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# Risk factors for unplanned transfer to the intensive care unit after emergency department admission

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ABSTRACT

*Introduction:* Unplanned Intensive Care Unit (ICU) admission has been used as a surrogate marker of adverse events, and is used by the Australian Council of Healthcare Accreditation as a reportable quality indicator. If we can identify independent variables predicting deterioration which require ICU transfer within 24 h after emergency department (ED) admission, direct ICU admission should be considered. This may improve patient safety and reduce adverse events by appropriate disposition of patients presenting to the ED.
*Objective(s):* The aim of this study was to identify independent variables predicting deterioration which require ICU transfer within 24 h after ED admission.
*Methods:* A case control study was performed to examine characteristics of patients who underwent an unplanned transfer to the ICU within 24 h after ED admission.
*Results:* There were significantly more hypercapnia patients in the ICU admission group ($n = 17$) compared to the non-ICU group ($n = 5$) ($p = 0.028$). There were significantly greater rates of tachypnea in septic patients ($p = 0.022$) and low oxygen saturation for patients with pneumonia ($p = 0.045$). The level of documentation of respiratory rate was poor.
*Conclusions:* In patients presenting to the ED, hypercapnia was a predictor for deterioration which requires ICU transfer within 24 h after ED admission. Additional predicting factors in patients with sepsis or pneumonia were respectively tachypnea and low oxygen saturation. For these patient groups direct ICU admission should be considered to prevent unplanned ICU admission. This data emphasizes the importance of measuring the vital signs, particularly the respiratory rate.



## 1. Introduction

### 1.1. Background

Patients transferred to the intensive care unit (ICU) for critical care management shortly after admission to the general wards, commonly referred to as unanticipated or unplanned ICU admission is a unique and important population of patients who have rapid disease progression and decompensation, new onset illness and, at times, potentially may represent mistriage of patients with unrecognized critical illness [1]. Prior studies demonstrate that unplanned ICU admissions are associated with worse outcomes and increased mortality [2,3]. This unplanned ICU admission has been used as a surrogate marker of adverse events and is used as a reportable quality indicator by the Australian Council of Healthcare Accreditation [4].

Appropriate disposition of patients presenting to the emergency department (ED) is very important and is likely to improve patient safety and reduce adverse events. It is one of the many challenges faced by emergency physicians, in particular determining which patients should be admitted to an ICU. ICUs provide essential but costly care to critically ill patients. While some patients obviously require ICU level of care, i.e. patients who are intubated or have shock requiring vasopressors, others appear stable but warrant ICU admission due to the risk of clinical deterioration [5].

While the identification of patients who are likely to deteriorate early in their hospital course is important, surprisingly little ED-based data exist either describing this population or identifying risk factors for early ward-to-ICU transfer [2]. Some researchers have tried to determine the risk of unplanned ICU transfer after ED admission and have used different pre-existing scoring systems which have been developed for other purposes, i.e. APACHE II, MEWS, SIRS, ESI, PIRO [6].

### 1.2. Objectives

The present study aimed to identify independent variables predicting deterioration which require ICU transfer within 24 h after ED admission. If these factors are present at ED presentation direct ICU admission should be considered.

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## 2. Methods

### 2.1. Study design and patients

A case control study was used to examine the characteristics of an unplanned ICU admission within 24 h after ED presentation. Unplanned ICU admission was defined as an unexpected transfer because of deterioration from the general wards to the ICU for critical care management. The study was performed at the St. Elisabeth Hospital Tilburg in the Netherlands, between January 1, 2013 and December 31, 2015.

The electronic patient record (EPR) selected all patients who presented at the ED and were admitted at the ICU within 24 h. All the medical records in which the emergency physician was involved were reviewed. Patients who were transferred to the ICU within 24 h for postoperative monitoring were excluded, as this is considered as an expected transfer. Patients younger than 16 years of age were also excluded as they would be transferred to another hospital with a pediatric ICU and therefore were lost to follow-up.

The included patients were divided in groups by diagnosis i.e. stroke, epileptic seizures, sepsis, pneumonia, COPD exacerbation, bleeding, peripheral arterial occlusive disease (PAOD) and all other diagnoses. For the 7 main diagnostic groups a comparison group was composed. The EPR selected all patients who presented at the ED between January 1, 2013 and December 31, 2015, were admitted to a general ward because of one of the 7 main diagnoses and were not transferred to the ICU within 24 h. All the medical records in which the emergency physician was involved were reviewed and the data required to compare the groups was extracted. Except for the stroke group, there were a lot more patients in the non-ICU admission group compared to the ICU admission group. To create comparable groups for analysis, for each main group by sampling the number of patients was selected to create an equally large group as the ICU admission group. For the 'stroke' group all patients were used for the non-ICU admission group.

