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Unplanned intensive care admission leading to an adverse event: Incidence, preventability and feature analysis

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ABSTRACT

Objective: To compare the characteristics of patients between adverse event (AE) group and non-AE group, and to assess the causes, preventability, and severity of AE.

Methods: A retrospective triple-phase medical record study was conducted at a Spanish tertiary hospital. Data was collected over a 6-month period, including all patients with an unplanned intensive care admission. Demographic characteristics, APACHE II, length of ICU stay, mortality were compare between AE and non-AE group causes, preventability and severity were analyzed in AE cases.

Results: 597 Patients were included in the study. The overall incidence of AEs was 17.3% ($n=103$), of which 83.5% were considered preventable. Mortality within the AE group was higher than in the non-AE group (23.3% vs. 13.6%), making it 1.7 times more frequent in the AE group (95% *CI*: 1.143–2.071). The primary cause of AE was associated with surgical procedures (43.7%). Of the AEs, 18.4% were classified as mild, 58.3% as moderate, and 23.3% as severe.

Conclusions: The incidence of unplanned intensive care admissions due to AE is high and potentially preventable. This is concerning given the high mortality observed in patients admitted to the intensive care unit because of an AE, although direct causality cannot always be established. The findings emphasize the importance of patient safety and underscore the need for improved quality and management of care resources. They also indicate where efforts should be directed to enhance care risk management.

KEYWORDS: Adverse effects; Intensive care unit; Patient admission; Patient outcome assessment

1. Introduction

It is estimated that 421 million people are hospitalized worldwide each year, and approximately 42.7 million patients experience an

Significance

Adverse events are frequently occurred in the daily practice. Adverse events imply unplanned intensive care admission, which is considered potentially preventable. Mortality related to this issue is relevant, so more attention to this issue plays a significant role to increase patient security.

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adverse event (AE)[1]. An AE is an unexpected situation or event not related to the natural course of the disease but rather to the care process received by a patient[2]. AEs can lead to negative outcomes such as injury, harm, disability, prolonged hospital stay, or death[2]. It is clear that AEs detract from the quality of care and health systems, in addition to having significant economic and psychological impacts on both patients and the involved professionals[3,4].

Identifying AEs and analyzing their causes is essential for learning from them and managing the associated risks, thereby improving care processes and promoting safer patient care. A patient who experiences an AE may require an unexpected intensive care unit admission (UIA) from a lower level of care within the hospital[5,6]. Recording UIAs can help quantify and assess the effects that AEs have on patients and health systems, serving as the first step to preventing their recurrence[7].

Preventable AEs are those that can be addressed to avoid them in the future. Baker *et al.*[8] found that 36.9% of AEs were preventable, De Vries *et al.*[9] identified 43.5% as preventable, Garry *et al.*[10] reported 77%, and the systematic review by Vlayen *et al.*[11] showed that 17% to 76.5% of AEs were preventable.

Therefore, the main objective of this study is to determine the incidence of UIAs due to AEs in prior hospital care and to compare the differences between patients transferred to the intensive care unit (ICU) because of an AE and those with other types of UIAs in terms of age, Acute Physiology and Chronic Health Evaluation II (APACHE II) score, length of stay in the ICU, and patient mortality. Additionally, the study aims to analyze AE characteristics by determining their severity and potential preventability.

2. Patients and Methods

2.1. Study setting

A triple-phase retrospective medical record study on the incidence and preventability of AEs requiring an unplanned UIA from a lower level of care was conducted in the ICU of a tertiary-care Spanish adult university-affiliated hospital, covering all specialties (Miguel Servet University Hospital).

2.2. Ethical consideration

Following institutional and university ethics approval, data were collected from medical charts and hospital information systems, including the hospital administrative database and ICU department database, over a 6-month observation period. Approval was obtained

from the local ethics committee (Approval No. HUMS_1112_2018).

2.3. Inclusion criteria and exclusion criteria

In the first phase, all UIA patients were selected by intensivists from the hospital between January 1, 2018, and June 30, 2018. Additionally, each patient's unplanned admission status had to be confirmed by an additional data source, either the ICU database or medical records.

