on nurses' workload (14). This similarity can be related to the fact that both studies were performed in trauma ICUs. In this study, the mean bed occupancy was 8.35 ± 0.855 . Since the evaluated hospital unit contained 9 beds, 92.7% of the beds were always occupied, which exceeds the bed occupancy rate reported in other similar studies (11, 15).

Based on the present findings, the mean daily NAS score was 65.32%, indicating high levels of required patient care and nursing workload in the ICU. The mean NAS scores in some different studies conducted in ICUs were almost similar to the present results (11, 15). On the other hand, the NAS score was reported to be 47% in a study by Reich et al. (2014) in a CCU and 34.9% by Panunto et al. (2015) in a gastroenterology unit (21, 22).

The mentioned scores were lower in comparison with the present study, indicating a high workload in ICUs, compared to other units. The highest NAS score (96.24%) was reported in a study by Stafseth (2011) in a heart surgical ICU in Norway (5). Babayi et al. (2012) also carried out a research in 2 heart surgery ICUs at Shahid Rajaei hospital of Tehran, Iran and measured the mean daily NAS score to be 82% (18); this finding reflects the high workload in heart surgical ICUs.

In the current study, the nurses' workload was more than 65% in the morning and evening shifts, reflecting high workloads in these shifts. Besides, the number of available nursing personnel was less than the required number in the evening and particularly morning shifts. Since many diagnostic and therapeutic procedures and nursing activities in this unit take place exclusively in the

morning and evening shifts, shortage of nursing staff in these shifts seems reasonable.

Compared to some similar studies, the nurse-patient ratio was higher in the present study (1:1.8 on day 16 of the study) (5, 11). The present findings were inconsistent with those reported by Padilha et al. (2010), who reported that the number of nurses available in the morning shifts exceeded the required number. This difference might be attributed to nurse-patient ratio and bed occupancy rate (11). In Iran, each nurse generally provides care for 1 or 2 patients in ICUs (23). This finding is important and reveals the necessity to reconsider the allocation of nursing staff in this unit.

In the night shifts, the mean workload was proportional to the number of personnel in the shifts; however, the length of these shifts was considerable. In Iran, most night shifts continue for 12 hours, which can cause fatigue and reduce the quality of care and patient safety (24, 25). Therefore, length of this shift is recommended to reduce and be possibly divided into 2 shifts (6 hours each), although it may impose a heavy economic burden on health organizations. According to the present findings, there was a significant correlation between LOS and NAS scores. Although there have been controversies about the association of NAS with LOS in the literature, studies conducted in ICUs of Brazil have shown that increased LOS is associated with greater NAS scores (13).

So far, few studies have estimated the required number of personnel based on workload using NAS. The present results showed a heavy nursing workload, especially in the morning and evening shifts; therefore, it is recommended to evaluate the workload using NAS. Moreover, a sufficient number of nurses should be allocated to ICUs to reduce their workload and increase patient safety and quality of care. In addition, some factors including the type of disease, unit, treatment, patient's age, and mean LOS in the unit should be considered in staff allocation.

The limitation of this study was nurses' understanding of recording care activities by researchers, which could lead to high workload during the study. However, the researcher recorded the data based on documentations, and the nurses were assured that the results of the study would not affect their professional status.

5.1. Conclusion

The results showed that nurses' workload was heavy in the trauma ICU in the morning and evening shifts based on NAS. Besides, shortage of nurses in the morning and evening shifts demonstrated the inefficiency of current methods of nursing staff allocation. Since NAS directly represents the percentage of time spent by nurses on patient

care, it can be used as a valuable tool for measuring workload in ICUs. It should be noted that staff allocation with respect to workload could eventually enhance care quality and reduce medical costs.

Acknowledgments

This article was extracted from an M.Sc. thesis in critical care nursing by Farzad Karimi. It was funded by the research vice-chancellor of Shiraz University of Medical Sciences (grant No., 94-7508). Hereby, we would like to thank A. Keivanshekouh at the research improvement center of Shiraz University of Medical Sciences for proofreading the manuscript. We also extend our gratitude to nurses and managers of Shahid Rajaei hospital for their cooperation.

Footnote

Conflict of Interests: None declared.

