# **Original Article**

# Relationship Between ICU Nurses' Working Shifts and the Time of Endotracheal Extubation After Cardiac Surgery

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### ABSTRACT

- *Background:* The aim of this study was to determine the relationship between nurses' work shifts in the intensive care unit (ICU) and the time of endotracheal extubation after cardiac surgery.
- *Methods:* The present study enrolled 210 patients that underwent cardiac surgery in a university referral cardiovascular center in 2018. Samples were selected via the convenience sampling method from adult patients that underwent elective cardiac surgery. The study samples were divided into 3 groups based on their admission time in the ICU: before 2 pm (morning shift), between 2 and 7 pm (evening shift), and after 7 pm (night shift). The patients' demographic characteristics, risk factors, and intraoperative and postoperative clinical variables were collected. Information regarding the time of admission into the ICU, the time of readiness for extubation, and the actual time of extubation was recorded. Finally, these times were compared between the patients admitted into ICU in the 3 abovementioned work shifts.
- **Results:** The study population was comprised of 210 patients, 142 (67.6%) male and 68 (32.4%) female, at an average age of 55 years old (44–63). According to the findings, tracheal extubation was usually performed in the work shift after the patients' admission time. There was a significant difference between the time of readiness for extubation and the actual time of tracheal tube removal on the different shifts, with the time being about 1 hour longer on the night shift than on the evening or morning shift (P < 0.05).
- *Conclusions:* Our cardiac surgery patients who were admitted into the ICU on the morning and evening shifts were ready for extubation earlier than those admitted on the night shift. (*Iranian Heart Journal 2020; 21(2): 34-40*)

KEYWORDS: Nursing shifts, Extubation, Cardiac surgery, Intensive care unit

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<b>Received:</b> May 25, 2019	Accepted: July 14, 2019			

Deciding to remove the tracheal tube is a very important moment for patients with an endotracheal tube. Not only is deciding to start the process of weaning from mechanical ventilation and extracting the tracheal tube is of great importance, but also the time of extubation is critical for patients admitted into the intensive care unit (ICU). In most cases, transition from mechanical ventilation support in voluntary breathing is without any problems; however, in some patients, this process may be challenging.

Failure to extubate the tracheal tube and reintubation could be directly related to each other, and there is a significant relationship between prolonging the removal of the tracheal tube and reintubation.<sup>1</sup> Respiratory complications after prolonged tract intubation are 3 times more frequent than the complications of early extubation (4.6% vs 12.6%). For this reason, the first goal after the intubation of the trachea is the extubation plan.<sup>2</sup> The rapid weaning process from the ventilator and the extraction of the tracheal tube in patients after cardiac surgery are very important for clinical reasons.<sup>3</sup>

By recognizing the effective factors, nurses will be able to identify patients' probable problems better and design and implement a more effective care plan for postoperative tasks.<sup>4</sup> It appears that one of the inhibitory factors in the process of weaning from mechanical ventilation is nurses' shift work during night shifts. A less effective work performance on night shifts could be considered a potential risk factor, rendering nurses liable to make mistakes in the face of the critical nature of the task. <sup>5</sup> Sleeping hours have an important impact on sleep disorders in nursing staff who have night shifts, and enough sleep hours are needed to ensure the quality of sleep and, thus, better service to patients. <sup>6</sup> During night shifts, the standard number of nursing staff is 1 for 2 ICU patients at 12 o'clock. <sup>7, 8</sup> Nurses,

doctors, and hospital staff working during night shifts often have irregular sleep and awakening intervals; less sleep in these individuals reduces consciousness and induces general fatigue. In these hours, mental activity, which requires care and attention, is affected more than physical activity.<sup>9</sup> Nursing, in comparison with other professions, requires more work shifts, especially night shifts. Nearly among 1 million nurses who work in Japan, 75% of them have night shifts.<sup>6</sup> Therefore, early weaning from mechanical ventilation on night shifts is not in the best interest of both patients and staff, for it may lead to reintubation. On the other hand, because the time of the tracheal tube removal after surgery is sometimes aligned with nurses' night shifts, it is possible that extubation will be postponed-without special reasonsuntil the next morning, depriving the patient of the benefits of this action by doing it properly.