To be considered valid, UIA patients had to be those who were not scheduled for postoperative admission to the ICU and had not already been admitted to the ICU at the start of the study. During the study period, there were 1267 ICU admissions, with a total of 670 exclusions (52.88%) due to being planned admissions to the ICU.

2.4. Measurements

In the first phase, all UIA patients were selected by intensivists from the hospital between January 1, 2018, and June 30, 2018. Additionally, each patient's unplanned admission status had to be confirmed by an additional data source, either the ICU database or medical records.

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In the second stage, UIA patients were classified into two groups by an independent clinical team consisting of a physician specializing in intensive care medicine and a physician specializing in urology, both of whom are specialist consultants at a university-affiliated hospital: the AE group and the non-AE group. This classification was based on a review of information provided by ICU medical records software and electronic medical history, including demographic variables, comorbidities, medical history before ICU admission, current health status, APACHE II score[12], medication, instrumental procedures, surgical procedures, and patient outcomes such as in-ICU mortality.

To reach the final decision, the team followed this definition of an AE[13], "The result of an incident resulting in harm or unexpected injury related to the healthcare received, without being a consequence of the natural course of the underlying disease or the worsening of the patient's underlying pathology within 12 hours prior to the AE". During this stage, the preventability of detected AEs was also assessed using a dichotomous subjective categorization based on evidence found in the clinical history, with the two observers reaching an agreement: preventable AE or non-preventable AE.

Further classification was performed based on the main cause of AE and its severity. The team was asked to select one of the following four causes of AEs: drug therapy (incorrect medication therapy, delay in treatment, or adverse drug reaction), procedural (related to a medical procedure, such as myocardial perforation during pacemaker placement), surgery (related to a surgical procedure), or diagnosis (delayed or incorrect diagnosis). The reviewers were also asked to assess the severity of the AEs according to the World Health Organization classification, depending on the medical needs that warranted ICU admission (*e.g.*, vasoactive drugs, orotracheal intubation, mechanical ventilation, or other specialized assistance): mild, moderate, or severe.

In the third stage, to avoid biases, the interobserver reliability was analyzed by assessing the concordance in identifying UIAs caused by an AE, reaching a consensus while also documenting the level of agreement in the results section. Figure 1 exposes a flowchart of the study.

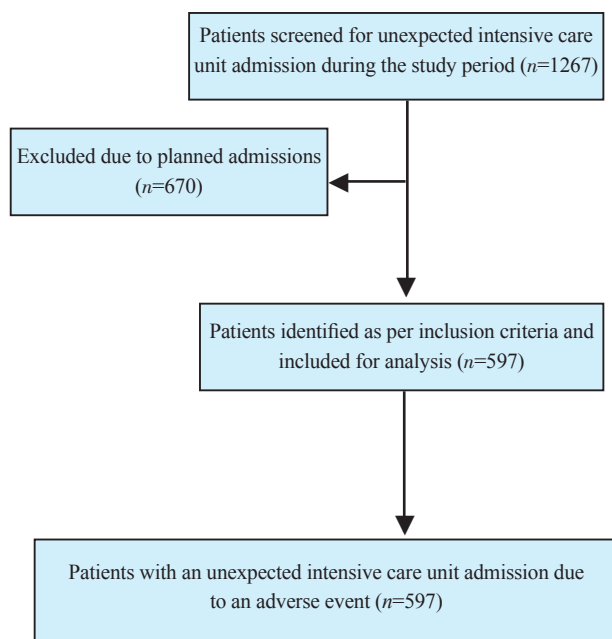


Figure 1. Flowchart of patients in different arms (unexpected intensive care unit admission due to an adverse event or not).

2.5. Statistical analysis

Demographic characteristics were expressed as absolute and relative frequencies or as means with standard deviations, or as medians with interquartile ranges (25th percentile - 75th percentile) if they did not meet normality criteria according to the Kolmogorov-Smirnov test.

