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One Fourth of Unplanned Transfers to a Higher Level of Care Are Associated With a Highly Preventable Adverse Event: A Patient Record Review in Six Belgian Hospitals

Kristel Marquet, RN, MSc, PhD student[1]; Neree Claes, MD, PhD, eMBA[1,2]; Elke De Troy, MSc[3]; Gaby Kox, MD[1]; Martijn Droogmans, MSc[1,3]; Ward Schrooten, MD, PhD[1,4]; Frank Weekers, MD, PhD[5]; Annemie Vlayen, MSc, PhD; Marjan Vandersteen, MD, PhD[1]; Arthur Vleugels, MD, PhD[1,6]

Objective: The objectives of this study are to determine the prevalence and preventability of adverse events requiring an unplanned higher level of care, defined as an unplanned transfer to the ICU or an in-hospital medical emergency team intervention, and to assess the type and the level of harm of each adverse event.

Design: A three-stage retrospective review process of screening, record review, and consensus judgment was performed.

Setting: Six Belgian acute hospitals.

Patients: During a 6-month period, all patients with an unplanned need for a higher level of care were selected.

Interventions: The records 6-month period, the records of all patients with an unplanned need for a higher level of care were assessed by a trained clinical team consisting of a research nurse, a physician, and a clinical pharmacist.

Measurements and Main Results: Adverse events were found in 465 of the 830 reviewed patient records (56%). Of these, 215 (46%) were highly preventable. The overall incidence rate of patients being transferred to a higher level of care involving an adverse event was 117.6 (95% CI, 106.9–128.3) per 100,000 patient days at risk, of which 54.4 (95% CI, 47.15–61.65) per 100,000 patient days at risk involving a highly preventable adverse event. This means that 25.9% of all unplanned transfers to a higher level of care were associated with a highly preventable adverse event. The adverse events were mainly associated with drug therapy (25.6%), surgery (23.7%), diagnosis (12.4%), and system issues (12.4%). The level of harm varied from temporary harm (55.7%) to long-term or permanent impairment (19.1%) and death (25.2%). Although the direct causality is often hard to prove, it is reasonable to consider these adverse events as a contributing factor.

Conclusion: Adverse events were found in 56% of the reviewed records, of which almost half were considered highly preventable. This means that one fourth of all unplanned transfers to a higher level of care were associated with a highly preventable adverse event. (*Crit Care Med* 2015; 43:1053–1061)

Key Words: adverse events; intensive care unit; medical emergency team; patient safety; record review; unplanned intensive care admission

[1]Faculty of Medicine and Life Sciences, Hasselt University, Diepenbeek, Belgium.

[2]Antwerp Management School, Health Care Management, Antwerp, Belgium.

[3]Vzw Jessa ziekenhuis, Hasselt, Belgium.

[4]Ziekenhuis Oost Limburg, Genk, Belgium.

[5]Algemeen Ziekenhuis Turnhout, Turnhout, Belgium.

[6]Center for Health Services and Nursing Research, Catholic University Leuven, Belgium.

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For information regarding this article, E-mail: kristel.marquet@uhasselt.be or marquet_kristel@yahoo.com

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Adverse events (AEs) are a world-wide concern for healthcare professionals, policy makers, and patients. An AE is 1) an unintended injury or complication, which results in 2) disability at discharge, death, or prolongation of hospital

stay, and 3) is caused by healthcare management (including omissions) rather than the patient's disease (1). Medical record reviews have shown that 2.9–33.2% of patients in acute hospitals experience one or more AEs (1–15). Several studies (1–3, 14–16) have used the Institute of Healthcare Improvement (IHI) Global Trigger Tool (GTT) to uncover AEs (17). A review on the overall prevalence and nature of in-hospital AEs through record review suggested that AEs affect 9.2% of the patients during hospital admission, of which almost half were assessed as being preventable (18). In Belgium, the occurrence of AEs has never been assessed through record review. However, a retrospective analysis of patient records on adverse drug events (ADE) found 2.5% of the patients having a preventable ADE (19). A retrospective analysis of the national hospital discharge dataset of all Belgian acute hospitals for the year 2000 estimated a prevalence of in-hospital AEs accounting for 7.1% of the medical stays and 6.3% for surgical hospital stays, with a high variability among hospitals (20).

