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Postoperative Delirium in Intensive Care Patients: Risk Factors and Outcome

Dalila Veiga [1], Clara Luis [1], Daniela Parente [1], Vera Fernandes [1], Miguela Botelho [1], Patricia Santos [1], Fernando Abelha [1,2]

Summary: Veiga D, Luis C, Parente D, Fernandes V, Botelho M, Santos P, Abelha F – Postoperative Delirium in Intensive Care Patients: Risk Factors and Outcome.

Background and objectives: Postoperative delirium (POD) in Surgical Intensive Care patients is an important independent outcome determinant. The purpose of our study was to evaluate the incidence and determinants of POD.

Methods: Prospective cohort study conducted during a period of 10 months in a Post-Anesthesia Care Unit (PACU) with five intensive care beds. All consecutive adult patients submitted to major surgery were enrolled. Demographic data, perioperative variables, length of stay (LOS) and the mortality at PACU, hospital and at 6-months follow-up were recorded. Postoperative delirium was evaluated using the Intensive Care Delirium Screening Checklist (ICDSC). Descriptive analyses were conducted and the Mann-Whitney test, Chi-square test or Fisher's exact test were used for comparisons. Logistic regression analysis evaluated the determinants of POD with calculation of odds ratio (OR) and its confidence interval 95% (95% CI).

Results: There were 775 adult PACU admissions and 95 patients had exclusion criteria. Of the remaining 680 patients, 128 (18.8%) developed POD. Independent determinants of POD identified were age, ASA-PS, emergency surgery and total amount of fresh frozen plasma administered during surgery. Patients with delirium had higher mortality rates, were more severely ill and stayed longer at the PACU and in the hospital. POD was an independent risk factor for hospital mortality

Discussion: There was a high incidence of delirium had a high incidence in intensive care surgical patients. POD was associated with worse severity of disease scores, longer LOS in hospital, and in PACU and higher mortality rates. The independent risk factors for POD were age, ASA-PS, emergency surgery and the amount of plasma administered during surgery.

Keywords: Anesthesia Recovery Period; Delirium; Postoperative Complications; Risk factors.

INTRODUCTION

Postoperative delirium is associated with a poor outcome, including increased length of stay (LOS) in hospital and in the intensive care unit (ICU) or Post Anesthesia Care Unit (PACU), frequent medical complications, increased costs of care, and increased mortality [1-8].

Delirium is often the first presenting feature of physical illness or drug toxicity, and a failure to detect it may lead to a delay in diagnosing and treating the underlying cause [8].

Given the high prevalence of delirium among critically ill patients and the adverse clinical outcomes associated with it, current practice guidelines recommend that ICU patients should be routinely screened for delirium using a validated screening tool [9]. Early recognition and treatment of delirium may be the key to reduce the duration and severity of delirium and negative outcomes [10-12].

In 2001, Bergeron et al. [13] created the Intensive Care Delirium Screening Checklist (ICDSC). The ICDSC includes eight items based on the Diagnostic and Statistical Manual of Mental Disorders (DSM) criteria and features of delirium including: inattention, disorientation, hallucination-delusion psychosis, psychomotor agitation or retardation, inappropriate speech or mood, sleep/wake cycle disturbances and symptom fluctuation according to a total score system from 0 to 8 points. In the same study, the ICDSC score of 4 or more correlateed well with a psychiatrist's clinical diagnosis of delirium and has a sensitivity of 99% and a specificity of 64% with an excellent interobserver reliability among nurses and between nurses and critical care physicians.

The purpose of this study was to evaluate the incidence and determinants of the development of delirium in the immediate postoperative period.

Received from the Department of Anesthesiology, Post-anesthesia Care Unit – Centro Hospitalar de São João, Portugal.