To measure the incidence of AEs among UIA patients and their preventability, proportions were calculated, as well as for the causes

of AEs, severity, and in-ICU mortality. The AE group was compared with the non-AE group using Mann-Whitney *U*-tests, or *Chi*-squared tests, as appropriate.

Finally, the level of exact agreement and the Cohen's kappa coefficient (κ), representing agreement beyond chance, were assessed. Proportions are expressed as percentages, and kappa scores are reported with 95% confidence intervals.

For all tests, statistical significance was set at $P < 0.05$. We used the Statistical Package for the Social Sciences (SPSS), IBM® Statistics, version 20.0.

3. Results

During the study period, 597 patients experienced an UIA. Relevant demographic data, APACHE II scores, length of ICU stay, and outcomes for UIA patients are detailed in Table 1.

3.1. Incidence of AEs among the UIA patients

The overall incidence of patients transferred to the ICU due to an AE was 17.3% of all UIA cases ($n=103$), while 494 patients (82.7%) were transferred for other reasons (non-AE group). The exact agreement between reviewers on whether a UIA was due to an AE or non-AE was almost perfect at 99.49%, with a kappa score of 0.98, indicating a high level of agreement beyond chance.

3.2. Characteristics in AE and non-AE groups

Demographic characteristics, APACHE II scores, length of ICU stay, and in-ICU mortality for both groups are summarized in Table 1. No statistically significant differences were observed between AE and non-AE patients concerning sex ($P=0.832$) or age ($P=0.447$). Additionally, the length of ICU stay was similar between both groups, with a median of 5 days ($P=0.374$).

However, APACHE II score was significantly higher in the AE group [17 (11, 23)] compared to the non-AE group [12 (8, 17)] ($P=0.001$).

3.3. Outcome (in-ICU mortality)

As shown in Table 1, the mortality rate in the AE group was higher (23.3%, $n=24$) than in the non-AE group (13.6%, $n=67$) ($\chi^2 = 6.256$; $P=0.012$). Among the UIA patients who died ($n=91$), 26.37% ($n=24$) were from the AE group. Our data indicate that the in-ICU mortality risk ratio attributable to AEs was 41.6%, with mortality during ICU stay being 1.7 times higher in the AE group (95% CI: 1.143-2.071, $P < 0.05$) than the non-AE group.

3.4. Causes of AEs

The most common causes of AE was associated with surgical procedures (43.7%, $n=45$), followed by medical procedures (24.3%, $n=25$), diagnostic issues (19.4%, $n=20$), and drug therapy-related events (12.6%, $n=13$).

3.5. Severity of AEs

The severity of AEs was classified as mild in 18.4% of cases ($n=19$), moderate in 58.3% ($n=60$), and severe in 23.3% ($n=24$) according to the reviewers.

3.6. Preventability of the AE

The reviewers determined that 86 AEs (83.5%) were preventable, while 17 AEs (16.5%) were not (Table 2). In the total UIA group, 14.4% (86/597) of patients were transferred to the ICU from a lower level of care due to a preventable AE. Moreover, 91.7% (22/24) of severe AEs, 85% (51/60) of moderate AEs, and 68.4% (13/19) of mild AEs were deemed preventable. Consequently, 24.17% (22/91) of the deceased patients had experienced a preventable AE.

4. Discussion

In our study of 597 patients with unplanned admissions to the ICU, the incidence of admissions due to an AE was 17.3%. We defined an AE as an incident that results in damage or unexpected injury related to the healthcare received, without being a consequence of the natural course of the disease or worsening of the underlying pathology within 12 hours prior to the AE. The methodology employed in our study allowed for an initial selection of patients admitted to the ICU without prior planning, followed by a detailed review of their medical histories by two independent reviewers—one an intensivist and the other a surgeon—to minimize specialty bias.