A patient with an AE may require an Unplanned Intensive care Admission (UIA). UIA is a validated clinical quality indicator (21) and is defined as "all patients unexpectedly admitted to the ICU from a lower level of care in the hospital" (22). The indicator was developed by the Australian and New Zealand College of Anaesthetists and the Australian Council on Healthcare Standards and has been recommended as a measure of patient safety (avoidable incidents in anesthesia) and effectiveness of care (lack of planning) (21, 23). Used as a screening tool, it can detect patients who possibly suffered from an avoidable iatrogenic complication (24). Posa et al (25) reported that 1–9% of all ICU admissions were unplanned. These unplanned transfers to ICU prolong hospital stay place additional pressure on ICU resources and increase the cost of hospitalization (26). More importantly, they have a strong impact on the patient and family. In the IHI-GTT, UIA is one of the triggers to uncover AEs (17). The positive predictive value (PPV) of this trigger was estimated at 18.6% (number of AEs/number of selected patients with this trigger) (16). A systematic review concluded that the percentage of surgical and medical AEs requiring ICU admission ranged from 1.1% to 37.2% (27). Furthermore, the preventability of the AEs varied from 17% to 76.5% (27). However, not every critical patient requiring an unplanned transfer to a higher level of care reaches the ICU. Therefore, it is also important to include patients with a medical emergency team (MET) intervention to detect AEs with an unplanned need for a higher level of care.

Although all AEs should be a concern for society, AEs that are preventable and result in serious harm are of particular concern (28). Garry et al (29) reported that 77% of the AEs preceding ICU admission were considered preventable. Layde et al (30) expressed that patient safety efforts should focus on medical injuries and prevention should focus on factors that are modifiable and most likely to bring effective change. Therefore, the objectives of this multicenter study are to determine the prevalence, the preventability, the type, and the level of harm of AEs that require an unplanned transfer to a higher level of care.

METHODOLOGY

A multistage retrospective medical record review study on prevalence and preventability of AEs requiring an unplanned transfer to a higher level of care was performed in one province of Belgium. All seven acute hospitals from the province of Limburg were invited to participate in this study. Six of seven hospitals confirmed their participation, including two teaching hospitals (31). Cardiac surgery, neurosurgery, and hematology are medical specialties which are provided only in the two academic hospitals. In total, these six hospitals account for 2,939 hospitals beds (range, 213–1,003) and 134 ICU beds (range, 8–52) spread over medical, surgical, mixed ICU, and coronary care units. Three hospitals also had a stroke unit; one hospital had a step-down unit.

During a 6-month observation period in each of the participating hospitals, the following cases were reviewed: 1) an unplanned (re)admission to the ICU or 2) an intervention by a MET due to an unanticipated change in the patient's clinical status during the index hospital admission. The index hospital admission is the admission during which the patient meets the inclusion criteria and therefore is sampled in the study. A hospital readmission within 72 hours from the index admission was regarded as the same admission. Planned admissions to the ICU (such as planned postoperative admission after major surgery) and ICU admissions directly from the emergency department were excluded. Because of their specific nature, neonatal and maternal ICUs were excluded.

Sample Size Calculation

Prior to this study, a 2-month pilot study was conducted to test the research protocol, train the clinical team, and obtain an initial estimate of the incidence rate in order to do a sample size calculation. Based on these findings, a sample size of 1,000 patient years or 365,000 patient days at risk would provide a CI of approximately 20% (± 10% around the estimate). As the total yearly number of inpatient days (excluding palliative, neonatal, pediatric, and 1 day-stay admissions) for the six participating hospitals was 760,057 (year 2010), the required sample size corresponds to an inclusion period of 6 months (32). The data obtained in the pilot study were not included in this study.