1. MD; Department of Anesthesiology, Centro Hospitalar de São João, Porto, Portugal
2. MD; PhD; Anesthesiology and Perioperative Care Unit, Surgical Department of the Faculdade de Medicina do Porto, Portugal

Correspondence to:
Fernando Abelha, MD, PhD
Anesthesiology Service - Post-anesthetic Unit
Cenrto Hospitalar São João
Alamenda Professor Hernani Monteiro
Porto, Portugal
E-mail: fernando.abelha@gmail.com

MATERIAL AND METHODS

The Institutional Review Board and the Ethic Committee of Hospital de São João approved the study and informed consent was obtained preoperatively from each studied patient. This prospective study was carried out in the multidisciplinary Post-Anesthesia Care Unit with five intensive care beds, at the Hospital São João, a community teaching hospital of 1,100 beds in Porto, Portugal.

All consecutive adult Portuguese-speaking patients submitted to major non-cardiac and non-neurological surgery requiring anesthesia and who were expected to remain in the hospital postoperatively for more than 48 hours were eligible to the study. We have included all patients admitted to the 5 ICU beds of the PACU, after major surgery, during a 10-month period between November 2008 and August 2009.

Patients who did not provide or were incapable of providing informed consent, with a history of central nervous system disease, Parkinson's disease, neurological or cardiac surgery, delirium or antipsychotic medication, drug, alcohol or opioid abuse, were excluded.

The following variables were recorded on admission to the PACU: age, gender, body mass index (BMI), preadmission comorbidities (specifically ischemic heart disease, congestive heart failure, cerebrovascular disease, hypertension, renal insufficiency, diabetes, dyslipidemia) American Society of Anesthesiologists Physical status (ASA-PS) and anesthesia data (specifically duration, type of anesthesia, fluids and blood products used). PACU data, hospital length of stay (LOS) and mortality were also recorded for all patients. The Acute Physiology and Chronic Health Evaluation (APACHE) II [14] and the Simplified Acute Physiology Score II (SAPS II) [15] were calculated using standard methods.

Using the classification developed by Lee et al. [16], we calculated the Revised Cardiac Risk Index (RCRI), assigning one point for each of the following risk factors: high-risk surgery, ischemic heart disease, cerebrovascular disease (defined as history of transient ischemic attack or history of cerebrovascular accident), diabetes mellitus requiring insulin therapy and renal failure.

We also recorded PACU and hospital LOS. For mortality, we have registered PACU mortality, hospital mortality and mortality at 6 months after PACU discharge.

Delirium evaluation

Each patient admitted to PACU and included in the study was evaluated for diagnosis of delirium using the Intensive Care Delirium Screening Checklist (ICDSC) [13]; according to ICDSC, a patient was defined as a delirium-positive if their test score was 4 or more points. The checklist was administered within 24h of admission and then every 8h.

Statistical method

Descriptive analyses of variables were used to summarize data and the Mann-Whitney U test was used to compare continuous variables; Chi-square or Fisher's exact test were used to compare proportions between two groups of subjects. To evaluate the determinants of post-operative delirium, multiple logistic regression analyses were used with an entry criterion of $p \leq 0.05$ and independent variables: age, gender, BMI, ASA-PS, type and magnitude of surgery, co-morbidities and RCRI score, type of anesthesia, length of anesthesia, temperature at admission to the PACU, SAPS II, PACU, and hospital mortality and LOS. All variables found to be significant ($p \leq 0.05$) were established as independent predictors.

A multiple regression binary logistic with forward conditional elimination was used to examine covariate effects of each factor on delirium development and to identify independent predictors of mortality. Covariates with a univariate $p \leq 0.05$ in the respective univariate analysis were entered in these models. The odds ratio (OR) and its 95% CI were calculated. Data were analyzed using SPSS for Windows version 19.0 (SPSS, Chicago, IL).

RESULTS

There were 775 adult PACU admissions during the study period. Ninety-five patients were excluded because they have exclusion criteria (some have more than one exclusion criteria). Fifty-four patients had a PACU LOS of less than 12 hours, 14 patients were excluded because they were submitted to neurosurgical surgery, eight were admitted more than once to the PACU, 14 were less than 18 years old, one did not speak Portuguese, one refused to participate, six were incapable of providing informed consent and a Mini Mental State Evaluation (MMSE) < 25, two had incapacitating previous neurological disease, 14 were admitted with a diagnosis of delirium or had antipsychotic medication and three were excluded because of alcohol or drug abuse. In nine patients, it was never possible to evaluate delirium with ICDSC.

