RESEARCH ARTICLES

Outcomes of patients admitted to the Intensive Care Unit after Postanesthesia Care Unit boarding

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ABSTRACT

Objective: This study aimed to investigate the associations of delayed admission to the intensive care unit (ICU), due to the boarding of critically ill patients in the postanesthesia care unit (PACU), with patient outcomes.

Background: Previous literature has provided conflicting findings about whether delayed admission to the ICU is associated with suboptimal patient care and worsened outcomes. In the limited studies on ICU patients boarded in the PACU, their ICU mortality, hospital and ICU length of stay, and duration of mechanical ventilation did not differ significantly when compared with those of patients directly admitted to the ICU.

Study design and methods: This was a single-centre, prospective, observational study. Patients consecutively admitted to the ICU from January 2021 to May 2023 were enrolled. Recorded data included patient demographics, clinical severity, multi-organ dysfunction and comorbidities, and the duration of PACU boarding. Adverse patient outcomes included prolonged duration of mechanical ventilation, prolonged ICU length of stay, incidence of infections and mortality during ICU stay. The associations between PACU boarding and its duration and adverse patient outcomes were evaluated with univariate comparisons and multivariate analyses.

Results: Two hundred thirty ICU patients were enrolled, with 83 (36.1%) of them being boarded in the PACU. Median duration of PACU boarding was 72.0 (48.0-144.0) hours, with 51 (61.4%) patients staying for > 48 hours. Patients with delayed admission to the ICU were more likely to be diagnosed with surgical wound infection ($p = .023$), but less likely to be diagnosed with pneumonia ($p = .008$) compared with those with direct ICU admission. However, in the multivariate level, no significant associations were detected between PACU boarding and its duration and adverse patient outcomes.

Conclusion: Delayed admission to the ICU after PACU boarding was not associated with worsened patient outcomes, which supports the competence of PACU nurses in caring for the critically ill.

Implications for practice: These findings add to the existing evidence that the PACU can be used safely in case of ICU bed shortages.

What is already known about the topic?

- The majority of the existing studies have indicated that delayed admission to the ICU of adult patients is associated with higher mortality, while prolonged ICU and hospital length of stay have also been reported.

- Delayed admission to the ICU may not be translated into suboptimal patient care in case critical care monitoring and treatments are provided outside the ICU.
- Boarding of critically ill patients in the PACU has not been associated with adverse outcomes, except for higher ICU mortality in case boarding duration was long.

What this paper adds

- PACU boarding was not associated with prolonged duration of mechanical ventilation, prolonged ICU LOS, infections and ICU mortality of patients.
- Even long duration (> 48 hours) of PACU boarding was not associated with worsened patient outcomes compared with direct admission to the ICU.
- The PACU can be used safely as a temporary admission location for ICU overflow patients.

Keywords: Delayed admission; infection; intensive care unit; mortality; postanesthesia care unit

BACKGROUND

Delayed admission to the ICU refers to the boarding of patients designated to need critical care in non-ICU settings until an ICU bed becomes available.[1,2] ICU bed shortages have been attributed to the imbalance between increasing demand and limited provision of critical care resources.[3,4] Although its incidence and duration vary considerably among hospitals, delayed admission to the ICU has been identified as a worldwide healthcare issue.[4-6]

The stay of critically ill patients outside the ICU can be followed by less intensive monitoring and delays in the initiation of time-sensitive care, such as antibiotic and vasoactive drug administration or haemodialysis, which could contribute to increased complication rates and adverse outcomes.[7-9] However, critical care treatments, such as non-invasive ventilation, are increasingly applied in non-ICU settings due to staff training and available specialised equipment.[10-12] Thus, delayed admission to the ICU may not be necessarily translated into suboptimal patient care. In a recent meta-analysis of 34 observational studies, delayed admission to the ICU of adult patients was associated with higher mortality [mainly during hospital or ICU stay, pooled odds ratio (OR) 1.61, 95% confidence interval (CI) 1.44-1.81].[13] Yet, in more than one-third of the included studies, mortality did not differ significantly according to delayed admission to the ICU. Besides mortality, some studies have reported that ICU or hospital length of stay (LOS) of critically ill patients boarded in the Emergency Department (ED) was significantly longer,[14-16] while in others prolonged hospital LOS was not associated with delayed admission to the ICU.[12,17]