Data Collection

A three-stage retrospective review process of screening, medical record review, and consensus judgment was used. The review process was deducted from the protocol of the Harvard Medical Practice Study I (3), which was already used by several nationwide studies (1–4, 9, 12, 15, 16). Definitions were adopted from previous AE studies (1, 2, 22, 33, 34) and were described in detail in the research protocol (32) and in **Supplemental Table 1** (Supplemental Digital Content 1, http://links.lww.com/CCM/B208).

In the first stage, all patients who required an unplanned transfer to a higher level of care between November 7, 2011, and May 6, 2012, were selected on the hospital sites by the ICU head nurses or the intensivists. To guarantee a uniform

selection across the hospitals, a half-day training on case selection was organized explaining the standardized selection form, the study protocol, the definitions, and the review forms. The elementary selection process consists of the selection of 1) all MET interventions and 2) UIAs by exclusion of the planned ICU admissions (such as planned postoperative admission after major surgery) and the ICU admissions directly from the emergency department. The UIAs and MET interventions were identified via the ICU or emergency logbook. In case of doubt, the record was forwarded for review in the second stage. There were in total 4,693 exclusions; these were mostly ICU admissions directly from the emergency department (50.9%) and planned admissions to the ICU (41.4%). In order to test the validity of the screening process, 470 excluded patients of the 4,693 excluded patients (a random sample of 10%) were reviewed by the principal investigator. Five percent of these controls ($n = 23$) were considered incorrectly classified and were subsequently included in the study. This degree of misclassification was similar among the hospitals.

In the second stage, a case note for each patient was made by the principal investigator. Patient characteristics (gender, year of birth, type of hospital admission, number of days in hospital prior to ICU transfer, number of prescribed medication before hospital admission, and Acute Physiology and Chronic Health Evaluation II) (35) at the moment of transfer were collected using Open Clinica (36). The anaesthetist estimated the American Society of Anaesthesiologists physical status at the time of the hospital admission (37, 38).

Subsequently, the record review was done to determine whether an AE requiring an unplanned transfer to a higher level of care had occurred. The review was done in the six hospitals by the same, experienced, and independent clinical team consisting of a research nurse (specialized in intensive care, emergency care, and healthcare management), a physician (specialized in anesthesiology and emergency medicine), and a clinical pharmacist. The three members of the clinical team were employed by the university to ensure an independent review process.

The clinical team used the definition of Wilson et al (1) which states that an AE is 1) an unintended injury or complication, which results in 2) disability at discharge, death, or prolongation of hospital stay, and 3) is caused by healthcare management (including omissions) rather than the patient's disease. For each case, the relevance of these three criteria was explicitly written out in the case note and the assessment of causation was done using a scale from 1 to 6 (1, 2, 33). Upon ratings of at least 4 (i.e., > 50% likelihood), unintended injuries or complications were classified as AEs (**Table 1**). It was not the purpose of this study to detect all the AEs in the inpatient records. The team only considered AEs in which there was a clear association with the required higher level of care.

