ORIGINAL ARTICLE

A retrospective analysis of postoperative patients admitted to the intensive care unit

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Abstract

Background: The aim of this retrospective study was to evaluate postoperative patients admitted to the intensive care unit (ICU) and to describe their characteristics and outcomes.

Methods: We performed a retrospective chart review of 1,756 postoperative patients admitted to the ICU of a tertiary referral hospital from January 2008 to December 2012. For each patient we recorded: demographic data, reason for admission to the ICU, duration of mechanical ventilation, elective versus emergency surgery, type of anaesthesia, American Society of Anesthesiologists (ASA) physical status, Acute Physiology and Chronic Health Evaluation (APACHE) II score, Glasgow Coma Score (GCS), and outcome.

Results: During the study period, the rate of postoperative ICU admission increased each year, and the number of ICU beds was increased in order to perform a greater number of elective surgical procedures for patients who required postoperative ICU care. In 2008, 20.80 % of the patients were postoperatively admitted to the ICU; 58.97 % were in 2012. The mean ratio of five years was 46.97 %. Median age was 63 (1-94) years, and 57.4 % of the patients were male. The most common reasons for admission were major surgery (41.90 %) and comorbidities (34.10 %). Mortality rates were higher in patients that underwent emergency surgery, received general anesthesia, were operated on by a general surgeon, or had low GCS scores coupled with high ASA or APACHE II scores.

Conclusions: The postoperative patients who had metabolic or hemodynamic instability, high ASA or APACHE II scores, and low GCS had higher mortality rates despite ICU care. Hippokratia 2016, 20(1): 38-43

Keywords: Surgical intensive care, postoperative care, critical care, postoperative complications.

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Introduction

In developed countries, patients undergoing high-risk, noncardiac surgery constitute a significant part of intensive care unit (ICU) admissions[1,2]. Although some scoring systems such as POSSUM and P-POSSUM were used to identify patients who required ICU admission following surgery, it is difficult to determine accurately which postoperative patients are at high risk of complications or death[3-5]. Even though the high-risk surgical population comprises a small part of the population that undergoes surgical procedures, the majority of postoperative complications and deaths are observed among high-risk surgical patients, and only one-third of these cases are admitted to the ICU after surgery[6].

Postoperative outcomes are related to patient factors and the nature of the surgery[5,7]. Previous studies suggest that postoperative care in the ICU may substantially reduce postoperative morbidity and mortality due to the early recognition and proper management of postoperative complications[5-8].

ICU beds are a scarce hospital resource, and various factors affect the decision to admit a patient to the ICU, including severity of co-existing disease, need for ICU-specific interventions, or bed availability[5,9]. There are several guidelines for ICU admissions, but no universally accepted criteria for admitting surgical patients to the ICU[8]. We believe that characterizing the surgical patients in the ICU will help to identify those patients who require postoperative ICU treatment; however, we aimed to assess retrospectively ICU admissions following noncardiac surgery.

Table 1: Characteristics of the 1,756 postoperative patients admitted to the intensive care unit, according to years.