The remaining 680 were followed for the development of postoperative delirium. One hundred twenty-eight patients (18.8%) developed delirium. The characteristics of patients with and without delirium are summarized in Table I. Patients with delirium were older (median age 71 versus 64 years, $p < 0.001$), had higher ASA-PS (86% versus 63% were ASA-PS III/IV, $p < 0.001$), were more likely to have been submitted to emergency surgery (31 versus 14%, $p < 0.001$), had more frequently hypertension (72% versus 56%, $p = 0.001$), hyperlipidemia (52% versus 36%, $p = 0.002$) ischemic heart disease (27% versus 16%, $p = 0.004$), congestive heart disease (48% versus 28%, $p < 0.001$), cerebrovascular disease (24% versus 15%, $p = 0.007$), previous renal insufficiency (14% versus 7%, $p = 0.013$), had higher RCRI scores (25% versus 12% had RCRI > 2, $p < 0.001$) and had higher volume of intraoperative fluids administered (1.3 ± 2.6 versus 0.7 ± 1.4, $p = 0.005$ for units of erythrocytes; 0.6 ± 2.3 versus 0.1 ± 0.6, $p < 0.001$ for units of fresh frozen plasma).

Table II shows the severity of disease scores and outcome for patients with and without delirium. Patients with delirium were more severely ill (median SAPS II 27 versus 19,

Table I – Patient Characteristics and Outcome (n = 680)

Variable	No delirium (n = 552) 81.2%	delirium (n = 128) 18.8%	p
Age in years, median (IQR)	64 (51-73)	71 (61-80)	< 0.001[b]
Age group, n (%)			< 0.001[a]
≥ 65 years	252 (46)	84 (66)	
< 65 years	300 (54)	44 (34)	
Gender, n (%)			0.291[a]
Male	330 (60)	83 (65)	
Female	222 (40)	45 (35)	
ASA physical status, n (%)			< 0.001[a]
I/II	204 (37)	18 (14)	
III/IV	348 (63)	110 (86)	
Body Mass Index in kg/m^2, median (IQR)	25 (23-28)	25 (23-28)	0.725[b]
Duration of anesthesia (min.), median (IQR)	240 (170-300)	210 (160-300)	0.343[b]
Type of anesthesia, n (%)			0.838[a]
General / Combined general locorregional	475 (86)	111 (87)	
Locorregional	77 (14)	17 (13)	
Emergency surgery, n (%)	79 (14)	39 (31)	< 0.001[a]
Temperature at PACU admission, median (IQR)	35.0 (34.0-35.9)	35.1 (34.0 - 35.8)	0.846 [b]
Troponin I at PACU admission	0.01(0.01-0.01)	0.01(0.01-0.04)	< 0.001[b]
Hypertension, n (%)	311 (56)	92 (72)	0.001 [a]
Hyperlipidemia, n (%)	201(36)	66(52)	0.002 [a]
COPD, n (%)	121 (22)	35 (27)	0.189 [a]
High-risk surgery, n (%)	280 (51)	71 (56)	0.333 [a]
Ischemic heart disease, n (%)	87 (16)	34 (27)	0.004 [a]
Congestive heart disease, n (%)	157 (28)	61 (48)	< 0.001 [a]
Cerebrovascular disease, n (%)	80 (15)	31 (24)	0.007 [a]
Renal insufficiency, n (%)	40 (7)	18 (14)	0.013 [a]
Insulin therapy for diabetes, n (%)	36 (7)	12 (9)	0.256 [a]
Total RCRI, n (%)			< 0.001[a]
≤ 2	488 (88)	96 (75)	
> 2	64 (12)	32 (25)	
Crystalloids (mL)	2,500 (1,978-4,000)	2,500 (2,000-4,219)	0.324 [b]
Colloids (mL)	0 (0-500)	0 (0-500)	0.062 [b]
Erythrocytes (Units)	0 (0-1)	0 (0-2)	0.005 [b]
Fresh Frozen Plasma (Units)	0 (0-0)	0 (0-0)	< 0.001[b]
Platelets (Units)	0 (0-0)	0 (0-0)	0.130 [b]