Accordingly, it is necessary to examine the relationship between the work shift of nurses and the time of extubation after cardiac surgery. Work shifts may be correlated with the time of tracheal extubation after cardiac surgery. The aim of this study was to determine the relationship between the work shifts of ICU nurses and the time of extubation after cardiac surgery.

#### **METHODS**

The current investigation enrolled 210 adult patients admitted into the ICU after cardiac surgery. Nurses who were responsible for their care-including weaning from the ventilator removal and the of the endotracheal tube in their work shifts-were also included in this study. The inclusion criteria consisted of age between 18 and 70 years old and candidacy for elective coronary artery bypass grafting or valve replacement (repair) of 1 or more heart valves. The study population was divided

The demographic characteristics of the nurses responsible for removing the patients' tracheal tube in terms of 8 variables namely age, sex, education, nurse-patient ratio, years of professional experience, clinical experience in the ICU, and total work hours per week—were entered into a checklist made by the researcher.

The type and dose of anesthetic drugs used in the heart surgical operations were the same for all the patients. On admission, the patients underwent arterial blood gas tests, which were subsequently repeated every 2 hours until extubation. The patients were then treated based on a written protocol (agreement) by the hospital's respiratory practitioners under the supervision of anesthesia fellows cardiac and were prepared for the extraction of the tracheal tube. The patients' readiness for extubation was determined by the written order of the cardiac anesthesia fellows in the medical sheet of the patients in the ICU.

Information on the time of admission into the ICU, the time of readiness for extubation, and the actual time of extubation was recorded. Finally, these times were compared between the patients admitted into the ICU on morning, evening, and night work shifts.

#### **Statistical Analysis**

The one-sample Kolmogorov–Smirnov test was used to examine the normal distribution among the numerical variables. For the comparison of the parameters between the 3 study groups, the Kruskal–Wallis,  $\chi^2$ , Fisher exact, and Mann–Whitney *U* tests were

utilized. The final statistical analyses were carried out using IBM SPSS Statistics, version 21. A P value of 0.05 or less was considered statistically significant.

#### RESULTS

In this study, 210 adult patients were divided into 3 groups according to the time of their admission into the ICU: morning shift (n =68), evening shift (n = 116), and night shift (n=26). The time of the patients' admission into the ICU was considered until they were prepared and ready for extubation. Efforts were made to create the same conditions for the study samples by using the same type of anesthetic drugs for the whole study population. On entrance into the ICU, the patients were connected to a single type of mechanical ventilator. Only a single type of device was used in order to check arterial blood gas and analyze vital signs in all the patients. Additionally, based on a single documented protocol, the process of weaning from mechanical ventilation was carried out by nurses. The relationship between the time of the patients' admission into the ICU and their preparation time for extubation is depicted in Table 1. In the patients admitted on the evening shift (n = 116), 108 patients were prepared for extubation on the night shift, which means that this was the most frequent and most appropriate time for the separation of the patients from the ventilator of the 3 ICU admission times. There was a significant difference between the time of readiness for extubation and the actual time of the tracheal tube removal on the different shifts. This time was almost 1 hour longer on the night shift than on the evening or morning shift (*P* < 0.05).