Patient Characteristics	2008 (n =77)	2009 (n =104)	2010 (n =444)	2011 (n =409)	2012 (n =662)	Totaly (n =1756)	p
Age (years)[a]	62 (4-91)	64 (1-91)	65 (6-94)	62 (2-93)	63 (2-93)	63 (1-94)	0.081
Sex (male/female)	41/36	92/72	237/207	232/177	410/252	1,012/744	0.056
Department							0.071
General Surgery	40 (51.9)	63 (38.4)	162 (36.5)	137 (33.5)	244 (36.9)	646 (36.8)	
Neurosurgery	22 (28.6)	38 (23.2)	100 (22.5)	105 (25.7)	133 (20.1)	398 (22.7)	
Obstetrics & Gynecology	2 (2.6)	3 (1.8)	12 (2.7)	11 (2.7)	21 (3.2)	49 (2.8)	
Orthopedics	6 (7.8)	23 (14.0)	74 (16.7)	59 (14.4)	86 (13.0)	248 (14.1)	
ENT Surgery	2 (2.6)	8 (4.9)	33 (7.4)	40 (9.8)	66 (10.0)	149 (8.5)	
Urology	4 (5.2)	29 (17.7)	62 (14.0)	52 (12.7)	102 (15.4)	249 (14.2)	
Other	1 (1.3)	0 (0)	1 (0.2)	5 (1.2)	10 (1.6)	17 (0.9)	
Types of surgery							<0.001
Emergency	35 (45.5)*	38 (23.2)*	46 (10.4)	68 (16.6)	99 (15.0)	286 (16.3)	
Elective	42 (54.5)*	126 (76.8)*	398 (89.6)	341 (83.4)	563 (85.0)	1,470 (83.7)	
Type of anesthesia							0.067
General	74 (96.1)	137 (83.5)	373 (84.0)	350 (85.6)	572 (86.4)	1,506 (85.8)	
Regional	3 (3.9)	27 (16.5)	71 (16.0)	59 (14.4)	90 (13.6)	250 (14.2)	
Reason of admission							0.224
Hemodynamic instability	21 (27.3)	28 (17.1)	52 (11.7)	63 (15.4)	88 (13.3)	252 (14.4)	
Major surgery	22 (28.6)	62(37.8)	200 (45.0)	175(42.8)	276 (41.7)	735 (41.9)	
Metabolic instability	11 (14.3)	3 (1.8)	11 (2.5)	7 (1.7)	13 (2.0)	45 (2.6)	
Perioperative arrest	2 (2.6)	5 (3.0)	4 (0.9)	5 (1.2)	8 (1.2)	24 (1.4)	
Postop respiratory failure	10 (13.0)	11 (6.7)	31 (7.0)	19 (4.6)	30 (4.5)	101 (5.8)	
Co-existing disease	11 (14.3)	55 (33.5)	146 (32.9)	140 (34.2)	247 (37.3)	599 (34.1)	
Length of stay[a]	12 (1-103)*	3 (1-226)*	1 (1-418)	1 (1-418)	1 (1-304)	1 (1-418)	<0.001
Duration of MV[a]	11 (0-103)*	1 (0-226)	1 (0-418)	1 (0-418)	1 (0-302)	1 (0-418)	<0.001
GCS	12.9 ± 3.3	14.2 ± 2.3	14.5 ± 1.9	14.5 ± 2.0	14.6 ± 1.8	14.4 ± 2.0	0.656
APACHE II score	17.6 ± 7.1*	13.9 ± 5.8	11.9 ± 5.0	13.4 ± 5.9	13.7 ± 5.6	13.3 ± 5.7	<0.001
Outcome							<0.001
Exitus	61 (79.2)*	48 (29.3)*	43 (9.7)	43 (10.5)	61 (9.2)	256 (14.6)	
Discharge to ward	16 (20.8)*	116 (70.7)*	401 (90.3)	366 (89.5)	601 (90.8)	1,500 (85.4)	

Data are given as: mean ± standard deviations, number and percent in brackets (% within the year), [a]: median (maximum-minimum), *: significant differences compare to other years, ENT: Ear Nose Throat, MV: Mechanical Ventilation, GCS: Glasgow Coma Score, APACHE: Acute Physiology and Cronic Health Evaluation.

Material and methods

The study was performed in the medical-surgical ICU of the Haseki Research and Training Hospital, a referral hospital with 600 beds in Istanbul, Turkey. Before 2010, the ICU had 15 beds; after 2010, there were 26 beds. General, urologic, orthopedic, obstetric and gynecological, ear-nose-throat, neurological, ophthalmic, and peripheral vascular surgical procedures were carried out in the hospital. The study protocol was approved by the Local Hospital Ethics Committee (No 114/2-5-2014) and conducted according to the Declaration of Helsinki. Postoperative patients that were directly admitted to the ICU from the operating room (OR) from 1 January 2008 to 31 December 2012, were included in this retrospective study. Patients that were readmitted to the ICU were excluded, and only the first admission was considered for the analysis. Study data were obtained from medical chart review and the ICU audit database. Data extracted from the audit database were provided using hospital computer software (Probel, Probel Corp. Cankaya, Izmir, Turkey). Data were collected by all the researchers, and were organized by the first author. For each patient we recorded: demographic data, surgical service, reasons for admission to the ICU, duration of mechanical ventilation, emergency or elective status of surgery, type of anaesthesia, American Society of Anesthesiologists (ASA) physical status, Acute Physiology and Chronic Health Evaluation (APACHE) II score, Glasgow Coma Score (GCS), and outcome.

Statistical analysis was made with the Statistical Package for Social Sciences (SPSS) software, version 15.0 (SPSS Inc., Chicago, IL, USA). Descriptive statistics were given as numbers and percentages for categorical variables or as the mean ± standard deviation and median (minimum-maximum) for numeric variables. Comparisons between two independent groups were performed with Student's t-test when the numeric variables were normally distributed or with the Mann-Whitney U test when they were not. Comparisons of numerical variables between more than two independent groups were performed with one-way ANOVA when the numeric variables were normally distributed or with Kruskal-Wallis test when they were not. The Kolmogorov-Smirnov test was used to assess whether the distribution was normal. When overall significance was observed, pairwise post hoc tests were performed using Tukey's test or the Mann-Whitney U test with Bonferroni correction. The ratios of the categorical

Table 2: Comparison of the characteristics of of the 1,756 postoperative patients admitted to the intensive care unit, according to outcome.