During the third stage of the review, preventability of the detected AEs was assessed using a 6-point scale (Table 1). Based on this scale, preventability was grouped into three categories: no (score 1), low (score 2, 3), and high (score 4–6) preventability (1, 2, 33). Rating preventability is important in understanding the system-specific aspects of healthcare processes in order to design preventive or mitigating barriers (32). Further classification was done by type of AE and the consequences of the events. The AEs were divided into types, such as drug therapy (an AE arising when a correct diagnosis was made, but there was incorrect medication therapy or delay in the medication treatment), surgery (related to a surgical procedure, such as a postoperative bleeding), diagnosis (a delayed or wrong diagnosis), system issues (in relation to problems with hospital processes, such as a nosocomial infection), procedural (in relation to a nonsurgical, medical procedure, such as a dissection during cardiac catheterization), therapeutic, excluding drug therapy, surgery or procedural (an AE arising when a correct diagnosis was made, but there was incorrect therapy or a delay in the treatment), adverse drug reactions (an effect which is noxious and unintended, and which occurs at doses used in man for prophylaxis, diagnosis, or therapy) (39), anesthesia, other clinical management (including nursing care and allied healthcare), and others (e.g., falls) (1, 40). The outcome was assessed as the level of harm at the moment of discharge from the hospital. It was divided into three categories: 1) temporary harm with a complete recovery expected within 12 months, 2) permanent impairment or resulted in permanent institutional or nursing care, and 3) all-cause mortality. Furthermore, the length of stay (LOS) in ICU, a redo or additional surgery, the destination after hospital discharge, and readmissions in the same hospital or death during a follow-up period of 1, 3, and 6 months were registered. Evidently, the outcome is also influenced by the underlying disease and comorbidities and other confounding factors as reason for hospital admission. Therefore, during this retrospective cohort study, the causality between the outcome and the AE was not discussed.

The clinical team referred to evidence-based guidelines to define AE and to assess the preventability. During the whole review process, an expert panel of physicians was available for advice. Records that were found to be incomplete were also included as particularly in these cases, the possibility of containing AEs might be higher (41). In 118 of the patient records (13.6%), some part of the information was missing. Of these, 80 were included as they were considered to contain enough information to be evaluated. However, 38 records (4.4%) were excluded as the research team considered them too incomplete to evaluate.

Ethical Approval and Confidentiality

Ethical approval was received from the Institutional Review Board of Hasselt University and each of the participating hospitals. The study was registered at ClinicalTrial.gov (NCT02044718). Researchers signed a confidentiality agreement with the hospitals, which was approved by the Belgian Privacy Commission (42).

Statistical Analyses

The patient characteristics were expressed as the means ± SD or as number and percentages. Incidence per 100,000 patient days and their 95% CI were calculated. All statistical calculations were performed using Statistical Package for Social Science

TABLE 1. Overview of the Basic Definitions

Adverse event	1) An unintended injury or complication, which results in 2) disability at discharge, death, or prolongation of hospital stay, and 3) is caused by healthcare management (including omissions) rather than the patient's disease (1)
Causation	Refers to injury caused by healthcare management including acts of omission (inactions), ie, failure to diagnose or treat, and acts of commission (affirmative actions), ie, incorrect diagnosis or treatment, or poor performance (12). To determine whether the injury is caused by healthcare management or the disease process, a 6-point scale will be used (1, 2, 33)
	1. (Virtually) no evidence for management causation
	2. Slight to modest evidence of management causation
	3. Management causation not likely (< 50/50, but "close call")
	4. Management causation more likely (> 50/50, but "close call")
	5. Moderate to strong evidence of management causation
	6. (Virtually) certain evidence of management causation
Preventable adverse event	An injury that is caused by medical intervention or management (rather than the disease process) and either prolonged hospital stay or caused disability at discharge, where there was enough information currently available to have avoided the event using currently accepted practices (34). The degree of preventability of the adverse events is measured on a 6-point scale, grouped into three categories (1, 2, 33)
	No preventability
	1. (Virtually) no evidence for preventability
	Low preventability
	2. Slight to modest evidence of preventability
	3. Preventability not likely (< 50/50, but "close call")
	High preventability
	4. Preventability more likely (> 50/50, but "close call")
	5. Moderate to strong evidence of preventability
	6. (Virtually) certain evidence of preventability

Data adapted from Vlayen et al (32).

(SPSS, Chicago, IL), version 20.0, and STATA 10.0 SE (StataCorp LP, College Station, TX).