The PACU has been traditionally used as a temporary admission location for ICU overflow patients for many reasons.[18,19] First, PACU nurses have the expertise to manage patients with hemodynamic instability and artificial airways. Second, the open-floor PACU design allows simultaneous observation of many patients. Third, there is available equipment necessary for critical care provision, such as monitors, ventilators and infusion pumps. However, since PACU care aims at the prevention of complications occurring after anaesthesia and surgery, previous reports have challenged the appropriateness of boarding critically ill patients in the PACU.[20-22] Caring for ICU overflow patients has been associated with increased workload and confusion about the treatment prioritisation by PACU nurses.[20,23] At the same time, the prevalence and volume of missed nursing care for postoperative patients have been significantly higher in the presence of even one ICU overflow patient.[24]

Existing evidence on the associations between boarding critically ill patients in the PACU and their outcomes is surprisingly limited compared with numerous respective studies conducted on patients boarded in the ED. In a retrospective study that employed 989 neurosurgical patients, outcomes did not differ significantly between those boarded in the PACU and those directly admitted to the ICU, including ICU mortality (5.2% vs. 3.8%, $p = .681$), ICU LOS (1.9 vs. 1.2 days, $p = .396$), hospital LOS (7.9 vs. 7.2 days, $p = .545$), duration of mechanical ventilation (20.5 vs. 15.0 hours, $p = .345$) and ICU readmission rate (1.9% vs. 2.7%, $p = .744$).[25] Likewise, in another retrospective study that included 2,279 postoperative patients, no significant differences were reported between those waiting in the PACU and those immediately admitted to the ICU, in terms of ICU mortality (8.6% vs. 6.7%, $p = .311$) ICU LOS (1.9 vs. 1.8 days, $p = .996$) and duration of mechanical ventilation (13.0 vs. 18.0 hours, $p = .751$).[26] However, delayed admission to the ICU for > 6 hours was associated with higher ICU mortality (OR 5.32, 95% CI 1.25-22.60, $p = .024$).

OBJECTIVE

The aims of the present study were to: (a) compare the outcomes between critically ill patients directly admitted to the ICU and those with delayed admission to the ICU after boarding in the PACU and (b) investigate the association between the duration of PACU boarding and patient outcomes. Our hypothesis was that adverse patient outcomes

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would be significantly more common in case of both PACU boarding and longer duration of delayed admission to the ICU.

STUDY DESIGN AND METHODS

DESIGN AND SETTINGS

This was a single-centre, prospective, observational study, which adhered to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) checklist for observational research. The study was conducted in the Phase I PACU and the ICU of Patras University Hospital, Patras, Greece, from January 2021 to May 2023. The PACU was staffed by registered nurses whose clinical experience ranged between 5-30 years, working on three 8-hour shifts. The ICU was a closed 13-bed unit, in which adult medical, surgical and trauma patients were admitted, and was staffed by registered and licensed practical nurses. Decisions about patient care management, including diagnostic testing, drug administration, ventilatory support and discharge from the ICU, were at the discretion of the attending intensivist.

PARTICIPANTS

Intensivists decided whether a patient was designated to need critical care and were responsible for the attendance of and consultation about critically ill patients boarded in non-ICU settings. Patients were directly admitted to the ICU in case of available ICU beds. In case no ICU bed was available, patient admission to the ICU was determined in general by the "first come, first served" sequence, which means that the priority for patient admission to the ICU was based on the time sequence that patients were designated to need critical care. In rare cases, priority could be overridden for patients considered to benefit significantly by their soonest possible admission to the ICU (e.g. need for specific treatments).

