

# Unplanned Intensive Care Unit Admission following Elective Surgical Adverse Events: Incidence, Patient Characteristics, Preventability, and Outcome

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## Abstract

**Context:** Adverse events (AEs) are a persistent and an important reason for Intensive Care Unit (ICU) admission. They lead to death, disability at the time of discharge, unplanned ICU admission (UIA), and prolonged hospital stay. They impose large financial costs on health-care systems. **Aims:** This study aimed to determine the incidence, patient characteristics, type, preventability, and outcome of UIA following elective surgical AE. **Settings and Design:** This is a single-center prospective study. **Methods:** Analysis of 15,372 elective surgical procedures was performed. We defined UIA as an ICU admission that was not anticipated preoperatively but was due to an AE occurring within 5 days after elective surgery. **Statistical Analysis:** Descriptive analysis using SPSS software version 18 was used for statistical analysis. **Results:** There were 75 UIA (0.48%) recorded during the 2-year study period. The average age of patients was  $54.64 \pm 18.02$  years. There was no sex predominance, and the majority of our patients had an American Society of Anesthesiologist classes 1 and 2. Nearly 29% of the UIA occurred after abdominal surgery and 22% after a trauma surgery. Regarding the causes of UIA, we observed that 44 UIA (58.7%) were related to surgical AE, 24 (32%) to anesthetic AE, and 7 (9.3%) to postoperative AE caused by care defects. Twenty-three UIA were judged as potentially preventable (30.7%). UIA was associated with negative outcomes, including increased use of ICU-specific interventions and high mortality rate (20%). **Conclusions:** Our analysis of UIA is a quality control exercise that helps identify high-risk patient groups and patterns of anesthesia or surgical care requiring improvement.

**Keywords:** Adverse events, elective surgery, outcomes, preventability, unplanned Intensive Care Unit admission

## INTRODUCTION

Adverse events (AEs) are unintentional injuries or complications that occur from health-care management. They lead to death, disability at the time of discharge, unplanned admission in critical care, and prolonged hospital stay.<sup>[1]</sup> They impose large financial costs on health-care systems.

Little is known about elective surgical AEs leading to an unanticipated admission in the Intensive Care Unit (ICU).

Unplanned ICU admission (UIA) is associated with a negative outcome<sup>[2]</sup> and has been shown to be an important safety measure of anesthesia and surgical care.<sup>[3]</sup>

The aim of our study was to determine the incidence, patient characteristics, type, preventability, and outcome of UIAs following elective surgical AE.

## METHODS

It is a single-center prospective study conducted in Mohammed V Training Military Hospital in Rabat, Morocco. The surgical ICU at our hospital is a 12-bedded unit with about 340 admissions per year. There are two operating theaters dedicated to elective surgery with 14 operating rooms. All surgical specialties were performing about 7500 operations per year except cardiac and vascular surgeries.

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Our study was approved by our Institutional Ethics Committee. The study period was 2 years (between January 1, 2014 and December 31, 2015). Our criteria for planned postoperative admission to the ICU were intracranial surgery, patients already in ICU before surgery, or major elective surgery in the American Society of Anesthesiologists (ASA) 3 and 4 patients. We defined UIA as an ICU admission not anticipated preoperatively but was due to an AE occurring within 5 days after elective surgery.

The exclusion criteria were as follows: patients already in the ICU before surgery, emergency surgery, and UIA occurred more than 5 days after surgery. We also excluded the cases where communication problems did not allow a preoperative ICU booking in spite of anticipating needs for ICU admission after surgery.

The following data were collected: demographic characteristics, medical background, ASA physical status, type of elective procedures and anesthesia, type of AE, and onset of time of AE (in operative room – or postanesthetic care unit [PACU] – or hospital units).

We also recorded Simplified acute physiological score (SAPS) score for each patient for the first 24 h of ICU stay, the use of ICU-specific interventions, the incidence of nosocomial infection, length of stay in ICU, and ICU mortality. The following procedures were considered ICU specific, tracheal intubation, mechanical ventilation, inotropic or vasoactive drug infusion, blood transfusion, and renal dialysis.