Patient Characteristics	Exitus (n =256)	Discharge to ward (n =1500)	p
Age (years)[a]	63 (1-91)	63 (2-94)	0.873
Sex (male/female)	133/123	879/621	0.055
ASA score			*<0.001
I	20 (7.3)	254 (92.7)	
II	46 (5.3)	815 (94.7)	
III	76 (15.9)*	403 (84.1)	
IV	105 (78.9)*	28 (21.1)	
V	9 (100)*	0(0)	
Department			*<0.001
General Surgery	139 (21.5)*	507 (79.5)	
Neurosurgery	83 (20.9)*	315 (79.1)	
Obstetrics & Gynecology	9 (18.4)*	40 (81.6)	
Orthopedics	15 (6)	233 (94)	
ENT Surgery	4 (2.7)	145 (97.3)	
Urology	6 (2.4)	243 (97.6)	
Others	0 (0)	17 (100)	
Types of surgery			*<0.001
Emergency	155 (54.2)*	131 (45.8)	
Elective	101 (6.9)	1,369 (93.1)	
Type of anesthesia			*<0.001
General	244 (16.2)*	1,262 (83.8)	
Regional	12 (4.8)	238 (95.2)	
Reason of admission		*<0.001	
Hemodynamic instability	104 (41.3)*	148 (58.7)	
Major surgery	66 (9)	669 (91)	
Metabolic instability	24 (53.3)*	21 (46.7)	
Perioperative arrest	22 (91.7)*	2 (8.3)	
Postoperative respiratory distress	16 (15.8)	85 (84.2)	
Comorbidity	24 (4)	575 (96)	
Length of stay[a]	12 (1-418)	1 (1-304)	<0.001
Duration of MV[a]	12 (1-418)	1 (0-295)	<0.001
GCS	11.9 ± 4.1	14.9 ± 0.9	<0.001
APACHE II score	20.8 ± 6.4	12.1 ± 4.5	<0.001

Data are given as: mean ± standard deviations, number and percent in brackets (% within the ASA, department, type of surgery and anesthesia, reason of admission), [a]: median (maximum-minimum), *: significant differences, ASA: American Society of Anesthesiologist, ENT: Ear Nose Throat, MV: Mechanical Ventilation, GCS: Glasgow Coma Score, APACHE: Acute Physiology and Cronic Health Evaluation.

variables between the groups were analyzed with Chi-Square analysis. The relationships between numeric variables were evaluated with the Spearman correlation analysis because the parametric test condition could not be established. A p value <0.05 was considered statistically significant.

Results

During the study period, 3,738 patients were admitted to the ICU, and 1,756 of them were postoperative patients (46.98 %). The number of intensive care beds (15 beds in 2008 and 26 beds in 2010 and thereafter) and the number of postoperative patients admitted to the ICU gradually increased over the years. Their percentages of the total patients were 21 % (n =77) in 2008, 22 % (n =164) in 2009, 47 % (n =444) in 2010, 50 % (n =409) in 2011, and 58 % (n =662) in 2012. Mean age was 60.4 ± 17.4 years, and 57.6 % of the patients were male (47.4 % were female). Mean age and sex did not show significant differences between the years (p =0.081 and p =0.056, respectively). Analysis of the patients by department showed that they most commonly underwent general surgery (36.8 %), neurosurgery (22.7 %), or orthopedic and traumatology surgical procedures (14.1 %). There were no significant differences between the years. Among all the postoperative patients admitted to the ICU, 16.3 % underwent emergency operations and 83.7 % elective operations. There was a statistically significant difference in the type of surgery between the years (p <0.001). The increase in the ratio of elective admissions was noteworthy. The operations were performed under general anesthesia in 85.8 % of the patients and regional anesthesia in 14.2 %. Comparison of anesthesia methods according to the years did not reveal a significant difference (p =0.067). There were no significant differences between the years with respect to indications for admission to the ICU (p =0.224). After the ICU, 85.4 % of the patients were discharged to the ward and 14.6 % died in the ICU (Table 1).

Table 3: Characteristics of the 1,756 postoperative patients admitted to the intensive care unit: elective versus emergency surgery.