Time of Readiness for Extubation	Admission Time			df	P value
	Morning	Evening	Night		
Morning shift	0	0	1(3.3%)	4	<0.001
Evening shift	26(36.1%)	0	0		
Night shift	46(63.9%)	108(100%)	29(96.7%)		

Actual Extubation Time	Admission Time			df	P value
	Morning	Evening	Night		
Morning shift	0	2(1.9%)	5(16.7%)	4	<0.001
Evening shift	15(20.8%)	0	0		
Night shift	57(79.2%)	106(98.1%)	25(83.3%)		

Table 3: Comparisons of the interval between the preparation time and the actual time of extubation on the different work shifts

Variable	Morning Shift	Evening Shift	Night Shift	Test	Test Statistics	P value
Interval between the	110(32-180)	180(90-300)	192(90-240)	Kruskal-	χ <sup>2</sup> =12.01	0.002
preparation time and				Wallis	df=2	
the actual time of						
extubation (min)						

As is shown in Table 2, there was a significant relationship between the time of patients' admission into the ICU and the actual time of extubation (P < 0.05). The majority of the patients who underwent extubation in the actual time entered the ICU during the evening shift. Of the patients admitted into the ICU during the night shift, 5 patients underwent extubation the next morning.

The mean interval time between the time of the patients' readiness for extubation and the actual time of extracting the tracheal tube was 150 minutes (60–270).

The relationship between the work shift and the preparation time for extubation and the actual time of removing the tracheal tube is illustrated in Table 3. There was an interval between the time of the patients' preparation for extubation and the actual time of extubation. The comparisons of this variable between the morning, evening, and night shifts revealed that only the nurses' work shift at night, which was the same period of the interval time, involved a delay in the extubation process. The numerical values obtained on the morning, evening, and night shifts were, respectively, 110 minutes, 180 minutes, and 192.5 minutes. There was a significant difference between the period of preparation for extubation until the actual removal of the tracheal tube and its relationship with the work shift (P < 0.05).

### **DISCUSSION**

In this study, the relationship between the time of patients' admission into the ICU and their preparation time for extubation was investigated. Our findings showed that 108 patients, who had been admitted into the ICU on the evening shift, were prepared for tracheal tube extubation during the next night shift. The night shift, therefore, appears to be the most frequent and most appropriate time for separating patients from mechanical ventilation of all the 3 ICU work shifts. There was a significant relationship between the time of the patients' admission into the ICU and the time of preparation for extubation (P < 0.05).

We also observed a meaningful association between the time of the patients' ICU admission and the actual time of extubation (P < 0.05). The majority of the patients who were extubated entered the ICU during the evening shift, whereas only a few patients entered the ICU during the night shift, among whom 5 patients underwent extubation the next morning. In order to determine the preparation time for the extubation of the endotracheal tube and the actual time of extubation for the purposes of the study, we calculated a median time of 150 minutes.

Durie et al <sup>10</sup> in Australia in 2015 conducted a study to investigate the effects of increasing the number of nurses in a 24-bed ICU during the night on the mechanical ventilation duration based on the assumption that this change (increasing the number of staff) would be accompanied by a decrease in mechanical ventilation and an increase in the extubation of endotracheal tubes, which is associated with night shifts. Nonetheless, Durie and colleagues detected no significant difference. It is noteworthy that several factors are involved during the process of the extubation of synthetic trachea tubes that vary depending on the time, location, and personnel of each treatment center. Faghani et al <sup>11</sup> in 2016 stated that the mean and standard deviation of the time of the tracheal tube extubation in 200 patients after cardiac surgery was  $9.39 \pm 2.77$ hours. Bensal et al <sup>12</sup> in 2013 reported a figure more than 7.3 times the aforementioned one, and Rezaeinzadeh et al <sup>13</sup> in 2015 asserted that the time of patients' admission into the ICU until the actual discharge of the endotracheal tube was  $10.4 \pm 27.39$  hours.

We calculated the interval between the time of the patients' readiness for extubation and the actual time of extubation in minutes in 3 ICU work shifts. Of the 3 ICU shifts of morning, evening, and night, only the night shift was associated with a delay in the process of extubation. The acquired numerical values were 110 minutes, 180 minutes, and 192.5 minutes in the 3 shifts of morning, evening, and night, respectively.

