Original Article

Comparison of Nurses' Workload and Multiple Organ Failure of Patients Hospitalized in the COVID-19 and Non–COVID-19 Intensive Care Units

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Abstract

Background: Measuring nurses' workload and related factors in intensive care units and reviewing their staffing is very important during COVID-19. This study aims to compare nurses' workload and multiple organ failure of patients hospitalized during the COVID-19 in intensive care units and non–COVID-19 intensive care units. **Materials and Methods:** An observational study was conducted with 768 patients hospitalized in intensive care units and Zanjan City (Iran) intensive care units in 2021. The data were collected using the Nursing Activities Score and the Sequential Organ Failure Assessment. Data analysis was performed by independent *t*-test, Chi-squared (χ^2) test, Pearson's correlation coefficient (r), and Multiple Linear Regression (MLR). The statistical significance level was set at $p < 0.05$. **Results:** NAS in non–COVID-19 intensive care units 59.90% (10.03) was significantly higher than that of COVID-19 intensive care units 56.38% (6.67) ($p < 0.001$). In addition, the SOFA score was higher in the non–COVID-19 intensive care units 6.98 (3.89) than in COVID-19 intensive care units 5.62 (3.98) ($p < 0.001$). The Nursing Activities Score had a positive and statistically significant relationship with the Sequential Organ Failure Assessment in both units, and this relationship was higher in the COVID-19 intensive care units (r = 0.71). In addition, predictors of NAS were identified as four variables, i.e. consciousness level, SOFA, length of stay, and having an artificial airway ($p < 0.05$). **Conclusions:** Non–COVID-19 ICUs had higher NAS and SOFA scores in the study. Further investigation is needed to identify additional workload aspects in intensive care units.

Keywords: *COVID-19, intensive care units, multiple organ failure, nurses, workload*

Introduction

The nurses' workload in the Intensive Care Unit (ICU) in the hospital is very high due to the complex conditions of the patients. The increased workload affects the quality of patient care and leads to fatigue and burnout in nursing professionals.[1] In this regard, reduced nurses' work performance, reduced quality of care provided, reduced patient safety, increased medical errors, and increased patient mortality are the consequences of high nursing workload.[2]

During the COVID-19 pandemic, the number of patients needing intensive care beds and the unplanned admissions increased the workload on the ICU nurses.[3] In addition, the unexpected outbreak and measures required to deal with the COVID-19 pandemic have rapidly changed the workload of the ICU. In this respect, COVID-19 patients often require mechanical ventilation, have higher morbidity and mortality, and have more prolonged ICU length of stay.[4] In addition, nurses' infection with COVID-19 decreases the number of nurses and increases the patient-to-nurse ratio. Moreover, the increased number of nurses' work shifts causes fatigue and burnout.[5] The mental workload is increased by the fear and anxiety of caring for patients with COVID-19. Protective equipment poses challenges for nurses in providing care.[6] COVID-19 is a systemic disease that affects other organs in addition to the lungs, and many infected patients need intensive care.[7] ICU-hospitalized COVID-19 patients often have many underlying diseases. As a result, Multiple Organ Failure (MOF) in these patients increases after contracting COVID-19. MOF is the leading cause of death in the ICU, especially due to COVID-19, because these infected patients require mechanical ventilation and prolonged ICU length of stay.[8] There are many overlapping duties for nurses and

