ORIGINAL ARTICLE

Effect of Admission Day and Time on Patient Outcome: An Observational Study in Intensive Care Units of a Tertiary Care Hospital in India

Mahuya Bhattacharyya[1], Subhash K Todi[2]

Received on: 07 December 2023; *Accepted on:* 18 March 2024; *Published on:* 30 April 2024

Abstract

Background: The current study aimed to assess any association between intensive care unit (ICU) and hospital outcomes with ICU admission timings of critically ill patients.

Methods: Retrospective observational single-center study involving all adult admissions. Each patient admission was categorized in "after-hours" (08:00 p.m.–07:59 a.m.), or "normal-hours" (08:00 a.m.–07:59 p.m.), "Weekday" (Monday–Saturday), or "Weekend" (Sunday), "Same day" (admission directly to ICU) or "other day admission" (admission to ICU after a hospital stay of ≥24 hours). Intensive care unit and hospital mortality, length of stay (LOS), and ICU readmission were assessed for any association with different admission timings.

Results: Among 3,029 patients, 54.2% (1,668) were male, with mean age 66.49 (SD ± 15.69) years, mean acute physiology and chronic health evaluation-IV (APACHE-IV) score 55.5 (SD ± 26.3). Around 86.1% of admission occurred during weekdays, 13.9% on weekends, 57.4% normal-hours, 42.6% after-hours, 66.3% same day and 33.7% other day admission. Intensive care unit and hospital mortality were 10.8 and 14.2% respectively. Neither ICU nor hospital mortality were significantly different among patients admitted normal vs after-hours ($p = 0.32$, 0.23), and weekdays vs weekends ($p = 0.09$, 0.93), nor was ICU LOS ($p = 0.21$, 0.74). Intensive care unit and hospital mortality ($p = 0.001$), DORB ($p = 0.001$), hospital LOS ($p = 0.001$), and readmission to ICU ($p = 0.001$) were significantly higher in the other day admission group compared to same-day admission. In a multivariate regression analysis age, APACHE IV score along with other day admission to ICU did have a significant effect on both ICU and hospital mortality.

Conclusion: Intensive care unit and hospital mortality and LOS did not differ significantly with hours or days of ICU admission though they were significantly higher in other day admission groups.

Keywords: Admission timings, Critically ill patients, Intensive care unit outcome, Length of stay, Mortality, Readmission.

Indian Journal of Critical Care Medicine (2024): 10.5005/jp-journals-10071-24694

Highlights

This study reflects the 'day-effect' and 'time-effect' of intensive care unit (ICU) admission on ICU and hospital outcomes. Any such effect could not be elicited when structure or process remains optimum to match the requirement of critically ill patients, rather outcome worsens if optimum ICU care gets delayed. The observations from this study may be more applicable in mixed medical-surgical ICUs admitting less emergency surgery and trauma patients.

Introduction

The outcome of ICU patients is predicted by different factors including medical and non-medical issues. Medical issues are existing comorbidities, the severity of illness, early diagnosis, and prompt formulation of the appropriate treatment plan along with avoidance of any treatment-related complication.[1] Non-medical issues are mainly administrative, like closed, semi-closed or open type ICUs, decision-making authority, stuffing pattern of doctors and nurses along with variation over the week, days, and timings of admission to ICU and transfer from ICU, and 24 × 7 availability of required services, consultant intensivist support and so on. Initial few hours management is very crucial for critically ill patients as clinical status remains dynamic with a tendency to worsen rapidly.[2,3] The non-availability of resources during nighttime or weekends may lead to delay in diagnosis and initiation of management which might worsen the outcome of patients. This aspect of critical care services is evaluated in several studies to understand the effect of admission timings of patients to ICU on outcomes. Study results remained inconsistent and are affected by variations in clinical practice and organizational structures in different countries.[1] Studies mainly compared admissions occurring during weekdays with weekends, and normal hours

[1,2]Department of Critical Care, AMRI Hospitals, Kolkata, West Bengal, India

Corresponding Author: Mahuya Bhattacharyya, Department of Critical Care, AMRI Hospitals, Kolkata, West Bengal, India, Phone: +91 9831024409, e-mail: mohua20002000@yahoo.com

How to cite this article: Bhattacharyya M, Todi SK. Effect of Admission Day and Time on Patient Outcome: An Observational Study in Intensive Care Units of a Tertiary Care Hospital in India. Indian J Crit Care Med 2024;28(5):436–441.