Patient Characteristics	Emergency (n =286)	Elective (n =1470)	p
Age (years)[a]	57 ± 19	61 ± 17	0.873
Sex (male/female)	164/122	848/622	0.914
Types of anesthesia			<0.001
General	284 (18.9)	1,222 (81.1)	
Regional	2 (0.8)	248 (99.2)	
Length of stay[a]	5 (1-418)	1 (1-226)	<0.001
Duration of MV[a]	5 (0-418)	1 (0-226)	<0.001
GCS	11.9 ± 4.1	14.9 ± 0.9	<0.001
APACHE II score	19.6 ± 5.8	12.1 ± 4.8	<0.001
Outcome			<0.001
Exitus	155 (60.5)	101 (39.5)	
Discharge to ward	131 (8.7)	1,369 (91.3)	

Data are given as: mean ± standard deviations, number and percent in brackets (% within the type of anesthesia and prognosis), [a]: median (maximum-minimum), MV: Mechanical Ventilation, GCS: Glasgow Coma Score, APACHE: Acute Physiology and Cronic Health Evaluation.

Mortality was higher in patients who underwent emergency operations, surgery under general anesthesia, developed perioperative arrest, or had hemodynamic or metabolic instability, high ASA or APACHE II scores, or low GCS scores. The ratios of patients who died were significantly higher in general surgery, neurosurgery, obstetric and gynecological operations (Table 2). The length of stay in the ICU and the duration of mechanical ventilation increased with higher APACHE II scores and ASA scores and with lower GCS scores. The Spearman's rho coefficient of the length of stay for APACHE II, GCS, and ASA scores were 0.320 (p <0.001), -0.329 (p <0.001), and 0.117 (p <0.001), respectively. The Spearman's rho coefficient of the duration of mechanical ventilation for APACHE II, GCS, and ASA scores were 0.227 (p <0.001), -0.354 (p <0.001), and 0.533 (p =0.015), respectively. The most common indications for being transferred to the ICU were hemodynamic instability in emergency operations (121 of 286; 42.3 %) and major surgery and comorbidity in elective operations (665 and 567 of 1,470; 45.2 and 36.8 %). In emergency operations, the mortality rate, length of stay, duration of mechanical ventilation, and APACHE II scores were significantly higher than in the elective operations (Table 3). Mortality rates were correlated with increased ASA scores (Spearman's rho coefficient= -0.368 and p <0.001). The ASA II patient group was the most common grouping among the patients admitted to the ICU (Table 2).

According to the cause for admission, patients admitted due to comorbidities had the shortest length of stay [median (min-max): 1 (1-102) days], followed by patients undergoing major surgery [median (min-max): 1 (1-226) days), among the other indications (p <0.001) [median (min-max): 3 (1-418) days in hemodynamic instability; 5 (1-63) in metabolic instability; 4 (1-418) in perioperative cardiac arrest; 3 (1-304) in postoperative respiratory distress]. Duration of mechanical ventilation was significantly lower in the major surgery and comorbidity groups than the other groups [median (min-max): 1 (0-226) and 1 (0-102) days, respectively) compared to others (p <0.001) [median (min-max): 3 (0-418) days in hemodynamic instability; 5 (1-63) in metabolic instability; 4 (1-418) in perioperative cardiac arrest; 2 (0-302) in postoperative respiratory distress]. The perioperative cardiac arrest group had significantly lower GCS scores (10.5 ± 5.0) than the other groups (p <0.001) (13.0 ± 3.5 in hemodynamic instability, 14.7 ± 1.3 in major surgery, 14.7 ± 0.9 in metabolic instability, 13.8 ± 3.1 in postoperative respiratory distress, 14.9 ± 0.5 in co-existing disease). APACHE II scores were significantly lower in the major surgery group (10.7 ± 4.6) than in the other groups (p <0.001) (18.2 ± 6.1 in hemodynamic instability, 18.1 ± 3.7 in metabolic instability, 29.5 ± 3.4 in perioperative cardiac arrest, 14.7 ± 5.2 in postoperative respiratory distress, 13.3 ± 4.3 in co-existing disease).

Discussion

The results of the present study showed that the ratio of ICU admissions from the OR to all ICU admissions increased 2.5-fold between 2008 and 2012. This increase is related to an increase in the number of ICU beds concurrent with an increase in the whole country[10]. The ratio of postoperative ICU admissions to all surgical operations was 1.99 % (1,756 of 87,954 patients) in the present study and comparable to other studies[5,6,11,12]. ICU admissions after surgery may vary from country to country, due to cultural, demographic, socioeconomic, and political differences between nations[5].