Our results also revealed a significant difference between the time of the patients' readiness for extubation and the actual time of the removal of the endotracheal tube and its relationship with work shifts (P < 0.05). Our finding in this regard is concordant with that reported by Hansen et al.<sup>7</sup> who conducted an investigation in December 2008 in the ICU on 68 adult patients undergoing mechanical ventilation so as to investigate the difference between the time it was possible to carry out extubation and the actual time of extubation. Elsewhere, Kwon and Chui<sup>15</sup> in 2017 investigated the factors associated with the extraction of the endotracheal tube without any plan in the ICU and found that nurses' night shifts were associated with this outcome (P < 0.001). Rogers et al <sup>16</sup> in 2004 stated that nurses with rotating shifts had the highest efficiency on morning shifts and the least efficiency on night shifts. In the explanation of this finding, it can be argued that by working during the normal hours of sleep, the brain function decreases, which in turn can lead to poorer nursing performance. In 2006, Berger et al <sup>17</sup> showed that the frequency of minor mistakes in the field of treatment during night shifts was high.

In this study, we found a statistically significant difference between the time of the patients' readiness for extubation and the actual time of the extubation of the tracheal in 3 different work shifts (P < 0.05). Moreover, the number of patients who were prepared for extubation during the night shift and were indeed extubated on that shift was higher than the number of patients in the other 2 groups. The exception was 1 patient, whose tracheal tube was removed during the next morning shift. We also factored in the effect of nurses' demographic factors on the separation process of patients from mechanical ventilation. We gathered data on the nurses' age, sex, marital status, education, work experience, and work experience in the

ICU and found no significant relationship between these variables and the actual time of extubation. The 2 factors of age and nursing experience in a study by Tanaka et al<sup>18</sup> in 2010 contradict our findings in this regard, although in terms of the variable of nurses' shift work, our results chime in (P < 0.01). Zakriyan et al <sup>19</sup> in 2019 showed that among nurses' personal factors, education positively significantly affected their and iob performance, which is contradictory to the results of the present study. This is due to the specificity of the extubation process in this study and the difference is in the variety of job performances in the study by Zakryan and coworkers. According to their results, an increase in the nurses' working hours per week more than their standard level, which could be in a single hospital or their total working hours in 2 treatment centers, did not have a positive effect on the time of extubation. However, Zakryan and colleagues stated that an increase in the total working hours of more than 40 hours a week led to a reduction in the job performance of the nurses in their investigation.

#### Limitations

The most significant limitation of the current study is that we did not include emergency cardiac surgeries. Another weakness of note is that we did not include admissions into the ICU during holidays. Additionally, the present study is a single-center investigation and the institutional protocol of postoperative weaning from mechanical ventilation may have affected the results.

#### CONCLUSIONS

The findings of the present study showed that the number of ICU nurses was low during the night shift; as a result, the interval between the time of the patients' readiness for extubation and the actual time of extubation was longer on the night shift. In light of the findings of the present study, it appears that in the postoperative period, the relationship between the ICU admission of cardiac surgery patients and ICU nurses' work shift is important.

#### Acknowledgments

This article was conducted under the aegis of Rajaie Cardiovascular, Medical, and Research Center, affiliated with Iran University of Medical Sciences, Tehran, Iran. Many thanks are due to the nurses in the cardiac surgery ICUs of the hospital.