Source of support: Nil

Conflict of interest: This study was approved for ISCCM research grant 2017.

Dr Subhash K Todi is associated as the Editorial board member of this journal and this manuscript was subjected to this journal's standard review procedures, with this peer review handled independently of this Editorial board member and his research group.

with after-hours. Weekends and after-hours are considered as a less active parts of the week and days according to the availability of staff, services, the experience of staff, and pattern of elective admission. Time definitions of after-hours and weekends varied in different literature available from different countries. These studies compared outcomes like mortality, length of stay (LOS), decision-making issues, on behalf of treating doctors or family members, the decision to withdraw of treatment support and other issues. The results varied in different trials and the reason could be multifactorial including case mix, hospital policies, and staff and resource availability in different hospital setups.[1,4] Some studies revealed that hours and weekend ICU admission carry a higher risk for adverse outcomes and mortality as compared to patients admitted during normal hours and weekdays on the other hand, some did not reveal any difference.[5–11] Literature also supports the fact that mortality was higher in patients who were transferred to higher care facilities after admission to the hospital.[12] Due to discrepancies in study results, paucity of data in India, and the shallow existence of weekend or after-hours in various organizations, it seems relevant to understand the effect of similar scenarios in the existing structure and processes of our ICUs. The current study aimed to assess the association of mortality (ICU and hospital), LOS, and readmission rate to ICU during the same admission in patients admitted to ICU during 'after-hours', 'weekends', and 'other day admission' with 'normal hours', 'weekdays' and 'same day admission' in a tertiary care ICU in India.

Methods

This retrospective observational study was conducted in 23-bed mixed medical-surgical ICUs of tertiary care private hospital in Kolkata, India, from October 2015 to December 2018. The key persons for patient management are consultant intensivists, resident doctors (including critical care fellow students), nurses, biomedical technicians, and respiratory therapists. There is no policy of a separate kind of roster on the weekends for consultants, doctors, nursing staff, and other general staff in these units, however, there is no biomedical technician on Sundays and after-hours, and no respiratory therapist is available during after-hours. Consultant intensivists are available on the phone on Sundays and after-hours unless needed onsite for any specific reason and interventional radiology, cardiology, and gastroenterology services run on an emergency basis. Generally, doctor-patient ratio is 1:5 and nurse-patient ratio for non-ventilated patients remains 1:3 and for ventilated patients 1:1. Until there is a gross staff crisis, the ratio is tried to be maintained like mentioned above and these parameters are not considered for analysis of this study. Consultant cover is there 24×7, either by physical presence or on the phone. The study was approved by the institutional ethical committee and informed consent was waived as the study was retrospective and observational in nature and used de-identified data.

Patients and Data Source

All consecutive adult patients (age >18 years) admitted to ICU and stayed for ≥24 hours were screened for inclusion. Patients with incomplete data were excluded from the study. The first admission was considered for analysis for patients with multiple ICU transfers during a single hospital admission. Data had been collected from an electronic database maintained by the Department of Critical Care of the hospital. Patient-related different variables are captured daily by data entry personnel prospectively, during the hospital stay of every patient in a predefined excel data entry system. The quality of data was assessed by critical care consultants by random checks of a certain number of files every month to identify any discrepancies. Required variables related to the study were retrieved from the database in de-identified form to maintain confidentiality.

Definition of Variables and Data Collection

For this study, admission day and timing were segregated in the following way. "After-hours" admission is considered for all admissions to ICU occurring between 08:00 p.m. and 07:59 a.m., and others are considered as "normal hours" admission. "Weekday" admission was considered for all admissions occurring from Monday to Saturday and "weekend" admission was considered for those admissions occurring on Sunday. "Same-day admission" was considered as admission directly to ICU and "other day admission" was considered as admission to the ICU after a hospital stay of at least 24 hours or more. Intensive care unit readmission was defined as patients getting back to ICU from wards or high dependency units within the current hospitalization irrespective of the time between their discharge and re-admission to ICU.