All patients consecutively admitted to the ICU during the study period were screened for eligibility. The exclusion criteria were:

(a) readmission to the ICU during the same hospitalisation,
(b) delayed admission to the ICU after boarding in non-ICU settings besides the PACU (ED or medical/surgical wards),
(c) death during PACU boarding,
(d) lost follow-up due to patient transfer to the ICU of another hospital,
(e) SARS-CoV-2 infection as ICU admission diagnosis (since all these patients were directly admitted to the ICU and were not boarded in the PACU).

Eligible patients were divided into two groups: (a) those directly admitted to the ICU (direct admission to the ICU group) and (b) those with delayed admission to the ICU after PACU boarding (delayed admission to the ICU group). The duration of PACU boarding was measured from the time the patient was designated to require critical care until his/her admission to the ICU. According to the duration of PACU boarding, patients were further divided into two groups, < 48 and > 48 hours.

DATA COLLECTION

The ICU information system and patient medical records were used for retrieving and recording patient data. Collected data included:

(a) Patient demographics and clinical characteristics: age, gender, admission type (surgical/trauma or medical) and diagnosis, clinical severity, multi-organ dysfunction, and comorbidities including diabetes mellitus, traumatic brain injury, ischemic heart disease, chronic respiratory disease and malignancy.
(b) Duration of PACU boarding (measured in hours).
(c) Patient outcomes: prolonged duration of mechanical ventilation, prolonged ICU LOS (both measured in days), incidence of infections and mortality during ICU stay. ICU LOS was measured from patient admission to the ICU until death or discharge from the ICU. Duration of mechanical ventilation was measured from patient admission to the ICU until death or complete restoration of spontaneous breathing. Prolonged duration of mechanical ventilation and prolonged ICU LOS were determined for values above the median. Infections included pneumonia, bacteraemia, urinary tract and surgical wound infection.

Clinical severity and multi-organ dysfunction of patients were assessed with the Acute Physiology and Chronic Health Evaluation (APACHE) II score and the Sequential Organ Failure Assessment (SOFA) score respectively on admission to the ICU, or on PACU admission for those boarded in the PACU.[27,28] Criteria for infection diagnosis were based on the definitions proposed by the Centers for Disease Control and Prevention.[29]

ETHICAL CONSIDERATIONS

Permission to conduct this study, which involved human research, was obtained by the Hospital Ethics Committee and the Hospital Science Council (approval number 9026/2-4-2021). Before enrolment in the study, each patient's designated healthcare surrogate provided written informed consent. To assure confidentiality of patient information, collected data was not discussed with other medical or nursing staff.

DATA ANALYSIS

Statistical analysis of collected data was conducted with the Statistical Package for Social Sciences v. 28.0 (SPSS Inc., Chicago, IL), and statistical significance was set at $p < .05$. Since all continuous variables were not normally distributed according to D'Agostino-Pearson omnibus test,

nonparametric tests (two-tailed) were used, and data was presented as median (interquartile range). Categorical variables were compared with chi-square or Fisher's exact test as appropriate, and data was presented as frequencies (%). Patient demographics, clinical characteristics and adverse outcomes (as binary variables) were compared between patients with direct and delayed admission to the ICU, as well as between groups according to the duration of PACU boarding.

To evaluate whether PACU boarding, and its duration were independently associated with adverse patient outcomes, multivariate logistic regression analyses were conducted (with backward Wald elimination), and ORs with 95% CIs were calculated. Adjustments included patient age, admission type, APACHE II and SOFA score, and the presence of comorbidities. Multicollinearity was identified by values of variance inflation factors > 5. Discrimination and calibration of the multivariate models were assessed by the area under the receiver operator curve and Hosmer-Lemeshow chi-square (goodness of fit) test respectively. A Kaplan-Meier survival curve was further constructed to analyse the time-to-event association between delayed admission to the ICU and death in the ICU. Patients with direct and delayed admission to the ICU were compared with the use of a log-rank test.