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doctors in the ICU. Nurses and physicians share evaluating multiorgan failure during ICU stay. Preventing multiple organ failure is crucial in a nurse's care objectives; care must be provided if it occurs.[9] Previous studies have determined the relationship between the severity of the disease and nursing workload.[10,11] Furthermore, increasing the rate of MOF of patients increases nurses' workload.[2] Although nursing workload was measured, no link was identified between it and multiorgan failure in COVID-19 and non–COVID-19 ICUs. Clinical and economic outcomes, such as infections, mortality, costs, and length of stay, are the focus of the relationship between nurse staffing and patient outcomes in critical care. Nurse staffing rarely matches patients' needs for nursing care.[3] ICU nurse staffing size must be adapted to account for the COVID-19 pandemic and nurse shortages.[12] Proper planning of nurse staffing requires evaluating the amount of workload and number of MOF patients in COVID-19 ICUs.[13] The ICUs in Iran faced nurse understaffing during the COVID-19 pandemic due to nurses leaving their jobs or contracting the COVID-19 infection. Therefore, this study was designed to compare nurses' workload and MOF of patients hospitalized in COVID-19 ICUs and non–COVID-19 ICUs.

Materials and Methods

This is an observational and prospective study that was conducted between July 21 and September 20, 2021, in Zanjan City (Iran). The Ayatollah Mousavi and Valiasr hospitals have ICUs in this city. Therefore, 4 ICUs (including a medical ICU with 23 beds, a surgical and trauma ICU with 23 beds, and two COVID-19 ICUs with 34 beds) were studied. The period of the current study coincided with the fifth peak of COVID-19 (i.e., the outbreak of the delta variant). All patients hospitalized in COVID-19 ICUs and non–COVID-19 ICUs affiliated with the hospitals of the Zanjan University of Medical Sciences were included in the study. The convenience method was used for patient sampling. The study's inclusion criteria comprised obtaining legal consent from the patient's guardian, being over 14 years old, and having spent no less than 24 hours hospitalized in the ICU during the sampling period. The study excluded patients who were readmitted. The sample size was estimated using the following formula according to study by Mohammadi *et al*.[14]: $\alpha = 0.05$, $\delta = 14$, and $d = 0.1$, resulting in an estimated sample size of 384 patients. Therefore, 384 patients were considered in each COVID-19 ICU and non–COVID-19 ICU. Overall, a total of 768 patients were investigated. Three instruments, including the patient profile, NAS, and Sequential Organ Failure Assessment (SOFA) were applied in this study. The patient profile checklist included age, gender, underlying disease, diagnosis at ICU admission, consciousness level based on the Glasgow Coma Scale (GCS), having an artificial airway, and length of ICU stay. The NAS was developed by Miranda *et al*. in 2003.[15] This tool is a scoring system ranging from 0% to 176.8%, with 100% showing a nurse–patient ratio of 1. The NAS weightings assess the time nurses spend on patient activities and reflect the ratio of nursing time allocated to the activities covered by the tool within a 24-hour cycle. The total weight of the scored items shows the time spent by nursing personnel in an ICU on their activities on a particular day. There are 23 items with variable weights related to activities. These items include basic activities, administrative and managerial tasks, ventilatory, cardiovascular, renal, neurological, and metabolic supports, in addition to specific interventions inside and outside the ICU. The summed score reflects 81% of nursing time. The remaining 19% comes from nursing activities deriving from medical interventions exclusively related to the patient's illness severity.[15] The validity and reliability of this score have been confirmed.[16] The present study assessed the questionnaire's Inter-Rater Reliability (IRR) using Cohen's kappa coefficient. The nursing activities score for 50 patients was simultaneously scored by two researchers. The agreement between the scores of these two researchers was 96%. The SOFA system was developed in 1994[17] "to quantitatively and as objectively as possible describe the degree of organ dysfunction/failure over time in groups of patients or even individual patients." The score was designed to describe a sequence of critical illness complications. The SOFA was based on six different scores, one for each of the respiratory, cardiovascular, hepatic, coagulation, renal, and neurological systems; each score varies from 0 to 4. An increase in the score indicates a worsening of the organ's function. The validity of this scale has been confirmed.[18] The IRR was assessed in this study using Cohen's kappa coefficient. The SOFA score for 50 patients was simultaneously assessed by two researchers. Eventually, the agreement between the scores of these two researchers was 97%.