[a] Pearson χ^2, [b] Mann-Whitney U test, IQR, interquartile range.
ASA: American Society of Anesthesiologists; COPD: Chronic Obstructive Pulmonary Disease; RCRI: Revised Cardiac Risk Index; PACU: Post Anesthesia Care Unit.

Table II – Severity of Disease Scores, Complications and Outcome (n = 680)

Variable	No delirium (n = 552)	delirium (n = 128)	p
APACHE II	8(5-11)	10(8-13)	< 0.001[c]
SAPS II	19(13-26)	27(18-36)	< 0.001[c]
PACU length of stay (hours), median (IQR)	19 (16-30)	40 (18-87)	< 0.001[c]
Hospital length of stay (days), median (IQR)	11 (5-24)	18 (8-35)	< 0.001[c]
Mortality in PACU, n (%)	4 (1)	4 (3)	0.023[b]
Mortality in hospital, n (%)	20 (4)	29 (23)	< 0.001[a]
Mortality at 6-month follow-up, n (%)	60(11)	48 (38)	< 0.001[a]

[a] Pearson χ^2, [b] Fisher's exact test, [c] Mann-Whitney U test, IQR, interquartile range.
SAPS II, Simplified Acute Physiology Score; APACHE II: Acute Physiology & Chronic Health Evaluation; PACU: Post Anesthesia Care Unit.

p < 0.001 and median APACHE II 10 versus 8, p < 0.001), stayed longer (hours) at the PACU (median LOS 40 versus 19, p < 0.001) and in the hospital (days) (median LOS 18 versus 11, p < 0.001). The unadjusted mortality rate at 6-month follow-up of patients with delirium was 38%, 3.5 times the mortality rate of those without delirium (38% versus 11%, p < 0.001). The increased mortality observed among patients with delirium was even greater for hospital mortality (23%, versus 4%, p < 0.001) and PACU mortality (3% versus 1%, p = 0.023).

Multiple regression logistic analysis was used to examine covariate effects of each factor on delirium development (Table III). In this analysis, the regression model included all variables that showed statistical significance in the univariate analysis made for determinants of delirium development. This analysis showed that significant risk factors for delirium were age (OR 1.05, 95% CI 1.04-1.07, p < 0.001), ASA-PS (OR 2.23, 95% CI 1.25-3.98, p = 0.007), emergency surgery (OR 2.65, 95%CI 1.55-4.53, p < 0.001) and fresh frozen plasma administered during surgery (OR 1.66 95% CI 1.28-2.15, p < 0.001).

Multiple logistic regression analyses was used to examine covariate effects of each factor on hospital mortality and on mortality at 6 month follow-up (Table IV and V). The regression model included all variables with statistical significance in the univariate analysis for determinants of mortality. These analysis showed that delirium was an independent risk factor for hospital mortality (OR 4.00, 95% CI 1.99-8.00, p < 0.001) and for mortality at 6-month follow-up (OR 3.00, 95% CI 1.80-5.00, p < 0.001) after adjustment for age, ASA-PS, high-risk surgery, congestive heart failure, emergency surgery, SAPS II, APACHE II, PACU LOS, RCRI. Other independent predictors of hospital mortality were age (OR 1.04, 95%CI 1.00-1.07, p = 0.014) RCRI (OR 2.61, 95%CI 1.25-5.48, p = 0.011, for RCRI > 2), SAPS II (OR 1.05, 95% CI 1.02-1.08, p < 0.001), PACU LOS (OR 1.01, 95%CI 1.00-1.01, p = 0.012) and hospital LOS (OR 1.01, 95%CI 1.01-1.02, p = 0.001).