RESULTS

Two hundred thirty patients were enrolled in the study. Of them, 161 (70.0%) were male and 124 (53.9%) were surgical/trauma. Median age was 61.0 (46.8-72.0) years, median APACHE II score was 20.0 (15.0-24.0) and median SOFA score was 8.0 (5.0-10.3). Among surgical/trauma patients, 40 (32.3%) had neurosurgery, 35 (28.2%) had abdominal surgery, and 25 (20.2%) had traumatic brain injury. Chronic respiratory disease ($n = 54$, 50.9%) and haemorrhagic stroke ($n = 19$, 17.9%) were the most common admission diagnoses in medical patients. The median duration of mechanical ventilation was 17.5 (6.0-41.0) days, with 115 (50.0%) patients having prolonged duration of mechanical ventilation. Median ICU LOS was 21.0 (8.8-48.3) days, with 110 (47.8%) patients having prolonged ICU LOS. Pneumonia, bacteraemia, urinary tract and surgical wound infection were diagnosed in 110 (47.8%), 216 (93.9%), 11 (4.8) and 13 (5.7%) patients respectively during ICU stay. Eighty-four (36.5%) patients died during ICU stay. Eighty-three (36.1%) patients were boarded in the PACU during the study period; of them, 32 (38.6%) were boarded for < 48 hours and 51 (61.4%) for > 48 hours. Median duration of PACU boarding was 72.0 (48.0-144.0) hours.

Demographics, clinical characteristics and outcomes of patients with direct and delayed admission to the ICU are compared in Table 1. With regard to patient outcomes, those

TABLE 1: DIFFERENCES AMONG PATIENT DEMOGRAPHICS, CLINICAL CHARACTERISTICS AND ADVERSE OUTCOMES ACCORDING TO DELAYED ICU ADMISSION AFTER PACU BOARDING AND ITS DURATION

Patient characteristics/outcomes	Direct admission to the ICU ($n = 147$)	Delayed admission to the ICU		
		All patients ($n = 83$)	< 48 hours ($n = 32$)	> 48 hours ($n = 51$)
Age [median (IQR), years]	61.0 (48.0-73.0)	60.0 (41.0-70.0)	50.5 (34.3-68.0)****	63.0 (47.0-73.0)
Gender [male, (%)]	104 (70.7%)	57 (68.7%)	21 (65.6%)	36 (70.6%)
Admission type† [surgical/trauma (%)]	52 (35.4%)	72 (86.7%)****	27 (84.4%)****	45 (88.2%)****
APACHE II score [median (IQR)]	20.0 (14.0-24.0)	20.0 (16.0-24.0)	21.0 (15.3-23.8)	20.0 (16.0-25.0)
SOFA score [median (IQR)]	8.0 (5.0-10.0)	8.0 (7.0-11.0)	8.5 (7.0-11.0)	8.0 (7.0-11.0)
Diabetes mellitus (%)	46 (31.3%)	17 (20.5%)	8 (25.0%)	9 (17.6%)
Traumatic brain injury (%)	44 (29.9%)	42 (50.6%)****	16 (50.0%)****	26 (51.0%)****
Ischemic heart disease (%)	7 (4.8%)	4 (4.8%)	1 (3.1%)	3 (5.9%)
Chronic respiratory disease (%)	88 (59.9%)	28 (33.7%)****	9 (28.1%)****	19 (37.3%)****
Malignancy (%)	17 (11.6%)	8 (9.6%)	2 (6.3%)	6 (11.8%)
Prolonged duration of mechanical ventilation* (%)	68 (46.3%)	47 (56.6%)	19 (59.4%)	28 (54.9%)
Prolonged ICU LOS** (%)	65 (44.2%)	45 (54.2%)	20 (62.5%)	25 (49.0)
Pneumonia*** (%)	80 (54.4%)	30 (36.1%)****	11 (34.4%)****	19 (37.3%)****
Bacteraemia*** (%)	139 (94.6%)	77 (92.8%)	29 (90.1%)	48 (94.1%)
Urinary tract infection*** (%)	7 (4.8%)	4 (4.8%)	1 (3.1%)	3 (5.9%)
Surgical wound infection*** (%)	5 (3.4%)	9 (10.8%)****	5 (15.6%)****	4 (7.8%)****
Mortality*** (%)	52 (35.4%)	32 (38.6%)	10 (31.3%)	22 (43.1%)

Note. ICU, Intensive Care Unit; IQR, interquartile range; APACHE, Acute Physiology and Chronic Health Evaluation; SOFA, Sequential Organ Failure Assessment; LOS, length of stay.