The NAS and SOFA scores of patients hospitalized in COVID-19 ICU and non–COVID-19 ICU were observed and recorded. Regardless of the duration of hospitalization, the researcher examined the NAS and SOFA scores of patients in the desired departments after 24 hours. Every patient was enrolled in the study only one time. The NAS was compiled for each patient at 10:00 a.m., reporting the previous 24 hours. By analyzing the patient's requirements and nursing activities performed in the last 24 hours, the researcher estimated each patient's workload. MOF of patients hospitalized in COVID-19 ICUs and non–COVID-19 ICUs was also measured at 10:00 a.m. using the SOFA (Appendix 1). The first author assessed NAS and SOFA. The researchers were given official permission to conduct the study by the ICU head nurses who were well-informed of its objectives.

Data were analyzed using the IBM Corporation's SPSS version 22 software. The normal distribution of the data was assessed using the Kurtosis and skewness. The Kurtosis and skewness of the data were in the range (2, -2), so the data had a normal distribution. Data analysis was performed using descriptive and inferential statistics. Also, an independent *t*-test was used to evaluate the difference

between the mean scores of NAS and SOFA according to the type of ICUs (COVID-19 ICUs and non–COVID-19 ICUs) and age, length of ICU stay, and GCS score. The Chi-squared test was used to compare the frequency of variables of gender, underlying disease, diagnosis, and having an artificial airway in COVID-19 ICUs and non–COVID-19 ICUs. In addition, Pearson's correlation coefficient was used to investigate the relationship between NAS and SOFA. The predictive ability of SOFA and patient profile variables for NAS was evaluated using Multiple Linear Regression (MLR). The statistical significance level was set at $p < 0.05$ in all analyses.

Ethical considerations

Iran's National Committee for Ethics in Biomedical Research approved this study (IR. ZUMS. REC.1400.178). Written informed consent was obtained from the legal guardian of the patient and the attending physician. It is of note that the patients' legal guardians were ensured of the questionnaires' anonymity and confidentiality of the data. The consent for conducting the research was attained from the appropriate officials and head nurses.

Results

A total of 768 patients were observed in this study. The results showed that most of the patients in the non–COVID-19 ICUs were male, while they were mostly females in the COVID-19 ICUs ($p < 0.001$). The number of patients with underlying diseases (57.80%) was statistically significantly ($p = 0.006$) higher in the COVID-19 ICUs. Cancer was the most common reason for hospitalization in non–COVID-19 ICUs. A higher percentage of patients in the non–COVID-19 ICUs had artificial airways (66.90%). The length of ICU stay in the non–COVID-19 ICUs was significantly higher than in the COVID-19 ICUs ($p < 0.001$). In addition, the GCS score of the patients in the COVID-19 ICU was significantly higher than in the non–COVID-19 ICUs ($p < 0.001$) [Table 1].

Table 1: Patient profile in COVID-19 ICUs and non–COVID-19 ICUs (*n*=768)

Variables	Non–COVID-19 ICUs *n* (%)	COVID-19 ICUs *n* (%)	*p*
Gender			*p*<0.001*
Female	159 (41.40)	243 (63.60)	
Male	255 (58.60)	141 (36.70)	
Underlying disease			*p*=0.006*
Yes	184 (47.90)	222 (57.80)	
No	200 (52.10)	162 (42.20)	
Diagnosis			*p*=1.000*
Trauma	62 (16.10)		
Cancer	155 (40.40)		
Heart diseases	30 (7.80)		
General surgery	46 (12.00)		
Neurosurgery	91 (23.70)		
COVID-19		384 (100.00)	
Artificial airway			*p*<0.001*
Yes	257 (66.90)	106 (27.60)	
No	127 (33.10)	278 (72.40)	
Variables	**Mean (SD)**	**Mean (SD)**	*p*
Age	57.48 (22.60)	58.51 (15.90)	*p*=0.466**
Length of ICU stay	10.70 (11.24)	6.19 (5.24)	*p*<0.001**
GCS score	8.80 (3.76)	11.91 (3.09)	*p*<0.001**