Different variables were included during data collection. Demographic data included age, gender, admission diagnosis, acute physiology and chronic health evaluation (APACHE) IV score, and presence of sepsis and its category. The sources of patients for admission to the ICU were emergency, ward, high dependency units, or operation theaters. Admission diagnosis was categorized as medical and surgical and according to primary diagnosis made in the first 24 hours of admission coded with APACHE IV.

Timings of ICU admission (hours, days, and delays) were the main exposures assessed in this study. The primary outcome was risk-adjusted hospital mortality and secondary outcomes were ICU mortality, ICU and hospital LOS, and ICU readmission. Patients were grouped according to the "day" and "time" definitions of admission in the ICU and demographics and outcome variables were compared for any statistically significant difference. "Weekday" admission was compared with "weekend" admission, "normal hour" admission with "after-hours" admission, and "same day admission" with "other day admission".

Statistical Analysis

Categorical variables are expressed as the number of patients and percentage of patients and compared across the groups using Pearson's Chi-square test for independence of attributes. Continuous variables are expressed as mean, median, and standard deviation and compared across the groups using the Mann–Whitney *U*-test since the data does not follow normal distribution. Predictive analysis was done using Binary Logistic Regression. The statistical software SPSS version 22 has been used for the analysis. An alpha level of 5% has been taken, i.e., if any p-value is less than 0.05, it has been considered as significant.

Results

A total of 3,077 patients were screened during the defined time period and 3,029 patients were included in the final analysis after excluding patients ($n = 48$) with incomplete data. Of all admissions, 86.1% occurred during weekdays, 13.9% during weekends, 57.4% during normal hours, 42.6% during after-hours, 66.3% got same-day admission in ICU, and 33.7% another day admission to ICU. Surgical

Table 1: Characteristics of study population

Parameters	*Normal hour admission (8 a.m.–7.59 p.m.) (n = 1,744)*	*After-hour admission (8 p.m.–7.59 a.m.) (n = 1,285)*	*p-value*	*Weekdays (Monday–Saturday) admission (n = 2,605)*	*Weekends (Sunday) admission (n = 424)*	*p-value*	*Same day admission (n = 2,005)*	*Other day admission (n = 1,024)*	*p-value*
Age (± SD) years	67.24 (15.18)	65.49 (16.3)	0.008	66.45 (15.67)	66.78 (15.83)	0.67	66.99 (15.76)	65.5 (15.5)	0.003
Male:Female	53:47	56:44	0.19	54:46	55:45	0.67	54:46	55:45	0.71
APACHE IV (mean± SD)	55.45 (26.14)	55.65 (26.72)	0.86	55.2 (26.23)	57.65 (27.26)	0.11	55.7 (25.03)	55.22 (28.8)	0.05
Medical: Surgical admission	84:16	96:4	0.0001	88:12	98:2	0.0001	97:3	73:27	0.0001
Septic shock (%)	17.2	16.8	0.80	16.5	20.3	0.06	14.3	22.4	0.0001

Table 2: Intensive care unit outcome variables as per ICU admission

Parameters	*Normal hours admission*	*After hour admission*	*p-value*	*Weekdays admission*	*Weekend admission*	*p-value*	*Same day admission*	*Other day admission*	*p-value*
Discharge against medical advice (%)	3.7	4.7	0.32	3.8	6.1	0.09	4.3	3.9	0.001
Death in ICU (%)	11.0	10.5	0.32	10.8	10.5	0.09	7.9	16.3	0.0001
ICU length of stay, days (mean ± SD)	3.96 ± 4.38	3.67 ± 3.95	0.21	3.86 ± 4.30	3.68 ± 3.52	0.74	3.79 ± 4.21	3.93 ± 4.19	0.13
Readmission to ICU	5.9	4.9	0.23	5.5	5.6	0.90	1.2	14.0	0.001

and medical patients comprised 10.9 and 89.1% of the whole study population respectively. The baseline characteristic of the study population is described in Table 1. Patients were categorized as per diagnosis obtained within 24 hours of admission and organ system involvement. Admission category included respiratory system (n = 658), renal (n = 474), GI and hepatobiliary system (n = 370), cardiovascular system (n = 283), central and peripheral nervous system (n = 163), oncology (n = 102), gynecology and obstetrics (n = 30), trauma (n = 21), and others (n = 969).