Medical records of our patients were reviewed independently by all authors to determine the origin of AE leading to UIA (anesthetic or surgical) and which AE could have been preventable. Finally, a consensus was formed after a meeting of all authors.

Statistical analysis was performed using SPSS software version 18 (SPSS Inc. Released 2009. PASW Statistics for Windows, Version 18.0. Chicago: SPSS Inc). We performed a descriptive analysis with quantitative variables expressed as mean  $\pm$  standard deviations and qualitative variables as number and percentage.

## RESULTS

There were 693 admissions into the adult surgical ICU during the 2-year study period. Seventy-five were UIA representing 10.82% of all ICU admissions. A total of 15,372 elective surgical procedures were performed giving a rate of 0.48%.

The mean age of our patients was  $56.21 \pm 16.65$  years (range: 20 and 96 years). Among those patients, 38 were men (50.7%) and 37 were women (49.3%) with sex ratio (male/female) of 1.02. The ASA status distribution from I to III was 33.3%, 58.7% and 8%, respectively.

Nearly 6.7% of patients admitted had an ICU stay history and no one had an anesthetic or surgical AE's history [Table 1]. In our study, abdominal and trauma surgeries were the most common procedures implicated on UIA with respective

**Table 1: Demographic characteristics and medical background of our patients**

Items	Mean $\pm$ SD or n (%)
Number of elective surgical procedures	15,372
Number of admission in ICU during the study period	693
Number of UIA patients	75
Age	54.64 $\pm$ 18.02
Gender (%)	
Female	37 (49.3)
Male	38 (50.7)
Obesity (BMI $\geq$ 30 kg/m <sup>2</sup> ) (%)	5 (6.8)
Hypertension (%)	21 (28)
Coronary artery disease (%)	4 (5.3)
Cancer (%)	12 (16)
Diabetes (%)	14 (18.7)
Asthma (%)	3 (4)
COPD (%)	4 (5.3)
ICU stay history (%)	5 (6.7)
ASA physical status class (%)	
1	25 (33.3)
2	44 (58.7)
3	6 (8)

Mean $\pm$ SD; n (%). ICU: Intensive Care Unit; UIA: Unplanned Intensive Care Unit admission; BMI: Body mass index; COPD: Chronic obstructive pulmonary disease; SD: Standard deviation; ASA: American Society of Anesthesiologists

**Table 2: Type of procedure leading to unplanned Intensive Care Unit admission**

Type of procedure	n (%)
Orthopedics	22 (29.3)
Abdominal surgery	23 (30.7)
Spine surgery	2 (2.7)
Urology	9 (12)
Gastrointestinal procedures	5 (6.9)
Endoscopic resection of a pituitary adenoma	1 (1.3)
Thyroidectomy	6 (8)
Gynecology	5 (6.7)
Thoracic surgery	1 (1.3)
Proctology	1 (1.3)

percentages of 30.7% and 29% [Table 2]. Nearly 80% of them were performed under general anesthesia (GA).

Regarding the causes of UIA, we observed that 44 UIA (58.7%) were related to surgical AE, 24 (32%) to anesthetic AE, and 7 (9.3%) were related to postoperative AE caused by care defects.

The intraoperative major bleeding and postoperative peritonitis were the main surgical AEs. They led to UIA in 24% and 13.3% of cases. Furthermore, anesthetic AEs were mainly cardiovascular in intraoperative period and respiratory in recovery period [Table 3].

The decision to transfer the patient to the ICU was taken in the operating room in 45.3% of cases, in the PACU in 18.7%, and in the hospital unit in 36% of cases.