All other diagnoses were excluded for further analysis, because of the large heterogeneity in this group it was impossible to create a comparable non-ICU admission group.

### 2.2. Data and variables

All medical records of the patients were reviewed and selected candidate predictor variables based on prior research [6] and demographic data (gender, age and past medical history) was extracted. The past medical history was scored by the Charlson Comorbidity Index (CCI).

Severity at ED presentation is expressed by the emergency severity index (ESI) which includes the vital signs. Based on the systemic inflammatory response syndrome (SIRS) criteria, respiratory rate, heart rate, white blood cell count and temperature were used [7]. The SIRS criteria and modified early warning score (MEWS) use the same variables but different threshold values. Additionally, the MEWS also includes age, medical history and Glasgow Coma Scale (GCS) [8]. Data used for the acute physiology and chronic health evaluation (APACHE II) score, which is the most widely used ICU mortality prediction score were also extracted. Besides the aforementioned vital signs and age it uses several laboratory test results, i.e. blood acidity (pH), arterial blood level of oxygen ($PaO_2$) and carbon dioxide ($pCO_2$), hematocrit level (Ht), white blood cell count (WBC), creatinine, potassium, sodium.

The first taken vital parameters at ED presentation were taken to get insight into the initial clinical state before resuscitation. Serial vital signs were not well documented so comparison of the first and the last set of vital signs to get insight in the efficacy of the resuscitation was not possible. As in the SIRS criteria, tachypnea was defined as a respiratory rate > 20/min, hypotension was defined as a systolic blood pressure (SBP) < 90 mm Hg, abnormal temperature was defined as a temperature < 36 °C or > 38 °C and a WBC $< 4 * 10^9$ or $> 12 * 10^9$ was abnormal. An oxygen saturation < 90% was defined as low, tachycardia was defined as a heart rate > 100/min and acidosis was defined as a pH < 7,35. In accordance with our local laboratory, hypercapnia was defined as a $pCO_2 > 45$ mm Hg and an elevated lactate was >2.5 mmol/L. Furthermore data was collected to understand the reason for deterioration and transfer to ICU. These reasons were grouped into respiratory failure, hemodynamic instability, medical treatment, neurological observation, metabolic or electrolyte disturbance, allergic reaction and cardiac rhythm observation.

### 2.3. Data analysis

In agreement with the in hospital medical statistician, SPSS was used for data-collection and analysis. Fisher's exact test was used to see whether the proportions of one variable were different. A p-value of <0.05 was defined as statistically significant. Unfortunately, it was not possible to perform analyses within all 7 main diagnoses groups, therefore subanalyses were only performed in the 3 largest groups.

### 2.4. Ethical approval

The Medical Ethical Committee Brabant, the Netherlands, concluded that approval was not required as research involving previously collected, non-identifiable data.

## 3. Results

In total 244 patients were transferred to the ICU within 24 h after ED admission. 77 patients were excluded because they were transferred to the ICU for postoperative monitoring. The remaining 167 patients were included in the ICU admission group and divided into 7 main groups: pneumonia (n = 18), COPD exacerbation (n = 16), stroke (n = 28), epileptic seizures (n = 12), bleeding (n = 10), PAOD (n = 14), sepsis (n = 27) and all other diagnoses (n = 42). After exclusion of the group with all other diagnoses, there were 125 patients brought forward for analysis.

In the non-ICU admission group in total 108 patients were included. Only for stroke the groups differ in the number of patients i.e. 11 patients in the non-ICU admission group compared to 28 patients in the ICU admission group.

For this study there was only access to data of those patients in which the emergency physician was consulted. In our hospital patients with a stroke are primarily seen by a neurologist. The emergency physician is only involved when consulted, for example with trauma screening or airway protection. For this reason there were only 11 patients which could be included in the non-ICU admission group (Fig. 1). Patient characteristics for both groups, ICU admission and non-ICU admission are shown in Table 1.

The reason for transfer to ICU was in most cases respiratory failure (32,0%) followed by hemodynamic instability (28,0%). All patients with epileptic seizure and PAOD were transferred to ICU for intravenous medical treatment (i.e. anticonvulsant drugs or urokinase) which requires monitoring in the ICU because of hemodynamic side effects (Table 2).

The ICU admission group and non-ICU admission group were compared for different variables as shown in Table 3. In the ICU admission group more patients were hypercapnic (n = 17) compared to the non-ICU admission group (n = 5), this difference was statistical significant (p 0,028). There was no statistical difference for other parameters.

When splitting up the groups by diagnosis, the groups became too small to make robust comment on any differences. Though, in the two of the three biggest groups a statistical significant difference was found for tachypnea in septic patients (p 0,022) and a low oxygen saturation for patients with a pneumonia (p = 0,045) (Table 4).

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