Outcome Parameters

Overall ICU and in-hospital mortality were (331/3,029) 10.8% and (385/2,698) 14.2% respectively. Intensive care unit and hospital mortality were not significantly different among patients admitted in normal or after-hours (p = 0.32, 0.23), and weekdays or weekends (p = 0.09, 0.93). Intensive care unit LOS was not different for admissions in normal hours vs after-hours, and weekdays vs weekend category as well (p = 0.21, 0.74). Discharge against medical advice from ICU and hospital were not significantly different among patients admitted in normal or after-hours, and on weekdays or weekends. However, ICU and hospital mortality (p = 0.001 for each), DORB (p = 0.001), hospital LOS (p = 0.001), and readmission to ICU (p = 0.001) were significantly higher in the other day admission group compared to same-day admission. Outcome parameters were described in Tables 2 and 3.

The predicted mortality rate (PMR) calculated from the APACHE IV score was not significantly different between weekdays vs weekends, and normal hours vs after-hours (p = 0.73, 0.42) respectively. However, PMR remained significantly high in patients who had other-day admission (p = 0.001). A rising trend is noted in SMR in the other day admission group compared to the same day admission group. The other day admission group was analyzed further for weekend and after-hour admission effects however, no significant outcome difference could be identified. Multivariate regression analysis was done to assess the effect of days and timings of admission on ICU and hospital outcomes (Table 4). Neither weekend admission nor after-hour admission showed any effect on mortality, however, age, APACHE IV score along with other day admission to the ICU did have significant effects on both ICU and hospital mortality.

Discussion

In this study, more patients were admitted during weekdays, normal hours, and directly to the ICU (same-day admission). The mean APACHE IV (±SD) score remained comparable across all the study groups. Intensive care unit or hospital mortality did not differ significantly with patients admitted on weekends or during after-hours compared to patients admitted on weekdays or normal hours. Acute physiology and chronic health evaluation IV score and

Table 3: Hospital outcome variables as per ICU admission

Parameters	*Normal hours admission*	*After hour admission*	*p-value*	*Weekdays admission*	*Weekend admission*	*p-value*	*Same day admission*	*Other day admission*	*p-value*
Discharge against medical advice (%)	7.7	9.4	0.23	8.4	8.7	0.93	8.7	7.7	0.001
Predicted mortality rate (PMR) (mean ± SD)	14.98 ± 19.77	13.82 ± 19.62	0.42	14.4 ± 19.5	14.7 ± 20.5	0.73	12.34 ± 17.43	18.73 ± 23.01	0.001
Death in hospital (%)	13.2	12.9	0.23	13.1	12.6	0.93	9.5	20.1	0.0001
SMR (observed death/ predicted death)	0.9	0.9		0.9	0.8		0.7	1.0	
Predicted hospital LOS (days) (mean ± SD)	4.73 ± 1.82	4.60 ± 1.65	0.11	4.69 ± 1.76	4.62 ± 1.65	0.69	4.37 ± 1.53	5.28 ± 1.99	0.0001
Hospital length of stay (days) (mean ± SD)	12.4 ± 13.42	10.77 ± 11.59	0.001	11.78 ± 12.03	11.2 ± 16.16	0.02	9.57 ± 9.64	15.94 ± 16.43	0.001

Table 4: Multiple logistic regression

			95% CI for odds ratio	
Variables	*p-value*	*Odds ratio*	*Lower*	*Upper*
PMR	<0.0001	1.043	1.038	1.048
Other day admission	<0.0001	2.023	1.582	2.587
After-hours admission	0.221	1.167	0.911	1.495
Weekend admission	0.845	0.965	0.676	1.377
Age	0.003	0.986	0.977	0.995
APACHE - IV	0.0001	1.052	1.046	1.058

its predicted hospital mortality, ICU, and hospital crude mortality were significantly higher in patients admitted to ICU after a stay of 24 hours or more in hospital (other day admission). Acute physiology and chronic health evaluation IV score was calculated in the 'other day admission' group of patients on the day of ICU admission and hence may not reflect the severity of illness on admission to the hospital. However, it represents the clinical status of the patient while transferred to the ICU which seemed to have happened after clinical worsening. Standardized mortality ratio (SMR) was highest in this group of patients and actual hospital LOS exceeded far beyond predicted LOS. The subgroup of patients with 'other day admission' was further analyzed for weekend and after-hours effect on mortality and LOS, and the difference was not statistically significant.