Other predictors of mortality at 6-month follow-up were congestive heart disease (OR 2.16, 95%CI 1.33-3.52, p = 0.002), SAPS II (OR 1.05, 95% CI 1.03-1.08, p < 0.001) and hospital LOS (OR 1.01, 95%CI 1.01-1.02, p < 0.001).

DISCUSSION

Postoperative delirium is an important condition with significant associated morbidity and mortality, especially in the intensive care patients [8]. As it has been associated with physical and cognitive morbidity clinicians should be aware of the evidence-based practices relating to its diagnosis, treatment and prevention [7].

The main results of our study were:

i) POD was common, although it had a slightly inferior incidence in our study population compared to the incidence described in the literature by others.

Table III – Multivariate Regression Analysis for Predictors of Delirium

Variable	Simple OR	p	Adjusted* OR (95% CI)	p*
Age	1.04 (1.03-1.06)	< 0.001	1.05 (1.04-1.07)	< 0.001
ASA Physical status		< 0.001	-	0.007
I/II	1		1	
III/IV	3.58 (2.11-6.07)		2.23 (1.25-3.98)	
Total RCRI		< 0.001		
≤ 2	1			
> 2	2.54 (1.58-4.10)			
Emergency surgery	2.62 (1.68-4.10)	< 0.001	2.65 (1.55-4.53)	< 0.001
Hypertension	1.98 (1.30-3.02)	0.001	-	
Hyperlipidemia	1.86 (1.26-2.74)	0.002	-	
Ischemic heart disease	1.93 (1.23-3.05)	0.004	-	
Congestive heart disease	2.29 (1.55-3.39)	< 0.001	-	
Cerebrovascular disease	1.89 (1.18-3.00)	0.008	-	
Renal Insufficiency	2.10 (1.16-3.79)	0.015	-	
Fresh Frozen Plasma	1.42 (1.17-1.72)	< 0.001	1.66 (1.28-2.15)	< 0.001
Erythrocytes	1.18 (1.07-1.31)	0.001	-	
Troponin I at PACU admission	6.36 (0.94-43.1)	0.058	-	

[a] Logistic regression analysis with stepwise forward method was used with an entry criterion of p < 0.05 and a removal criterion of p > 0.1.
ASA: American Society of Anesthesiologists; RCRI: Revised Cardiac Risk Index; PACU: Post-Anesthesia Care Unit.
*Adjusted to age, ASA Physical status, total RCRI, emergency surgery, hypertension, hyperlipidemia, ischemic heart disease, congestive heart disease, cerebrovascular disease, renal insufficiency, fresh frozen plasma, erythrocytes and troponin I.

Table IV – Multivariate Regression Analysis for Predictors of Hospital Mortality

Variable	Simple OR	p	Adjusted* OR (95% CI)	p*
Age	1.06 (1.03-1.09)	< 0.001	1.04 (1.00-1.07	0.014
ASA Physical status		0.007		
I/II	1			
III/IV	3.10 (1.37-7.02)			
Total RCRI		< 0.001		0.011
≤ 2	1		1	
> 2	3.71 (1.97-7.00)		2.61 (1.25-5.48)	
Emergency surgery	3.40 (1.84-6.29)	< 0.001		
Congestive heart disease	3.72 (2.04-6.78)	< 0.001		
Renal Insufficiency	3.14 (1.46-6.62)	0.003		
Platelets	1.27 (1.04-1.54)	0.017		
APACHE II	1.14 (1.08-1.20)	< 0.001		
SAPS II	1.06 (1.04-1.09)	< 0.001	1.05 (1.02-1.08)	< 0.001
PACU length of stay (hours)	1.01 (1.00-1.01)	< 0.001	1.01 (1.00-1.01)	0.012
Hospital length of stay (days)	1.01 (1.01-1.02)	< 0.001	1.01 (1.01-1.02)	0.001
Delirium	7.79 (4.24-14.32)	< 0.001	4.00 (1.99-8.00)	< 0.001

[a] Logistic regression analysis with stepwise forward method was used with an entry criterion of p < 0.05 and a removal criterion of p > 0.1.
ASA: American Society of Anesthesiologists; RCRI: Revised Cardiac Risk Index; SAPS II: Simplified Acute Physiology Score,; APACHE II: Acute Physiology & Chronic Health Evaluation; PACU: Post Anesthesia Care Unit.
*Adjusted to age, ASA physical status , total RCRI, emergency surgery, congestive heart disease, renal insufficiency, platelets, SAPS II , APACHE II, PACU length of stay, hospital length of stay and delirium.