**Table 3: Adverse events leading to unplanned Intensive Care Unit admissions**

	<i>n</i> (%)
Surgical AE leading to UIA	
In operative room	
Excess if bleeding	18 (24)
In PACU	
Respiratory failure following recurrent nerve injury	4 (5.3)
Others	2 (2.6)
In hospital (≤5 days)	
Peritonitis	10 (13.3)
Hemorrhagic shock	6 (8)
Septic shock secondary to equipment infection	3 (4)
Pancreatitis	1 (1.3)
Total	44 (58.7)
Anesthetic AE leading to UIA	
Operative room	
Cardiogenic shock	4 (5.3)
Anaphylactoid drug reaction	2 (2.7)
Acute atrial fibrillation	3 (4)
Malignant hyperthermia	2 (2.7)
Others	5 (6.6)
PACU	
Delay to wake	2 (2.7)
Respiratory failure	5 (6.6)
Seizures	1 (1.3)
Total	24 (32)
AE leading to UIA related to postoperative care defects	
In hospital (≤5 days)	
Pulmonary embolism	2 (2.7)
Septic shock related to care defect	4 (5.3)
Unsupplemented hypokalemia	1 (1.3)
Total	7 (9.3)

AE: Adverse event; UIA: Unplanned Intensive Care Unit admission; PACU: Postanesthetic care unit

**Table 4: Characteristics of Intensive Care Unit stay**

Items	Mean±SD or <i>n</i> (%)
Number of elective surgical procedures	15,372
Number of admission in ICU during the study period	693
Number of UIA patients	75
The mean SAPS score for the first 24 h of ICU stay	34.08±14.52
Need for ICU-specific interventions (%)	67 (89.3)
Need for mechanical ventilation (%)	54 (72)
Need for inotropic and vasoactive drug infusion (%)	43 (57.3)
Renal dialysis (%)	2 (2.7)
Blood transfusion (%)	30 (40)
Nosocomial infection (%)	6 (8)
Length of stay in ICU (days) (%)	3 (2-6)
ICU mortality (%)	15 (20)

Mean±SD; *n* (%). ICU: Intensive Care Unit; SD: Standard deviation; SAPS: Simplified acute physiological score ; UIA: Unplanned Intensive Care Unit admission

A total of 23 UIA were judged as potentially preventable giving a rate of 30.7%.

UIA was associated with negative outcomes. The mean SAPS score for the first 24 h of ICU stay was 34.08 ± 14.52. Nearly 72% of our patients have recourse to the mechanical ventilation. The need for blood transfusion and inotropic and vasoactive drug infusion was 40% and 57.3%, respectively. Otherwise, only eight patients did not receive any ICU specific interventions.

The rate of nosocomial infection was 8%. The mean length of ICU stay was 3 days (with ranges 2 and 6 days). The related ICU mortality rate was 20%. [Table 4]

## DISCUSSION

Our study is, to our knowledge, the first in Morocco to focus on UIA following an elective surgery.

The incidence of UIA is varying in literature between 0.12% and 0.79%.<sup>[4,5]</sup>

In our study, we found an incidence of 0.49%. It is less than that reported by Piercy *et al.* (0.79%)<sup>[5]</sup> and higher than that reported by Quinn *et al.* (0.12%),<sup>[4]</sup> but comparable to that reported by Okafor (0.58%)<sup>[6]</sup> and Cullen *et al.* (0.42%).<sup>[7]</sup>

The reason for this variation could be the difference in the methods of data collection, study's prospective or retrospective character, inclusion criteria, sample size, definition of the UIA, or even institution's practices.<sup>[4,6,7]</sup>

In most surveys, emergency and elective surgeries were included and UIA was defined as UIA within 1 or 2 days after surgery. In our study, we focus on UIA occurring after elective surgery within 5 days. We chose 5 days as a cutoff period because it corresponds on average to discharge from the hospital following elective surgery. Therefore, the actual incidence of UIA within these studies has been probably underestimated.