References

- Heckemann B, Zeller A, Hahn S, Dassen T, Schols JM, Halfens RJ. The effect of aggression management training programmes for nursing staff and students working in an acute hospital setting. A narrative review of current literature. *Nurse Educ Today*. 2015;**35**(1):212–9. doi: [10.1016/j.nedt.2014.08.003](https://doi.org/10.1016/j.nedt.2014.08.003). [PubMed: 25200511].
- Maenhout B, Vanhoucke M. An integrated nurse staffing and scheduling analysis for longer-term nursing staff allocation problems. *Omega*. 2013;**41**(2):485–99. doi: [10.1016/j.omega.2012.01.002](https://doi.org/10.1016/j.omega.2012.01.002).
- Centeno MA, Giachetti R, Linn R, Ismail AM, editors. Emergency departments II: a simulation-ILP based tool for scheduling ER staff. *Proceedings of the 35th conference on Winter simulation: driving innovation*. 2003; New Orleans.
- Dal Poz MR, Gupta N, Quain E, Soucat ALB. *Handbook on monitoring and evaluation of human resources for health: with special applications for low-and middle-income countries*. Geneva: World Health Organization; 2009.
- Stafseth SK, Solms D, Bredal IS. The characterisation of workloads and nursing staff allocation in intensive care units: a descriptive study using the Nursing Activities Score for the first time in Norway. *Intensive Crit Care Nurs*. 2011;**27**(5):290–4. doi: [10.1016/j.iccn.2011.07.003](https://doi.org/10.1016/j.iccn.2011.07.003). [PubMed: 21871805].
- Carayon P, Gurses AP. A human factors engineering conceptual framework of nursing workload and patient safety in intensive care units. *Intensive Crit Care Nurs*. 2005;**21**(5):284–301. doi: [10.1016/j.iccn.2004.12.003](https://doi.org/10.1016/j.iccn.2004.12.003). [PubMed: 16182125].
- Myny D, Van Hecke A, De Bacquer D, Verhaeghe S, Gobert M, Defloor T, et al. Determining a set of measurable and relevant factors affecting nursing workload in the acute care hospital setting: a cross-sectional study. *Int J Nurs Stud*. 2012;**49**(4):427–36. doi: [10.1016/j.ijnurstu.2011.10.005](https://doi.org/10.1016/j.ijnurstu.2011.10.005). [PubMed: 22030021].
- Tarnow-Mordi WO, Hau C, Warden A, Shearer AJ. Hospital mortality in relation to staff workload: a 4-year study in an adult intensive-care unit. *Lancet*. 2000;**356**(9225):185–9. doi: [10.1016/S0140-6736\(00\)02478-8](https://doi.org/10.1016/S0140-6736(00)02478-8). [PubMed: 10963195].
- Aiken LH, Sloane DM, Bruyneel L, Van den Heede K, Griffiths P, Busse R, et al. Nurse staffing and education and hospital mortality in nine European countries: a retrospective observational study. *Lancet*. 2014;**383**(9931):1824–30. doi: [10.1016/S0140-6736\(13\)62631-8](https://doi.org/10.1016/S0140-6736(13)62631-8). [PubMed: 24581683].
- Gurses AP, Carayon P. Performance obstacles of intensive care nurses. *Nurs Res*. 2007;**56**(3):185–94. doi: [10.1097/01.NNR.0000270028.75112.00](https://doi.org/10.1097/01.NNR.0000270028.75112.00). [PubMed: 17495574].
- Padilha KG, de Sousa RM, Garcia PC, Bento ST, Finardi EM, Hatarashi RH. Nursing workload and staff allocation in an intensive care unit: a pilot study according to Nursing Activities Score (NAS). *Intensive Crit Care Nurs*. 2010;**26**(2):108–13. doi: [10.1016/j.iccn.2009.12.002](https://doi.org/10.1016/j.iccn.2009.12.002). [PubMed: 20060720].
- Daud-Gallotti RM, Costa SF, Guimaraes T, Padilha KG, Inoue EN, Vasconcelos TN, et al. Nursing workload as a risk factor for healthcare associated infections in ICU: a prospective study. *PLoS One*. 2012;**7**(12):e52342. doi: [10.1371/journal.pone.0052342](https://doi.org/10.1371/journal.pone.0052342). [PubMed: 23300645].