Table V – Multivariate Regression Analysis for Predictors of Mortality at 6-month Follow-up

Variable	Simple OR	p	Adjusted* OR (95% CI)	p*
Age	1.03 (1.02-1.05)	< 0.001		
ASA Physical status		0.009		
I/II	1			
III/IV	1.93 (1.18-3.16)			
Total RCRI		< 0.001		
≤ 2	1			
> 2	2.50 (1.50-4.14)			
Emergency surgery	2.71 (1.69-4.32)	< 0.001		
High-risk surgery	1.63 (1.07-2.49)	0.023		
Congestive heart disease	2.68 (1.76-4.08)	< 0.001	2.16 (1.33-3.52)	0.002
Renal Insufficiency	2.45 (1.33-4.49)	0.004		
Fresh Frozen Plasma	1.15 (0.99-1.32)	0.061		
Erythrocytes	1.14 (1.03-1.26)	0.011		
Platelets	1.26 (1.05-1.50)	0.006		
Troponin I at PACU admission	1.07 (0.88-1.32)	0.488		
APACHE II	1.14 (1.09-1.19)	< 0.001		
SAPS II	1.07 (1.05-1.09)	< 0.001	1.05 (1.03-1.08)	< 0.001
PACU length of stay (hours)	1.01 (1.00-1.01)	< 0.001		
Hospital length of stay (days)	1.01 (1.01-1.02)	< 0.001	1.01 (1.01-1.02)	< 0.001
Delirium	5.00 (3.20-7.83)	< 0.001	3.00 (1.80-5.00)	< 0.001

[a] Logistic regression analysis with stepwise forward method was used with an entry criterion of p < 0.05 and a removal criterion of p > 0.1.
ASA: American Society of Anesthesiologists; RCRI: Revised Cardiac Risk Index; SAPS II: Simplified Acute Physiology Score; APACHE II: Acute Physiology & Chronic Health Evaluation; PACU: Post Anesthesia Care Unit.
*Adjusted to age, ASA physical status, total RCRI, emergency surgery, congestive heart disease, renal insufficiency, fresh frozen plasma, erythrocytes, platelets, troponin I, SAPS II, APACHE II, PACU length of stay, hospital length of stay and delirium.

ii) The independent risk factors for POD identified were older age, ASA-PS, emergency surgery and fresh frozen plasma.
iii) Patients that developed POD were more severely ill, had longer length of stay at the hospital and at the PACU.
iv) POD was an independent determinant for hospital mortality and for mortality at 6-month follow-up.

Delirium in the postoperative period was very common. In the literature, delirium has a reported incidence that varies between 10% to 24% in the adult general medical population and 37% to 46% in the general surgical population [7]. Some authors reported an incidence as high as 60%-80% in the intensive care unit [17]. According to the literature, the incidence of POD is dependent upon the severity of illness observed and diagnostic methods used. Despite its high incidence, delirium often goes unrecognized by clinicians, or its symptoms are incorrectly attributed to dementia, depression or ICU syndrome [8]. In this study using ICDSC, considered very sensitive tool for screening of delirium, we found a POD incidence slightly inferior of that found by other authors. [18-24]. This lower incidence may be explained by the demographic characteristics of the study population with younger patients and a better preoperative status (patients with lower ASA-PS and lower RCRI). Surgical factors may also contribute to this lower incidence because only 17% of patients were submitted to emergency surgery. In addition, all the patients submitted to cardiac and neurological surgery were excluded from the study what may have lowered the global incidence because it is accepted that these surgeries are associated with a higher incidence of POD [19,25-27].