*Chi-Squared test; **Independent *t*-test

The NAS mean (SD) score was significantly higher in the non–COVID-19 ICUs 59.90% (10.03%) than in the COVID-19 ICUs 56.38% (6.67%) ($p < 0.001$; Table 2). Respiratory system failure occurred more frequently in COVID-19 ICUs than in non–COVID-19 ICUs ($p < 0.001$). Neurological and renal system failure was higher in non–COVID-19 ICUs than in COVID-19 ICUs ($p < 0.050$). The SOFA mean (SD) score in the non–COVID-19 ICUs was significantly higher than in the COVID-19 ICUs ($p < 0.001$; Table 3). In comparison, there was a positive and significant relationship between NAS and SOFA scores in the non–COVID-19 ICUs ($r = 0.59$, $p < 0.001$) and the COVID-19 ICUs ($r = 0.71$, $p < 0.001$) [Table 4].

A stepwise multiple linear regression test was performed to predict the NAS. The variables of consciousness level, age, SOFA, type of ward, diagnosis, having an airway, underlying disease, and length of stay were imported into the model as independent variables and NAS as the dependent variable. The collinearity of independent variables was assessed using tolerance and Variance Inflation Factor (VIF). For tolerance < 0.1 or the VIF > 10, it is decided that there is collinearity between the independent variables. In this model, there was no collinearity between the independent variables.

The model was implemented in 4 steps, and only variables of consciousness level, SOFA, length of stay, and having an artificial airway remained in the model. These 4 variables were predictors of NAS. The model results showed that the R2-adj is 0.46, suggesting that these 4 variables can predict 46% of the changes related to NAS [Table 5].

Discussion

Comparing the workload of COVID-19 ICUs and non–COVID-19 ICUs showed that the NAS was significantly higher in non–COVID-19 ICUs than for COVID-19 ICUs. The SOFA score was also significantly higher in non–COVID-19 ICUs than in COVID-19 ICUs. The NAS had a positive and statistically significant relationship with SOFA in both units, but the correlation was stronger in the COVID-19 ICUs.

The mean NAS in one study was 54.81%) 2.34%), which was similar to those of the present study.[19] Various mean NAS scores have been reported in different countries. For instance, in studying 19 ICUs in seven countries, Padilha

Table 2: Comparison of mean NAS items in COVID-19 ICUs and non–COVID-19 ICUs

Variable (Score)	Non–COVID-19 ICUs Mean (SD)	COVID-19 ICUs Mean (SD)
Monitoring and titration (4.5-19.6)	12.20 (0.85)	12.16 (0.66)
Laboratory (4.3)	4.30 (0.00)	4.30 (0.00)
Medication (5.6)	5.60 (0.00)	5.60 (0.00)
Hygiene procedures (4.1-20.0)	4.34 (1.73)	4.10 (0.00)
Care of drains all (1.8)	0.30 (0.68)	0.51 (0.30)
Mobilization and positioning (5.5-17.0)	8.86 (3.45)	7.49 (3.13)
Support and care of relatives and patients (4.0-32.0)	4.00 (2.02)	4.00 (0.00)
Administrative and managerial tasks (4.2-30.0)	4.42 (2.13)	4.25 (0.97)
Respiratory support (1.4)	1.18 (0.85)	0.48 (0.80)
Care of artificial airways (1.8)	0.78 (0.89)	0.89 (0.90)
Treatment for improving lung function (4.4)	0.25 (0.49)	12.16 (0.66)
Vasoactive medication (1.2)	0.25 (0.49)	0.18 (0.43)
Intravenous replacement of large fluid losses (2.5)	0.36 (0.88)	0.02 (0.22)
Left atrium monitoring (1.7)	-	-
Cardiopulmonary resuscitation after arrest (7.1)	0.09 (0.80)	0.20 (1.19)
Hemofiltration techniques (7.7)	0.50 (1.90)	0.06 (0.68)
Quantitative urine output measurement (7.0)	7.00 (0.00)	7.00 (0.00)
Measurement of intracranial pressure (1.6)	-	-
Treatment of complicated metabolic acidosis/ alkalosis (1.3)	0.04 (0.31)	-
Intravenous hyperalimentation (2.8)	0.09 (0.50)	0.01 (0.14)
Enteral feeding (1.3)	0.64 (0.65)	0.19 (0.46)
Specific intervention(s) in the intensive care unit (2.8)	0.05 (0.38)	0.17 (0.66)
Specific interventions outside the intensive care unit (1.9)	0.15 (0.51)	0.10 (0.44)
Total of Nursing Activities Score*	59.90 (10.03)	56.38 (6.67)