Note. † surgical/trauma or medical, * > 17.5 days, ** > 21.0 days, *** during ICU stay, **** $p < .05$; for all comparisons, direct admission to the ICU was used as the reference group.

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TABLE 2: ADJUSTED RISK FOR ADVERSE PATIENT OUTCOMES ACCORDING TO DELAYED ADMISSION TO THE ICU AFTER PACU BOARDING AND ITS DURATION

Adverse patient outcomes	Adjusted ORs (95% CIs) for delayed admission to the ICU		
	All patients (*n* = 83)	< 48 hours (*n* = 32)	> 48 hours (*n* = 51)
Prolonged duration of mechanical ventilation†	1.04 (0.54-2.01)	1.31 (0.51-3.34)	1.16 (0.55-2.45)
Prolonged ICU LOS*	1.21 (0.63-2.32)	1.72 (0.72-4.13)	0.97 (0.46-2.05)
Pneumonia**	0.76 (0.39-1.47)	0.72 (0.29-1.74)	0.79 (0.37-1.69)
Bacteraemia**	0.68 (0.18-2.48)	0.51 (0.11-2.44)	0.84 (0.18-3.92)
Urinary tract infection**	1.02 (0.24-4.38)	0.93 (0.74-1.17)	1.24 (0.26-5.85)
Surgical wound infection**	1.75 (0.50-6.08)	2.97 (0.69-10.78)	1.17 (0.27-5.06)
Mortality**	1.39 (0.62-3.11)	0.99 (0.35-2.86)	1.73 (0.70-4.29)

Note. ICU, Intensive Care Unit; LOS, length of stay; OR, odds ratio; CI, confidence interval.

Note. For all comparisons, direct admission to the ICU was used as the reference group. For all analyses: (a) adjustment included patient age, admission type, APACHE II and SOFA score, and the presence of diabetes mellitus, traumatic brain injury, ischemic heart disease, chronic respiratory disease and malignancy; (b) area under receiver operator curve was > 0.612 with p < .001; (c) p > .705 for Hosmer-Lemeshow chi-square test, with correct classification > 62.3%.

Note. † > 17.5 days, * > 21.0 days, ** during ICU stay.

with delayed admission to the ICU were significantly more likely to be diagnosed with surgical wound infection, but less likely to be diagnosed with pneumonia. Likewise, patients of both groups with duration of PACU boarding of < 48 hours and of > 48 hours were significantly more likely to be diagnosed with surgical wound infection, but less likely to be diagnosed with pneumonia.

The findings of multivariate logistic regression analyses are presented in Table 2. After adjustment for patient demographics and clinical characteristics (which could act as confounding factors), neither delayed admission to the ICU nor the duration of PACU boarding were independently associated with adverse patient outcomes. Multicollinearity was not identified. All multivariate models demonstrated satisfactory calibration and discrimination (footnote of Table 2).

According to the Kaplan-Meier survival curve, ICU survival did not differ significantly between patients with direct and delayed admission to the ICU after PACU boarding (log rank $p = .525$, Figure 1).