#### REFERENCES

- Bansal S, Thai H, Hsu C, Sai-Sudhakar C, Goldman S, Rhenman B. Fast track extubation post coronary artery bypass graft: a retrospective review of predictors of clinical outcomes. World Journal of Cardiovascular Surgery. 2013;3(02):81-6.
- 2. Berger AM, Hobbs BB. Impact of shift work on the health and safety of nurses and patients. Clinical journal of oncology nursing. 2006;10(4):465-71.
- 3. College of Intensive Care Medicine of Australia and New Zealand. Minimum Standards for Intensive Care Unit: College of Intensive Care Medicine of Australia and New Zealand; 2011 [2018/11/018]. Available from: https://www.cicm.org.au/.../IC-1-Minimum-Standards-for-Intensive-Care-Units.pdf.
- **4.** Durie M, Darvall J, Rechnitzer T, Tacey M. Impact of increasing overnight intensive care unit registrar staffing on duration of intubation of elective cardiac surgery patients. Anaesthesia & Intensive Care. 2015;43(5):600-7.
- 5. Ebrahimian A. [Accuracy in night work nurses]. Payesh. 2006;5(2):123-30.
- Faghani H, Mosavinasab N, Gholipour Baradari A, Moosazadeh M, Kheradmand M, Esmaeili R. [Duration of Intubation after Coronary Artery Bypass Graft Surgery and Its Related Factors]. Journal of Mazandaran University of Medical Sciences. 2017;26(146):68-79.

- Hansen BS, Fjaelberg WTM, Nilsen OB, Lossius HM, Søreide E. Mechanical ventilation in the ICU -is there a gap between the time available and time used for nurse-led weaning? Scandinavian journal of trauma, resuscitation and emergency medicine. 2008;16:1-8. PubMed PMID: 19055712.
- **8.** Jaber S, Jung B. Non-invasive ventilation failure rates during day and night shifts: is the night shift the dark side of the moon? Minerva anestesiologica. 2010;76(4):237.
- **9.** Jafroudi S, Mehdizadeh Attar M, Farmanbar R, Kazemnejadleili E, Paryad E. [Predictors' issues of intubation time after coronary artery bypass graft surgery]. Journal of Holistic Nursing and Midwifery. 2015;24(4):20-9.
- **10.** Karmarkar S, Varshney S. Tracheal extubation. Continuing Education in Anaesthesia Critical Care & Pain. 2008;8(6):214-20.
- **11.** Kwon E, Choi K. Case-control Study on Risk Factors of Unplanned Extubation Based on Patient Safety Model in Critically Ill Patients with Mechanical Ventilation. Asian Nursing Research. 2017;11(1):74-8.
- **12.** Nicholson D, Kowalski S, Hamilton G, Meyers M, Serrette C, Duke P. Postoperative pulmonary function in coronary artery bypass graft surgery patients undergoing early tracheal extubation: A comparison between short-term mechanical ventilation and early extubation. J Cardiothorac Vasc Anesth. 2002;16(1):27-31.
- 13. Ohida T, Kamal A, Sone T, Ishii T, Uchiyama M, Minowa M, et al. Night-shift

work related problems in young female nurses in Japan. Journal of occupational health. 2001;43(3):150-6.

- **14.** Rezaianzadeh A, Maghsoudi B, Tabatabaee H, Keshavarzi S, Bagheri Z, Sajedianfard J, et al. Factors associated with extubation time in coronary artery bypass grafting patients. PeerJ. 2015;3:e1414.
- **15.** Rogers AE, Hwang W-T, Scott LD, Aiken LH, Dinges DF. The working hours of hospital staff nurses and patient safety. Health affairs. 2004;23(4):202-12.
- **16.** Salminen S. Shift Work and Extended Working Hours as Risk Factors for Occupational Injury. The Ergonomics Open Journal. 2010;3.
- **17.** Tanaka K, Takahashi M, Hiro H, Kakinuma M, Tanaka M, Kamata N, et al. Differences in medical error risk among nurses working two-and three-shift systems at teaching hospitals: a six-month prospective study. Industrial health. 2010;48(3):357-64.
- **18.** Thille AW, Cortés-Puch I, Esteban A. Weaning from the ventilator and extubation in ICU. Current Opinion in Critical Care. 2013;19(1):57-64.
- 19. Zakerian SA, Mosaferchi S, Sepidarkish M, Nasiri Z, Momenyan S, Mortezapour Soufiani A, et al. [The Role of Individual Effective Factors on Nurses' Job Performance. A Case Study: Selected Hospitals in Tehran]. Occupational Medicine Quarterly Journal. 2018;10(1):54-61.