*t=5.73, df=766, p<0.001

Table 3: Comparison of mean SOFA items in COVID-19 ICUs and non–COVID-19 ICUs

Variable	Non–COVID-19 ICU Mean (SD)	COVID-19 ICU Mean (SD)	*t*	df	*p**
Respiratory system	2.62 (1.31)	2.67 (0.99)	-0.62	766	<0.001
Neurological system	2.41 (1.33)	1.27 (1.52)	11.01	766	<0.001
Cardiovascular system	0.44 (1.06)	0.40 (1.10)	0.233	766	0.831
Hepatic system	0.09 (0.39)	091 (0.35)	<0.001	766	1.000
Coagulation	0.72 (0.99)	0.67 (0.94)	0.71	766	0.145
Renal system	0.73 (1.14)	0.52 (0.88)	2.82	766	0.005
SOFA** total	6.98 (3.89)	5.62 (3.98)	4.80	766	<0.001

*Independent *t*-test, **SOFA: Sequential Organ Failure Assessment

Table 4: Comparison of the relationship between NAS and SOFA scores in the non–COVID-19 ICUs and COVID-19 ICU

Variable	SOFA*			
	Non–COVID-19 ICU		COVID-19 ICU	
	r	*p*	*r*	*p*
NAS**	0.59	0.001	0.71	0.001

*SOFA: Sequential Organ Failure Assessment, **NAS: Nursing Activities Score

et al.[20] reported a mean NAS of 72.8%, varying from 44.5% in Spain to 101.8% in Norway. The mean NAS in 16 hospitals in Belgium was 68.6%. In a study by Momennasab *et al*.[21] in Shiraz (Iran), the mean NAS in the trauma ICUs was 65.3% (23.19%). The highest mean NAS in a study by Campagner *et al*.[22] was reported for the pediatric ICU. In addition, the highest mean NAS in a study by Camuci *et al*.[23] was reported in the burn ICU at 70.4%.

The type of patients hospitalized in the ICU can be related to the mean NAS. The NAS in the present study was lower in the COVID-19 ICUs due to the admission of only COVID-19 patients. However, the variety of patients admitted (cancer, trauma, and surgery patients) to the non–COVID-19 ICUs probably increased the NAS. These results are inconsistent with those of Reper *et al*.[24] who reported higher NAS in the COVID-19 ICUs.

Table 5: Multiple Linear Regression model for predictors of NAS**

Model	Unstandardized Coefficients		Standardized Coefficients	*t*	*p*	5.0% Confidence Interval for B	
	B	Std. Error	Beta			Upper Bound	Lower Bound
Constant	58.45	1.75		33.45	0.001	55.02	61.88
Level of consciousness	-0.43	0.14	-0.21	-3.03	0.003	-0.72	-0.15
Total score SOFA*	0.76	0.10	0.35	7.38	0.001	0.56	0.97
Hospitalization day	0.07	0.03	0.08	2.67	0.008	0.02	0.13
Artificial airway	-2.33	1.01	-0.13	-2.30	0.02	-4.30	-0.34