RESULTS

Patient Characteristics

During the 6-month observation period, 395,338 patient hospitalization days, 5,446 admissions to the ICUs, and 255 MET interventions were registered in the six participating hospitals. Seven hundred fifty-three of the transfers to intensive care (13.8%) were unplanned; 183 of these (24.3%) were readmissions to the ICU. One hundred fifteen patients received a MET intervention without transfer to intensive care. Combined, 868 patients with an unplanned need for higher level of care were included in the record review (**Fig. 1**), of which 515 (59.3%) were included by the two teaching hospitals. Of this initial cohort, 38 records (4.4%) were found too incomplete for the review and were excluded. Therefore, 830 patient records were reviewed. Their demographic and clinical characteristics are shown in **Table 2** and in **Supplement Table 2** (Supplemental Digital Content 2, http://links.lww.com/CCM/B209).

Prevalence of AEs Requiring a Higher Level of Care

One or more AEs were detected in 465 patient records (56% of the reviewed records): 457 patients (98%) had one AE and eight patients (2%) had more than one AE. In total, 473 AEs were found (Fig. 1). In the 6-month measurement period, there were 395,338 patient days (1,083 yr) at risk (all patient days excluding palliative, neonatal, pediatric, and 1 day-stay admissions) in the six participating hospitals. The overall incidence rate of patients transferred to a higher level of care involving an AE(s) was 117.6 (95% CI, 106.9–128.3) per 100,000 patient days at risk. The PPV was 56.0% (95% CI, 52.6–59.4) for unplanned transfer to a higher level of care (465 patients with an AE(s) per 830 UIA and/or MET intervention with a record review). Selecting only the patients with an UIA, the PPV was 57.7% (95% CI, 54.0–61.4) being 415 patients with an AE(s) per 719 UIA with a record review.

Preventability of the AEs

The reviewers considered 215 AEs (46%) to be highly preventable AEs; 209 AEs (44.6%) and 44 AEs (9.4%) were considered low or not preventable, respectively (Fig. 1). This means that 215 of the unplanned transfers (25.9%) to a higher level of care were related to a highly preventable AE. The overall incidence rate of highly preventable AEs requiring a higher level of care was 54.4 (95% CI, 47.15–61.65) per 100,000 patients days at risk.

Type of the AEs

The AEs were mainly associated with drug therapy (n = 134, 25.6%), surgery (n = 124, 23.7%), diagnosis (n = 65, 12.4%), system issues (n = 65, 12.4%), and procedural (n = 49, 9.4%) (**Table 3**). The drug-related AEs were mainly associated with antibiotics and antithrombotic agents.

Outcomes

All the observed AEs required a higher level of care. This has important implications for the patients and their relatives. The severity of the harm, however, varied. A redo or additional surgery was necessary for 110 patients with an AE(s) (23.7%). Overall, 259 AEs (55.7%) resulted in temporary harm with a complete recovery expected within 12 months, while 89 AEs (19.1%) caused long-term or permanent impairment or resulted in permanent institutional or nursing care. The all-cause mortality rate of the patients with an AE was 25.2% (117 of 465 patients). Nevertheless, in the group of patients without the detection of an AE, also 28.7% of the patients died. The majority of these patients had multiple comorbidities and polypharmacy.

In this study, the causality of the mortality was not discussed. However, in the group of patients with an unplanned transfer to higher level of care, 243 died, 98.4% of these deceased patients had no preexisting do-not-resuscitate order; 117 (48.1%) had an AE of which 62 (51.7%) were highly preventable. Therefore, 25.5% of the deceased patients (62 of 243) suffered from a highly preventable AE.

The mean ICU LOS of patients with a highly preventable AE was 6.20 ± 7.3 days and had a median ICU LOS of 3.5 days (Q1–Q3, 2–8 d). The total ICU LOS of patients who had an UIA and a highly preventable AE was 1,166 days (5.64% of the total LOS ICU). Upon discharge, 301 patients with an AE went back to the original home situation (64.7%), and 47 patients (10.1%) required a different type of care than before the admission (transfer to another [university] hospital, rehabilitation center, nursing home). One hundred seventeen patients (25.2%) died during the hospitalization. Within 1, 3, and 6 months, respectively, 68 (19.6%), 105 (30.1%), and 131 (37.6%) of the surviving patients with an AE had a readmission in the same hospital.