- Padilha KG, de Sousa RM, Queijo AF, Mendes AM, Reis Miranda D. Nursing Activities Score in the intensive care unit: analysis of the related factors. *Intensive Crit Care Nurs*. 2008;**24**(3):197–204. doi: [10.1016/j.iccn.2007.09.004](https://doi.org/10.1016/j.iccn.2007.09.004). [PubMed: 17976989].
- Nogueira Lde S, Domingues Cde A, Poggetti RS, de Sousa RM. Nursing workload in intensive care unit trauma patients: analysis of associated factors. *PLoS One*. 2014;**9**(11):e112125. doi: [10.1371/journal.pone.0112125](https://doi.org/10.1371/journal.pone.0112125). [PubMed: 25375369].
- Carmona-Monge FJ, Jara-Perez A, Quiros-Herranz C, Rollan-Rodriguez G, Cerrillo-Gonzalez I, Garcia-Gomez S, et al. Assessment of nursing workload in three groups of patients in a Spanish ICU using the Nursing Activities Score Scale. *Rev Esc Enferm USP*. 2013;**47**(2):335–40. doi: [10.1590/S0080-62342013000200009](https://doi.org/10.1590/S0080-62342013000200009). [PubMed: 23743898].
- Farzianpour F, Abbasi M, Foruoshani AR, Pooyan EJ. The Relationship between Hofstede Organizational Culture and Employees Job Burnout in Hospitals of Tehran University of Medical Sciences 2014–2015. *Mater Sociomed*. 2016;**28**(1):26–31. doi: [10.5455/msm.2016.28.26-31](https://doi.org/10.5455/msm.2016.28.26-31). [PubMed: 27047263].
- Miranda DR, Nap R, de Rijk A, Schaufeli W, Iapichino G, Tiss Working Group. Therapeutic Intervention Scoring System . Nursing activities score. *Crit Care Med*. 2003;**31**(2):374–82. doi: [10.1097/01.CCM.0000045567.78801.CC](https://doi.org/10.1097/01.CCM.0000045567.78801.CC). [PubMed: 12576939].
- babayi A. *Assessment of nursing workload in intensive care units of shahid rajaei heart center according to nursing activity score (NAS)*. 2013.
- Alizadeh M, Heidari Gorji MA, Khalilian AR, Esmaeili R. Assessment of nursing workload and related factors in intensive care units using the Nursing Activities Score [In Persian]. *J Mazandaran Univ Med Sci*. 2015;**24**(122):147–57.
- Goncalves LA, Padilha KG, Cardoso Sousa RM. Nursing activities score (NAS): a proposal for practical application in intensive care units. *Intensive Crit Care Nurs*. 2007;**23**(6):355–61. doi: [10.1016/j.iccn.2007.04.009](https://doi.org/10.1016/j.iccn.2007.04.009). [PubMed: 17689247].
- Panunto MR, Guirardello Ede B. Nursing workload at a gastroenterology unit. *Rev Lat Am Enfermagem*. 2009;**17**(6):1009–14. doi: [10.1590/S0104-11692009000600013](https://doi.org/10.1590/S0104-11692009000600013). [PubMed: 20126944].
- Reich R, Vieira DF, de Lima LB, Rabelo-Silva ER. Nursing workload in a coronary unit according to the Nursing Activities Score. *Rev Gaucha Enferm*. 2015;**36**(3):28–35. doi: [10.1590/1983-1447.2015.03.51367](https://doi.org/10.1590/1983-1447.2015.03.51367). [PubMed: 26486896].
- Momennasab M, Ghahramani T, Yektatalab S, Zand F. Physical and Mental Health of Patients Immediately After Discharge From Intensive Care Unit and 24 Hours Later. *Trauma Mon*. 2016;**21**(1):e29231. doi: [10.5812/traumamon.29231](https://doi.org/10.5812/traumamon.29231). [PubMed: 27218059].
- Griffiths P, Dall'Ora C, Simon M, Ball J, Lindqvist R, Rafferty AM, et al. Nurses' shift length and overtime working in 12 European countries: the association with perceived quality of care and patient safety. *Med Care*. 2014;**52**(11):975–81. doi: [10.1097/MLR.0000000000000233](https://doi.org/10.1097/MLR.0000000000000233). [PubMed: 25226543].
- Rivaz M, Momennasab M, Yektatalab Sh, Momennasab M, Ebadi A. Adequate Resources as Essential Component in the Nursing Practice Environment: A Qualitative Study. *J Clin Diag Res*. 2017;**11**(6):IC01–IC04. doi: [10.7860/JCDR/2017/25349.9986](https://doi.org/10.7860/JCDR/2017/25349.9986).