Trunet *et al.* published one of the earliest studies on the incidence of AE-related ICU admissions, reporting a rate of 12.6%[14]. More recently, Bapoj   *et al.* found an incidence of 19%[15]. Garry *et al.*, in a multicenter review, reported an incidence of 27.14%, with only 10% of AEs directly causing ICU admission and 19.6% contributing to it[10]. Vlayen *et al.*, in a systematic review of 27 studies, noted a broad range in incidence (1.1% to 37.2%) and mortality (0% to 58%), with variability often reflecting overall mortality rather than a direct comparison between AE and non-AE groups[11,16].

The increase in the incidence of ICU admissions due to AEs, observed in our study and those of Bapoj   and Garry, is surprising

Table 1. Patient characteristics in different groups.

Patient characteristics	UIA ($n=597$)	AE group ($n=103$)	Non-AE group ($n=494$)	<i>P</i>
Sex				0.832
Male	411 (68.8%)	70 (11.7%)	341 (57.1%)	
Female	186 (31.2%)	33 (5.5%)	153 (25.6%)	
Age, years, median, Q1, Q3	64 (52, 76)	66 (54, 79)	64 (53, 76)	0.447
< 36	52 (8.7%)	13 (12.6%)	39 (7.9%)	0.895
36-59	195 (32.7%)	23 (22.3%)	172 (34.8%)	
60-79	275 (46.1%)	51 (49.5%)	224 (45.3%)	
> 79	75 (12.6%)	16 (15.5%)	59 (11.9%)	
APACHE II, median, Q1, Q3	13 (8, 18)	17 (11, 23)	12 (8, 17)	<0.05
Length of ICU stay, days, median, Q1, Q3	5 (3, 8)	5 (2, 8)	5 (3, 8)	0.374
< 3	77 (12.9%)	22 (21.3%)	55 (11.1%)	<0.35
3-7	349 (58.5%)	52 (50%)	297 (60.1%)	
8-14	100 (16.7%)	18 (17.8%)	82 (16.6%)	
15-30	43 (7.2%)	6 (5.8%)	37 (7.5%)	
> 30	28 (4.7%)	5 (4.9%)	23 (4.7%)	
In-ICU mortality (n, %)				<0.05
No	506 (84.8%)	79 (76.7%)	427 (86.4%)	
Yes	91 (15.2%)	24 (23.3%)	67 (13.6%)	

UIA: unexpected intensive care unit admission; AE: adverse event; APACHE II: acute physiology and chronic health evaluation II; ICU: intensive care unit.

Table 2. Causes, severity and preventability.

Parameters	Number of patients	Preventable (Number of cases)	Non-preventable (Number of cases)
Surgical			
Mild AE	11	7	4
Moderate AE	24	20	4
Severe AE	10	10	0
(In total)	45	37 (82.2%)	8 (17.8%)
Drug therapy			
Mild AE	3	2	1
Moderate AE	9	8	1
Severe AE	1	0	1
(In total)	13	10 (76.9%)	3 (23.1%)
Diagnosis			
Mild AE	2	2	0
Moderate AE	10	9	1
Severe AE	8	7	1
(In total)	20	18 (90.0%)	2 (10.0%)
Medical procedure			
Mild AE	3	2	1
Moderate AE	17	14	3
Severe AE	5	5	0
(In total)	25	21 (84.0%)	4 (16.0%)

AE: Adverse event.

given nearly 40 years of efforts to implement safety systems in healthcare. This rise could be attributed to the increased potency and invasiveness of diagnostic and therapeutic techniques rather than simply the age of patients. In our study, the average age of patients in the AE group was 66 years, similar to the 63 years reported by Garry, compared to 57.9 years in Trunet's study. Bapojé's study reported an average age of 52 years, suggesting that the impact of patient age on AE incidence requires further examination with robust statistical evidence[10,14,15].

The high level of agreement (99.5%) between the two independent clinical reviewers in classifying UIA cases as AE or non-AE is noteworthy and rarely reported in the literature. The kappa index of 0.982 indicates an almost perfect agreement, surpassing the concordance index reported by Haller *et al.* ($\kappa=0.44$)[17]. This high level of agreement lends strong methodological support to our findings, suggesting robustness in the review process that minimizes bias and ensures reliability in AE classification.