Several studies were conducted in different period addressing the effect of weekday vs weekend and normal hours vs after-hours admission to ICU on the outcome. Weekdays, weekends, normal hours, and hours were defined differently in various studies mainly based on services available at that period. A number of patient admissions varied according to different time frames in various studies.[13–16] On risk-adjusted analysis of mortality, the study result differed as well in different studies. Cavallazzi et al. concluded in a meta-analysis that weekend admission was found to be associated with worse outcome which again is similar to a large Dutch study.[4,17] Similarly, an Australian study including nearly one-quarter million ICU admissions indicated increased risk for adverse outcomes for night and weekend admissions.[18] The study results, however, were never uniform in different parts of the world. In a study conducted in the UK no influence of week and time of admission on mortality could be found.[8] Similarly, ICU admission time and weekend admission were not independent risk factors of hospital mortality in critically ill patients with sepsis in a study done by Zhou et al.[19]

As far as research methodology is concerned, heterogeneity in study design, case mix, and bias related to the choice of variables may be responsible for the overall varied outcomes in different studies. If structure, process, and quality issues are analyzed for ICU outcome, several researchers have suggested factors that may influence outcome for weekend or after-hour admissions to the ICU. Risk factors identified in several studies with similar sickness and type of illness are closed vs open ICU models, nurse-patient ratio, availability of another healthcare worker, availability of experienced intensivists and/or on-site attending junior doctors, and access to all treatment services and procedures.[4,17,20,21] All these led to probable inconsistencies of care. In the case of different types of illness studies with emergency surgical admissions have greater odds of death if admitted during the weekend, so also trauma patients.[22,23] Sometimes, inaccurate coding in routine administrative data led to an artifactual increase in weekend mortality in the UK.[24] Inconsistencies in the availability of services or quality care can be considered as a major safety issue.

Our study did not demonstrate any association between a day of the week (weekend) and time (after hour) of admission with mortality and LOS (both ICU and hospital). Weekend in our study is considered only on Sundays, depending on the availability of services for critically ill patients. Several factors are speculated to play a role in determining the outcome of our study. Firstly, a trained intensivist is available on-site or on call throughout the week and his/her input is available within an hour of the admission of a patient. Patients admitted after-hours or on weekends are usually seen in person by a fellow or senior medical officer immediately. Procedural support like endoscopy, bronchoscopy, cariology intervention, and interventional radiology services that were required on an emergency basis, were available, though routine procedure was not done during after-hours and weekends. Level of sickness and PMR did not differ significantly as per the APACHE IV score calculated in the first 24 hours of admission in weekend and after-hours groups. Surgical admission was significantly low in the study population and trauma and emergency surgery patients requiring immediate and specific resources were less. Number of patients admitted with septic shock was not significantly higher in after-hours or weekend groups. These ICUs follow a definite nursing staff schedule which does not allow very low and different nursing numbers during weekends or after-hours. A number of patients with weekend admission also remained low. It is presumed that the pattern of patients and their sickness matched with optimum and quality care required at the time of admission. All these might be responsible for the lack of outcome difference for weekday vs weekend admission and normal hours vs after-hours admission.

Initial resuscitation and stabilization of the critically ill patient is crucial for treating patients in acute care medicine and any differences and deviations in the standard of care at this stage are likely to affect mortality. Patients seeking admission to ICU after a hospital stay of 24 hours or more did not fare well in our study. It is speculated that the apparent better condition of patients as assessed during admission triaged these patients to non-ICU areas, and pre-ICU care in this group may be inadequate given the delay in initiation or decision making which subsequently increased mortality.