The vast majority of patients admitted to the ICU after surgery was patients who underwent abdominal or cranial surgery and they had the highest mortality rates (Table 1, Table 2). It was previously reported that gastrointestinal and cranial surgical procedures were associated with higher postoperative morbidity and mortality than other types of surgery, such as gynecological or musculoskeletal surgery[12-15]. Another finding of the study was that regional anesthesia improved the mortality rate. We confirmed previous studies that showed better prognoses with regional anesthesia, compared to general anesthesia, for high-risk surgical patients[16]. However, regional anesthesia may be preferred for appropriate surgical procedures.

Most scoring systems help to estimate the mortality of patients admitted to the ICU[17]. Although the scoring systems were not developed solely for surgical patients, they may be used for postoperative patients and enable risk estimation of that population[5,7,8,18]. The APACHE II, developed by Knaus et al[19], is one of the most common scoring systems. Numerous studies have been performed to show whether high APACHE II scores are related to mortality[20,21]. In our study, APACHE II scores were higher in patients who underwent emergency operations and died. Ipairment of consciousness level is practically evaluated with GCS[22]. In the present study, we found that lower GCS scores were associated with higher mortality. We also showed that length of stay and the duration of mechanical ventilation were also longer in patients who died (Table 2). These results were comparable to those of other studies[23-25].

Numerous preoperative factors, such as comorbidities, may be assessed by various means, which helps in the estimation of the postoperative prognosis[8]. Despite the significant inter-observer variability, the ASA classification has been widely accepted in the estimation of postoperative morbidity and mortality[5,7,8,26]. Regardless of anesthesia application, mortality and morbidity are expected in patients in poor physical condition due to severe systemic illness[21]. Therefore, patients in bad health condition are expected to have higher rates of admission to the ICU2-8. Our study showed that mortality, length of stay in the ICU, and duration of mechanical ventilation increased as ASA scores increased. Although all these scoring systems are helpful for estimating patient prognoses, it should be remembered that prognoses may be different for every patient[27].

Almost all studies have shown that the emergency nature of the operation is an additional risk[5,6,26]. Although emergency operations were more frequent in ICU admissions in some studies, the rate of elective operations was greater in our study[12]. Time, staff and the conditions provided for elective operations may not always be available for emergency operations. Insufficient preoperative workup and preparation result in a greater mortality rate in emergency patients. Our study showed that the mortality rates were higher in patients admitted to the ICU after emergency operations than after elective operations.

The ratio of low-risk postoperative patients admitted to the ICU to all postoperative patients is reported to be between 20 and 40 %[11,12]. In our study, 1,219 (69.4 %) patients were admitted in the ICU for only one day, and then discharged to the ward the next day. This figure is higher than the 20-40 % (that included only low-risk and follow-up admissions) reported by other ICUs[11,12]. It appears necessary to use the intermediate ICUs, rather than the general ICUs, for the care of these low-risk patients who also have low mortality rates[11]. Some authors disagree with this due to the possible late complications that may require early and efficient intervention; they also state that these patients should be taken into private sections inside the ICU, which can be utilized as intermediate ICUs[11].

Studies emphasize that it is possible to follow-up high-risk patients outside the ICU, and suggest specific criteria for admission to the ICU[28,29]. As an alternative to the ICUs, level 2 ICUs [high-dependency unit (HDU)], which are more advanced than the regular ward, offer monitoring of low-risk patients[30]. When beds are unavailable in the ICU, post-anaesthetic care units (PACUs) may be used temporarily; however, those patients who will receive the greatest benefit from the ICU should be transferred to the ICU immediately[31].

In a recent study, it was reported that only one-third of high-risk surgical patients was admitted to the ICU postoperatively[31]. Also, the study found that patients admitted to the ICU had higher survival rates than patients who were re-admitted to the ICU or admitted late to the ICU. In another study, Goldhill and Down[9] reported that while some groups of patients were routinely admitted to the ICU, others were rarely admitted, and there were consistencies in ICU admission.

In our study, the most common reasons for admission to the ICU were major surgery and follow-up of patients with severe co-existing disease. The mortality rates, length of stay in the ICU, and duration of mechanical ventilation were shorter in these groups of patients. Perioperative cardiac arrest patients had the highest mortality rate, similar to previous studies[32].

In conclusion, because of higher mortality rates, the patients with hemodynamic or metabolic instability, high ASA or APACHE II scores, or low GCS scores must be assessed carefully for postoperative ICU follow-up. Due to the increased number of ICU beds in our hospital, a greater number of high-risk surgical patients underwent elective non-cardiac surgery.

Conflict of interest

Authors declare no conflicts of interest.

Acknowledment

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