DISCUSSION

The overall incidence of AEs requiring an unplanned higher level of care was 117.6 per 100,000 patient days at risk. A higher level of

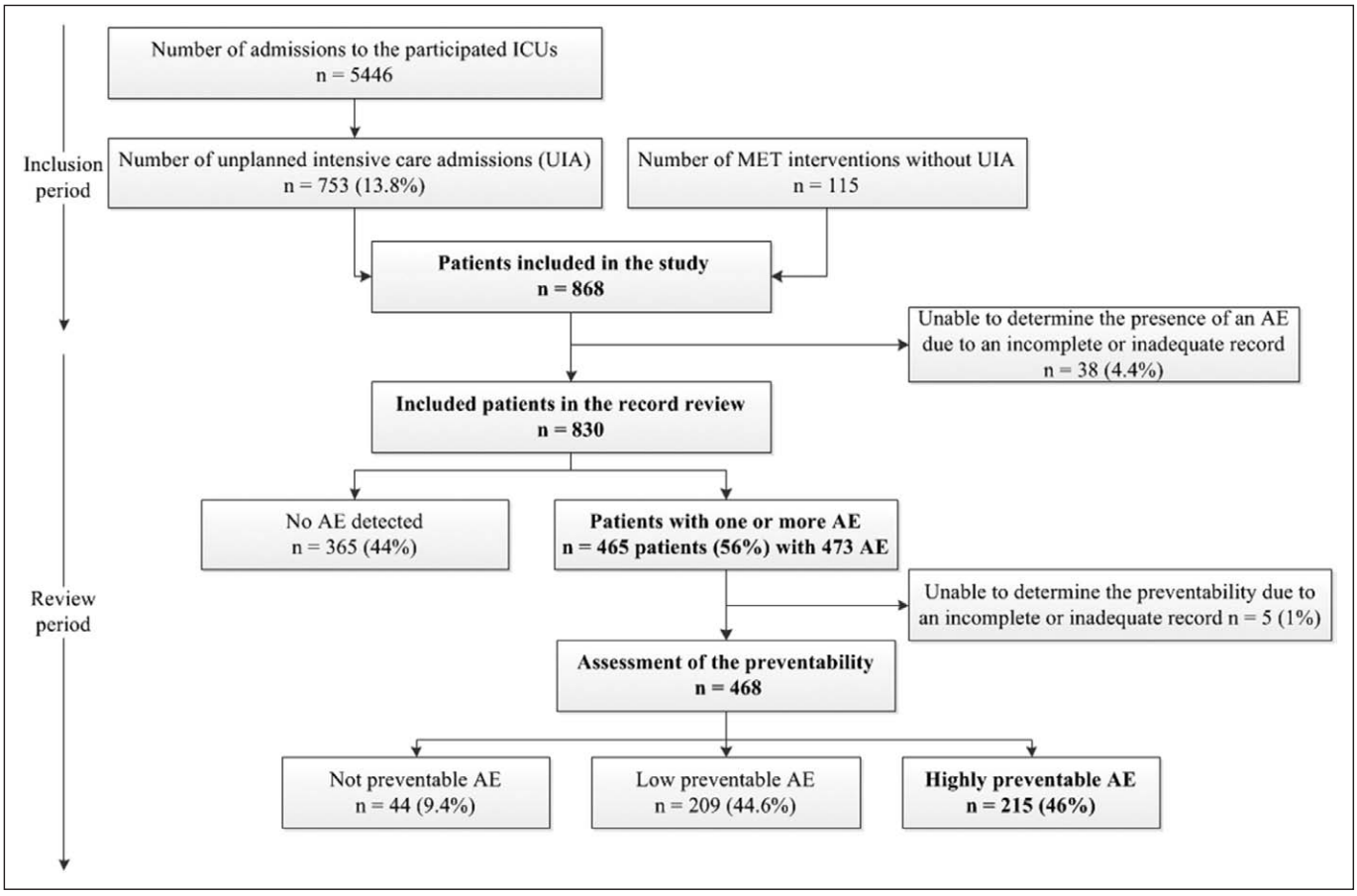

Figure 1. Overview of the inclusion and review process of patients with an unplanned transfer to a higher level of care during a 6-month period. AE = adverse events, MET = medical emergency team.