In our study, the average age of patients was 54.64 ± 18.02 years, no sex predominance, and the majority of our patients had ASA classes 1 and 2. These results were close to those found by Phyu Phyu T *et al.*<sup>[8]</sup>

Otherwise, in data extracted from National Anesthesia Clinical Outcomes registry, Quinn *et al.* have found an association of advanced age and higher ASA class with UIA after surgery.<sup>[4]</sup>

In our data, we have shown that abdominal and trauma surgery patients were more likely to have a UIA than other patients. Similar results have been found by Haller *et al.*<sup>[3]</sup>

However, Quinn *et al.* have found that vascular and thoracic procedures were mostly implicated in the UIA and bowel resection, and repair of hip fractures was the most common surgery involved.<sup>[4]</sup>

A complete analysis of literature has shown a trend toward less UIA occurred after surgery performed under regional anesthesia versus GA.<sup>[2,4]</sup> In our study, 80% of UIA occurred after surgery under GA.

Elective surgical AEs leading to UIA are multifactorial. It is difficult to determine the contribution of anesthetic care or surgical management to AEs occurring after elective surgery.<sup>[1,4]</sup> In our study, 64% of UIAs were related to surgical AEs and 36% to anesthetic AEs. Our results are similar to those found by Piercy *et al.* who investigated all ICU admissions from three Australian hospitals for 3 months. They found that 33.3% of UIA following elective surgical procedures contained an anesthetic contribution.<sup>[2]</sup>

In our survey, intraoperative major bleeding and postoperative peritonitis were the main surgical AEs leading to UIA. Moreover, anesthetic AEs were mainly cardiovascular in the intraoperative period and respiratory in recovery period. Similar results have been found in literature. Quinn *et al.* have found that the main causes of UIA were cardiovascular and respiratory distress requiring intubation.<sup>[4]</sup> While Bhat *et al.* have found that persistent tachycardia, major bleeding, and hypotension requiring use of vasoactive drugs were the main AEs leading to UIA.<sup>[9]</sup>

Nearly 30.7% of UIA were judged in our survey as potentially preventable. It is higher than the rate reported by Piercy *et al.* (10.4%).<sup>[2]</sup>

In our study, UIA was associated with negative outcomes, including increased use of ICU-specific interventions and high mortality rate. Almost 89% of our patients have required ICU interventions. Nearly 72% of them have benefited from a MV and 40% required blood transfusion. Vasoactive drugs were used in 57.3% of cases. This can be explained by the nature of AE at the origin of the UIA.

This rate of ICU-specific interventions is higher than that reported by Swann *et al.* who have found a rate of 64%, and consequently, they suggest the creation of intermediate care units.<sup>[10]</sup>

The mortality rate in our study was 20%. This rate is very high compared to that found by Quinn *et al.*, which did not exceed 0.64%<sup>[4]</sup> and even in studies conducted by Pearse *et al.* (8%),<sup>[5]</sup> Phyu Phyu T *et al.* (15.4%), and bhat *et al.* (13.7%).<sup>[8,9]</sup> However, the rate found in our study is lower than that found by Okafor (30.7%)<sup>[6]</sup> and Bhat *et al.* (36.2%).<sup>[9]</sup>

Given the limited data available and the fact that there are a handful of retrospective studies on this topic in the literature, we hope with this study to eventually gain insight into ways we can improve the quality of peri-operative anesthetic and surgical care and to better allocate ICU resources.

To optimally assess clinical relevance of this study, some of its limitations deserve to be emphasized. Patients were recruited from a single center and may therefore not be representative for all Moroccan ICU centers. A more extensive and multi-center analysis of unplanned postoperative admissions to the ICU is needed in the future.

## CONCLUSIONS

Unplanned admission to the ICU after elective surgery is a rare event. It is associated with negative outcomes. The contribution of anesthetic management is low compared to surgery. UIAs are an indicator of quality of the entire peri-operative process. It is considered a global measure of surgical patient safety. Our analysis of UIA is a quality control exercise. It is useful for us to identify patterns of anesthesia or surgical care requiring improvement.

It would be interesting to link the results of this study to the hospital's administrative databases to trace whether AEs can be identified to gain insights into potential preventive strategies.

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## Conflicts of interest

There are no conflicts of interest.

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