Like other studies [7,24,28], delirium patients were older than non-delirium patients. These patients have a reduced physical reserve that can predispose them to higher severity of illness and, therefore, higher incidence of POD.

Patients with POD were more likely to have ASA-PS III/IV (86% versus 63%, $p < 0.001$) and a higher score for ASA-PS leading to a high risk of developing POD (OR of 2.23, $p < 0.001$). Patients submitted to emergency surgery were at higher risk of developing POD (OR 2.65, $p < 0.001$). These patients may have been more prone to intraoperative hemodynamic complications that may contribute to POD development [7].

Bleeding is also identified as a risk factor for POD [29] and in this study patients that developed POD received greater volumes of erythrocytes (OR 1,18, $p < 0.001$) and fresh frozen plasma (OR 1.42, $p < 0.001$). However, it could have been an observational bias because the worse the general condition of a patient, the higher amount of transfusions the patient may need to achieve hemodynamic stability.

In patients with delirium, as others have reported, this study did not find any significant difference between the type of anesthesia (locorregional versus general) neither with duration of anesthesia [26,30,31].

In this study, we identified as predictors of hospital mortality older age, RCRI, emergence surgery, higher APACHE or SPAPS II scores, longer length of stay in PACU, and hospital and POD. Older age is usually associated with a reduced physical reserve and higher morbidity [7]. Moreover, the other risk factors are associated with higher severity of disease and, therefore are clearly associated with a high risk of in-hospital mortality [1,32]. POD was associated with higher hospital mortality and this has been also reported in the literature [1,8]. This association can be explained because of the higher incidence of POD in critically ill patients with highest severity of disease.

POD is also associated with higher costs of care because, and with higher length of stay in intensive care unit and hospital, as well as, higher severity of illness [33].

In our study, a mortality rate of 15.8% at 6-month follow-up was observed and POD was an independent risk factor for mortality as well as other observed risk factors namely congestive heart disease, severity of disease scores (higher SAPS II and APACHE II) and longer length of stay at the PACU and in the hospital [1,4].

Patients with congestive heart disease have lower cardiac reserve that could have imposed a higher risk of intraoperative hemodynamic complications and, therefore, may have contributed to higher mortality. Moreover, congestive heart disease represents an important co-morbidity that itself has a high mortality due its own pathophysiology.

This study has several limitations. The first one is the small number of patients included in the analysis. This sample may have been small to detect some statistically significant conclusions. Second, patients were screened for delirium only in the PACU, where many of these patients stayed for a short period of time. As a result, later development of POD may have been missed as most cases of POD have arisen on the second day [18,34]. Third, this study was not a randomized controlled trial, so any conclusions will still need to be proven by prospective interventional trials.

In this study, we have not evaluated the association between POD with sleep disturbances, pain, or sedative and analgesic medications. This is another limitation of our study, since these have been identified as significant risk factors for POD [8].

This study showed that POD is an important complication that may arise after surgery and may carry a worse outcome in the surgical patient. It seems to be higher in older patients, those with worse ASA-PS, and submitted to emergency surgery. This study showed that fresh frozen plasma was an independent risk factor for POD probably because its use is associated with hemodynamic instability and intraoperative hemorrhage [19]. These and other risk factors should be investigated and prevented in the early pre-operative study in order to reduce the risk of these patients developing POD [8,35].

This study allowed us to evaluate the incidence of POD in surgical critically ill patients and identified independent risk factors for POD development. Postoperative delirium had impact on PACU length of stay and mortality and was an independent risk factor for hospital mortality and for mortality at 6-month follow-up.

Authors' contributions

All people listed as authors contributed to the preparation of the manuscript and no person or persons other than the authors listed have contributed significantly to its preparation.

Each listed author participated in the work to the extent they could all publicly defend its content. They all read the manuscript before its submission for publication and are prepared to sign a statement stating they had read the manuscript and agree to its publication.

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