The similarity in age between the AE and non-AE groups in our study allows for a comparison that is not often addressed in the literature, where AE patients are typically reported as older[6,18-20]. The median APACHE II score in the overall UIA sample was 13, corresponding to a 15% mortality rate[12]. Indeed, the mortality rate in our study was 15.2%. AE patients had higher APACHE II scores compared to non-AE patients, despite both groups being UIA. Comparing these results with other studies is challenging due to the

great heterogeneity in severity scales reported other than APACHE II.

Regarding in-ICU mortality, there was a higher APACHE II score in the deceased group, as well as increased age compared to the non-deceased group. Mortality in the ICU is influenced by confounding factors such as age, underlying disease, comorbidities, or the reason for hospital admission, suggesting the need for additional studies focused on causality. Nonetheless, the proportion of in-ICU deaths in the AE group was 23.3%, while the non-AE group showed a 10% lower mortality rate. Few studies compare mortality between these patient groups, likely due to the difficulty in proving direct causality, though an AE could be considered a contributing factor. Darchy *et al.* and Lehmann *et al.* found opposite results (13.2% vs. 16.7% and 12.1% vs. 22.4%), with the former also finding a lower incidence of AEs in a larger sample compared to ours[18,19].

Another cornerstone of this study is the analysis of AE preventability. The consensus among reviewers classified 83.5% of AEs requiring UIA as preventable, similar to Garry *et al.*'s findings (77%)[10]. This suggests that more work is needed to improve care processes outside the ICU[21]. Our data also indicate that the severity of an AE is associated with a higher percentage of preventable AEs and, consequently, higher in-ICU mortality. The highest concentration of preventable AEs was found in diagnostic AEs (90% compared to less than 85% in other types of AEs), highlighting the need for improvements in this area. Additionally, the primary type of AE was related to surgical procedures (43.7%), consistent with Dunn *et al.*'s findings (50%)[22].

The study has several limitations. Firstly, the retrospective nature of the study and the potential subjectivity in judging the presence of AEs are methodological limitations. Although we attempted to mitigate bias through review and consensus by two observers, incomplete information in medical records may have led to an underestimation of AEs. Despite this, the retrospective method is the most suitable for assessing preventability[23]. Another limitation of the retrospective approach is the inability to include other variables of interest, some of which are included in other studies, which could have facilitated better comparisons with other samples.

Secondly, while the study includes a large number of UIA cases within the data collection period, extending the study over several years could eliminate potential biases related to seasonality. Additionally, expanding to a multicenter study would allow for broader comparison and sample enlargement. Thirdly, the study focuses on AEs that caused transfers to a higher level of care but overlooks AEs that resulted in in-situ deaths or those that were not admitted to the ICU for various reasons (*e.g.*, therapeutic limitations, lack of notification to expand care, or spontaneous recovery).

AEs have negative consequences for patients, population health, and medical care costs[24]. Our findings regarding the incidence of UIA due to AEs, the impact of AEs on outcomes, and their preventability should raise awareness and drive further national

and international studies aimed at optimizing hospital care and preventing events across all hospitalized patients, implementing measures to prevent the recurrence of such events.

In conclusion, this retrospective record review study, AEs during hospital admission that lead to ICU transfer are frequent, occurring in 17.3% of all UIA cases, and resulting in a lethal outcome in 23.3% of cases. Given that a substantial portion of AEs are preventable (83.5%), efforts and quality improvement programs should focus on interventions aimed at reducing this portion of events.

Conflict of interest statement

The authors report no conflict of interest.

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Data availability statement

The data supporting the findings of this study are available from the corresponding authors upon request.

Authors' contributions

MFC design the study, perform the experimental study as well as data acquisition. The manuscript was wrote by her. SES perform the data analysis and the experimental study. PSC collaborate with the design, literature research and review. ATA collaborate with the design, literature research and review. EEZ collaborate with the design, literature research, review and English language.

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