A major strength of our study is a comparison of predicted vs crude mortality and standardized mortality ratio and the inclusion of all consecutive admissions in the medical-surgical unit. The main limitations of the study was, firstly adequacy of treatment issues were not addressed, secondly, ICU discharge timings were not considered for the analysis which is otherwise considered a major factor altering hospital outcome of ICU patients, thirdly, nurse-patient ratio and physician-patient ratio was not detailed, though an overall pattern of functioning of the unit is described, fourthly, resuscitation and stabilization in an emergency before transfer to ICU is not addressed in this study and finally, the reason for delayed admission was not addressed for patients who were admitted to ICU later on.

Conclusion

Intensive care unit and hospital mortality and LOS did not differ significantly with hours or days of ICU admission though they were significantly higher in the other day admission (delayed admission) group. This study points towards standard, uniform, safe, and stable ICU care for all admitted patients taking medical and non-medical issues into consideration and then the outcome will be comparable, be it weekend, be it after-hours. For patients who got transferred to ICU later on, the reason for triaging to non-ICU areas on admission, ways of early risk assessment, and management of clinical deterioration should be the area of further research to reduce mortality and achieve a better outcome in these groups of patients.

Orcid

Mahuya Bhattacharyya https://orcid.org/0000-0002-4178-6068

Subhash K Todi https://orcid.org/0000-0003-2306-6080

References

1. Galloway M, Hegarty A, McGill S, Arulkumaran N, Brett SJ, Harrison D. The effect of ICU out-of-hours admission on mortality: A systematic review and meta-analysis. Crit Care Med 2018;46(2):290–299. DOI: 10.1097/CCM.0000000000002837.
2. Rivers E, Nguyen B, Havstad S, Ressler J, Muzzin A, Knoblich B, et al. Early goal-directed therapy in the treatment of severe sepsis and septic shock. N Engl J Med 2001;345(19):1368–1377. DOI: 10.1056/NEJMoa010307.
3. Meynaar IA, van der Spoel JI, Rommes JH, van Spreuwel-Verheijen M, Bosman RJ, Spronk PE. Off hour admission to an intensivist-led ICU is not associated with increased mortality. Crit Care 2009;13(3):R84. DOI: 10.1186/cc7904.
4. Cavallazzi R, Marik PE, Hirani A, Pachinburavan M, Vasu TS, Leiby BE. Association between time of admission to the ICU and mortality: A systematic review and metaanalysis. Chest 2010;138(1):68–75. DOI: 10.1378/chest.09-3018.
5. Vest-Hansen B, Riis AH, Sørensen HT, Christiansen CF. Out-of-hours and weekend admissions to Danish medical departments: Admission rates and 30-day mortality for 20 common medical conditions. BMJ Open 2015;5(3):e006731. DOI: 10.1136/bmjopen-2014-006731.
6. Bhonagiri D, Pilcher DV, Bailey MJ. Increased mortality associated with after-hours and weekend admission to the intensive care unit: A retrospective analysis. Med J Aust 2011;194(6):287–292. DOI: 10.5694/j.1326-5377.2011.tb02976.x.
7. Zampieri FG, Lisboa TC, Correa TD, Bozza FA, Ferez M, Fernandes HS, et al. Role of organisational factors on the "weekend effect" in critically ill patients in Brazil: A retrospective cohort analysis. BMJ Open 2018;8(1):e018541. DOI: 10.1136/bmjopen-2017-018541.
8. Arulkumaran N, Harrison DA, Brett SJ. Association between day and time of admission to critical care and acute hospital outcome for unplanned admissions to adult general critical care units: Cohort study exploring the "weekend effect". Br J Anaesth 2017;118(1):112–122. DOI: 10.1093/bja/aew398.
9. Brunot V, Landreau L, Corne P, Platon L, Besnard N, Buzançais A, et al. Mortality associated with night and weekend admissions to ICU with onsite intensivist coverage: Results of a nine-year Cohort Study (2006–2014). PLoS ONE 2016;11(12):e0168548. DOI: 10.1371/journal.pone.0168548.
10. Orsini J, Rajayer S, Ahmad N, Din N, Morante J, Malik R, et al. Effects of time and day of admission on the outcome of critically ill patients admitted to ICU. J Community Hosp Intern Med Perspect 2016;6(6):33478. DOI: 10.3402/jchimp.v6.33478.
11. Namikata Y, Matsuoka Y, Ito J, Seo R, Hijikata Y, Itaya T, et al. Association between ICU admission during off-hours and in-hospital mortality: A multicenter registry in Japan. J Intensive Care 2022;10(1):41. DOI: 10.1186/s40560-022-00634-3.
12. Escobar GJ, Greene JD, Gardner MN, Marelich GP, Quick B, Kipnis P. Intra-hospital transfers to a higher level of care: Contribution to total hospital and intensive care unit (ICU) mortality and length of stay (LOS). J Hosp Med 2011;6(2):74–80. DOI: 10.1002/jhm.817.
13. Luyt CE, Combes A, Aegerter P, Guidet B, Trouillet JL, Gibert C, et al. Mortality among patients admitted to intensive care units during weekday day shifts compared with off hours. Crit Care Med 2007;35(1):3–11. DOI: 10.1097/01.CCM.0000249832.36518.11.