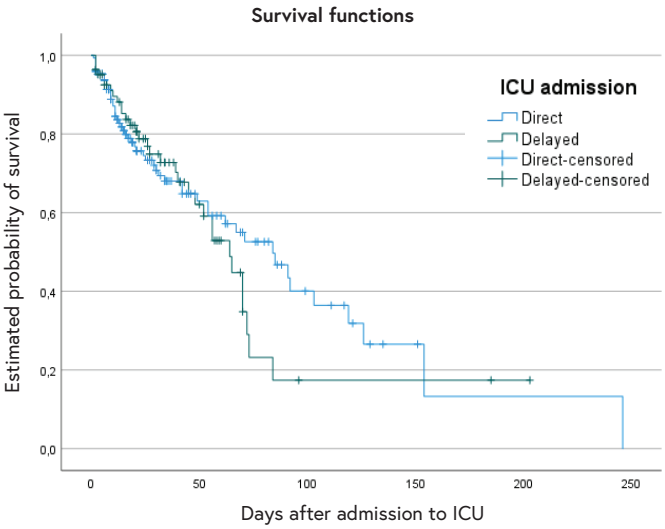

FIGURE 1: KAPLAN-MEIER SURVIVAL CURVES FOR PATIENTS WITH DIRECT AND DELAYED ADMISSION TO THE ICU AFTER PACU BOARDING

DISCUSSION

The findings of our study are in agreement with those of previous studies and add to the existing evidence that delayed admission to the ICU after PACU boarding is not followed by worsened patient outcomes compared with direct admission to the ICU.[25,26] Excluding random variation, patient outcomes depend generally on patient characteristics and the quality of care provided. To control for possible effects of selection bias and differences in patient characteristics, studied outcomes were adjusted for patient age, admission type, APACHE II and SOFA score, and the presence of comorbidities. Therefore, our findings seem to support that PACU personnel can provide safe care for ICU overflow patients until an ICU bed becomes available.

The outcomes of critically ill patients boarded in the PACU can be affected negatively by the provision of suboptimal nursing care and insufficient medical coverage by intensivists.[22] PACU nurses have reported the sense of giving less than the best care to the critically ill, while care omissions are possible due to the priority given to postoperative patients.[23] It seems therefore plausible that the longer the duration of suboptimal or missed nursing care and insufficient medical coverage for critically ill patients due to delayed admission to the ICU the higher the risk for worsened outcomes. This hypothesis seems to be supported

by the previous finding that although PACU boarding in total was not associated with higher ICU mortality, this association became significant when patients who waited for ≥ 6 hours were separately studied.[26] Likewise, studies that compared the outcomes between patients directly admitted to the ICU and those boarded in the ED, have reported that ICU or hospital mortality were significantly higher for longer delays in the admission to the ICU.[6,15]

Our study was the first that enrolled patients who were boarded in the PACU for a median duration of 72 hours. In contrast, the duration of PACU boarding was particularly short in previous studies, as indicated by its median of 4.3 hours and being < 6 hours for the majority of patients.[25,26] It could therefore be speculated that the short duration of PACU boarding precluded the detection of negative effects of suboptimal or missed nursing care and insufficient medical coverage on patient outcomes, while its much longer duration in our study would allow the detection of such effects. Yet, such associations were detected neither for the entirety of patients boarded in the PACU nor for those who stayed for > 48 hours. These findings imply that both nursing care and medical coverage, even if they were suboptimal compared with the ICU, were not compromised below a critical safety level, e.g. there were no delays in the initiation of time-sensitive drug treatment or omissions that could lead to serious cardiorespiratory complications.

The fact that surgical/trauma patients were the majority among those boarded in the PACU (86.7%) but the minority among those directly admitted to the ICU (35.4%) raises concerns about the heterogeneity and comparability of these two groups. In a previous study, medical patients had significantly higher clinical severity, higher ICU mortality, and longer ICU LOS than surgical ones.[30] However, in this study, significant differences in the outcomes between surgical/trauma and medical patients were detected only for the incidence of pneumonia (35.5% vs. 62.3% respectively, $p < .001$) and surgical wound infection (11.5% vs. 0.9% respectively, $p < .001$). These differences possibly accounted for the fact that the incidence of pneumonia and surgical wound infection were significantly higher in patients directly admitted to the ICU and those boarded in the PACU respectively. In the multivariate level, both differences became non-significant after adjustment for admission type. Furthermore, studied outcomes were compared between surgical/trauma patients boarded in the PACU ($n = 72$) and those directly admitted to the ICU ($n = 52$). No significant differences were detected for any outcome, both for all patients and for subgroups according to the duration of PACU boarding.