*SOFA: Sequential Organ Failure Assessment, **NAS: Nursing Activities Score

The incidence of MOF is higher in non–COVID-19 ICUs because of the severity of the patient's illness and extended hospitalization. ICU admission of COVID-19 patients is primarily linked to respiratory issues, and for those with underlying conditions, other organ failures manifest gradually.[25]

The COVID-19 pandemic outbreak has imposed much fear and anxiety on ICU nurses due to the possibility of infection, transmission of the disease to family members, and equipment shortage. These conditions increase the mental workload of nurses in the COVID-19 ICUs.[6] However, the mental workload caused by COVID-19 for ICU nurses has decreased to some extent by controlling the COVID-19 disease.[26] The NAS calculates the time allocated to each activity and cannot calculate the mental workload of nurses. In this respect, the mental workload of nurses can reduce the quality of nursing care and cause burnout.[27] Therefore, it is necessary to consider an item in the calculation of nurses' workload because it can be included in the staffing of ICU nurses.

The study findings show a stronger correlation between NAS and SOFA in COVID-19 ICUs (r = 0.71) compared with non–COVID-19 ICUs (r = 0.59). The correlation coefficient (r = 0.51) found between the NAS and SOFA scores in the study conducted by Altafin *et al*.[28] was comparable to that observed in the non–COVID-19 ICUs in our current study. A significant proportion of the COVID-19 patients admitted to the ICU in this study had preexisting medical conditions. The infection caused by COVID-19 elevates the MOF of the affected patients.[29] Consequently, the nursing staff's workload increased because of the surge in MOF cases within COVID-19 ICUs.

In this study, consciousness level, SOFA, length of stay, and having an artificial airway were predictors of NAS. In line with the present study, Padilha *et al*.[30] showed that the highest NAS score was associated with increased length of stay and severity of illness (Simplified Acute Physiology Score; SAPS II) in the ICU. In Carrara *et al*.'s study,[31] NAS and SOFA scores were predictors of mortality in obese patients. However, in the study by Fasoi *et al*.,[19] NAS was not associated with the mortality of patients.

Another important factor was there was no change in the ratio of nurses to patients (1:2 or 1:3) in ICUs during the COVID-19 pandemic. Despite transferring nurses from other departments to the ICU for COVID-19, the nurse-to-patient ratio remained the same because of the high infection rate among ICU nurses. The perception of COVID-19 risk among nurses was high at the beginning of the COVID-19 pandemic, and most nurses working in COVID-19 ICUs experienced much stress. It is noteworthy that regarding the increase in the number of ICU beds during COVID-19, nurse understaffing was resolved by employing nurses from other departments or hiring daily wage nurses from among unemployed nurses. The lack of skills among these nurses who were forced to work immediately in COVID-19 ICUs imposed a significant mental workload on these nurses. In addition, the feeling of job insecurity among these nurses increased their mental tension. Many of these nurses notably became unemployed following the decrease in COVID-19 patients. The shortage of nursing staff and equipment during the COVID-19 pandemic imposed a great workload on nurses, which is not foreseen in the NAS of these cases. Therefore, researchers should pay attention to the time nurses spend to compensate for the lack of equipment and skilled nurses in the ICUs. Hence, the mental workload aspect of nurses due to these shortages should be included in estimating the nurses' actual workload. Correctly estimating nurses' workload and correct and fair nurse staffing can increase the quality of nursing services and prevent violations of nurses' rights. Although NAS is the most practical score available to evaluate nurses' workload, it cannot measure other aspects of nurses' workload. Considering Iran's cultural, economic, and political conditions, the generalizability of the results of this study to other situations is limited.

Conclusion

This study showed that NAS and SOFA scores were higher in non–COVID-19 ICUs than in COVID-19 ICUs. By comparing the workload and MOF between non–COVID-19 ICUs and COVID-19 ICUs, the present study offers a general view of these variables during the pandemic. However, aspects of the workload in the COVID-19 ICUs remained undetected.

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Conflicts of interest

Nothing to declare.

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