14. Arabi Y, Alshimemeri A, Taher S. Weekend and weeknight admissions have the same outcome of weekday admissions to an intensive care unit with onsite intensivist coverage. Crit Care Med 2006;34(3): 605–611. DOI: 10.1097/01.ccm.0000203947.60552.dd.
15. Wunsch H, Mapstone J, Brady T, Hanks R, Rowan K. Hospital mortality associated with day and time of admission to intensive care units. Intensive Care Med 2004;30(5):895–901. DOI: 10.1007/s00134-004-2170-3.
16. Barnett MJ, Kaboli PJ, Sirio CA, Rosenthal GE. Day of the week of intensive care admission and patient outcomes: A multisite regional evaluation. Med Care 2002;40(6):530–539. DOI: 10.1097/00005650-200206000-00010.
17. Kuijsten HAJM, Brinkman S, Meynaar IA, Spronk PE, van der Spoel JI, Bosman RJ, et al. Hospital mortality is associated with ICU admission time. Intensive Care Med 2010;36(10):1765–1771. DOI: 10.1007/s00134-010-1918-1.
18. Kevat DA, Davies AR, Cameron PA, Rajaratnam SM. Increased mortality associated with after-hours and weekend admission to the intensivecare unit: A retrospective analysis. Med J Aust 2011;194(11):616. DOI: 10.5694/j.1326-5377.2011.tb03126.x.
19. Zhou X, Weng J, Xu Z, Yang J, Lin J, Hou R, et al. Effect of admission and discharge times on hospital mortality in patients with sepsis. Crit Care Med 2023;51(3):e81–e89. DOI: 10.1097/CCM.0000000000005767.
20. Needleman J, Buerhaus P, Pankratz VS, Leibson CL, Stevens SR, Harris M. Nurse staffing and inpatient hospital mortality. N Engl J Med 2011;364(11):1037–1045. DOI: 10.1056/NEJMsa1001025.
21. Laupland KB, Shahpori R, Kirkpatrick AW, Stelfox HT. Hospital mortality among adults admitted to and discharged from intensive care on weekends and evenings. J Crit Care 2008;23(3):317–324. DOI: 10.1016/j.jcrc.2007.09.001.
22. Ozdemir BA, Sinha S, Karthikesalingam A, Poloniecki JD, PearseRM, Grocott MPW, et al. Mortality of emergency general surgical patients and associations with hospital structures and processes. Br J Anaesth 2016;116(1):54–62. DOI: 10.1093/bja/aev372.
23. Carr BG, Reilly PM, Schwab CW, Branas CC, Geiger J, Wiebe DJ. Weekend and night outcomes in a statewide trauma system. Arch Surg 2011;146(7):810–817. DOI: 10.1001/archsurg.2011.60.
24. Li L, Rothwell P, Oxford Vascular Study. Biases in detection of apparent "weekend effect" on outcome with administrative coding data: Population based study of stroke. Br Med J 2016;353:i2648. DOI: 10.1136/bmj.i2648.