It cannot be excluded that the definitions and characteristics of patient outcomes accounted for the lack of detecting significant associations between them and PACU boarding. Infection risk tends to increase shortly after exposure to suboptimal care (e.g. lack of compliance with infection control measures),[31] which means that the incidence of infections would be more likely to increase during the first days after admission to the ICU in case of suboptimal care during PACU boarding. Since infections were studied for the whole ICU stay, this temporal association could have been difficult to detect, while long ICU stay could have increased the incidence of infections irrespective of the care provided during PACU boarding. In addition, the duration of mechanical ventilation and ICU LOS were very long for most patients in our study compared with those in previous ones,[25,26] which could have masked possible effects of suboptimal care during PACU boarding (e.g. delayed weaning from mechanical ventilation in patients boarded in the PACU could have led to significantly longer duration of mechanical ventilation in them in case this duration was shorter in total).

LIMITATIONS AND STRENGTHS

The small sample size was the most serious limitation of our study; it cannot be excluded that significant associations would have been detected in case more patients were enrolled. It should be noted that no power analysis was conducted prior to study conduction, since it was considered impossible to enrol more patients than the existing studies due to the exclusion of those with COVID-19 and long ICU LOS.25,26 Second, the single-centre study design limited the generalisability of our findings. Third, different proportions of surgical/trauma patients among those boarded in the PACU and those directly admitted to the ICU might have favoured selection bias; it is, however, worth noticing that surgical/trauma and medical ICU patients did not differ significantly in terms of their studied outcomes. Fourth, the decisions of the attending intensivists on discontinuing mechanical ventilation and patient discharge from the ICU were not protocolised. Fifth, no adjustment was conducted for other possible confounding factors that might have affected patient outcomes, such as the variation of PACU nurse staffing levels and ICU occupancy rates.

Our study had a significant strength as well. ICU patients were boarded in the PACU for a remarkably longer time compared with previous studies, thus the detection of negative effects of suboptimal care on their outcomes would have been much more possible.

CONCLUSION

Delayed admission to the ICU after PACU boarding, regardless of duration, was not associated with worsened patient outcomes, including prolonged mechanical ventilation, prolonged ICU LOS, increased incidence of infections and mortality during ICU stay. These findings confirm that PACU nurses have adequate competence in caring for the critically ill and support that, in case of unavailability of ICU beds, the PACU constitutes a safe admission location for patients who need critical care.

IMPLICATIONS FOR PRACTICE AND RESEARCH

According to the "ICU without walls", geographically isolated ICUs should be replaced by the provision of critical care wherever critical illness occurs, and nursing personnel employed outside the ICU should be competent and skilled in caring for the critically ill.[32] In this context, the absence of worsened outcomes of patients with delayed admission to the ICU indicates that PACU boarding is a safe solution and a primary alternative in cases of ICU bed shortages. However, ICU overflow patients can slow surgical schedules, increase missed care of postoperative patients and favour feelings of anxiety, confusion and incompetence of PACU nurses;[23,24] these negative effects should not be overlooked. Moreover, continuous admission of a large number of critically ill patients in the PACU confirms the lack of a sufficient number of ICU beds for appropriately covering population demands. Thus, PACU nurses need to improve their competence and maintain safe practice for ICU overflow patients through critical care education and training. At the same time, the availability of ICU beds is strongly recommended to increase, so that critically ill patients receive the best possible care and PACU nurses focus on their primary duty of caring for postoperative ones.[33]

The associations between the duration of PACU boarding and adverse patient outcomes are recommended to be further investigated by the use of multi-centre design and the enrolment of large patient samples, in order to detect small effect sizes and increase the generalisability of findings. Future studies should also focus on temporal associations between PACU boarding and infections, possibly by exploring their incidence during PACU boarding or the first few days after patient transfer to the ICU.

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