TABLE 2. Characteristics, Medical History, and Type of Admission of the Included Patients (*n* = 830)

Variable	*n* (%)
Age category	
21–40	45 (5.4)
41–65	218 (26.3)
66–79	328 (39.5)
≥ 80	239 (28.8)
Male	421 (50.7)
Comorbidities: American Society of Anaesthesiologists classification	
I: Normal healthy patient	60 (7.2)
II: Patient with mild systematic disease	171 (20.6)
III: Patient with severe systematic disease	231 (27.8)
IV: Patient with severe systematic disease that is a constant threat to life	368 (44.3)
Activities of daily living functional limitations	545 (65.7)
Previous hospital admission ≤ 3 mo	380 (45.8)
Cognitive impairment	77 (9.3)
Acute Physiology and Chronic Health Evaluation II at ICU admission, mean ± SD	17.8 ± 8.7
Number of medications at admission, mean ± SD	7.4 ± 4.7
Polypharmacy at admission (≥ 5 different prescription medications)	588 (70.8)
Admission to the hospital by emergency department	
Emergency admission	538 (64.8)
Elective admission	233 (28.1)
Admission after consultation	36 (4.3)
Transfer from another hospital	23 (2.8)
Classification based on All Patient Refined Diagnosis Related Group, version 15	
Surgical patient	415 (50.5)
Extreme (class IV) Severity Index	389 (47.4)
Extreme (class IV) Risk of Mortality	360 (43.4)
Top 3 of verified admission diagnosis	
ICD-9-codes 390–459: diseases of the circulatory system	226 (27.7)
ICD-9-codes 460–519: diseases of the respiratory system	120 (14.7)
ICD-9-codes 520–579: diseases of the digestive system	106 (13.0)

ICD-9 = *International Classification of Diseases, 9th Revision.*

care was defined as 1) an unplanned (re)admission to the ICU or 2) an intervention by a MET due to an unanticipated change in the patient's clinical status. In 56% of the patients with an unplanned need for a higher level of care, an AE was found. This study methodology, using unplanned transfer to a higher level of care as a trigger, has a much higher AE detection rate compared with previous record review studies (1–12). The PPV, which reflects the reliability of the screening criteria, was 56% for unplanned transfer to a higher level of care (UIA and MET interventions). Selecting only the patients with an UIA, the PPV was 57.7%. A previous retrospective record review based on the use of 18 screening criteria of the IHI GTT described a PPV for UIA of 18.6% (16). Explanations for the higher proportion can be found in the different methodology. First, in our study, the clinical team consisted of a research nurse, a physician, and a clinical pharmacist and was supported by a panel of experts. In addition, the composition of the team was the same for the six hospitals to ensure a uniform decision process. Based on this multidisciplinary approach, the assessment of the AEs differs from the assessment by one discipline, which is a strength of our methodology. Second, the selection of patients differed. In previous research, the IHI GTT with 18 triggers was used and 648 patients were selected, whereas in our study, only patients based on the trigger "unplanned transfer to a higher level of care" were selected. Therefore, the PPV for UIA of our study is calculated on a much higher sample size. Based on the PPV and the fact that record review is a costly and time-consuming method (43), focusing on unplanned transfer to a higher level of care to detect the most serious AEs is more efficient compared with reviewing random records.

One in four unplanned transfers to a higher level of care was related to a highly preventable AE. A systematic review of retrospective record studies found the proportion of highly preventable AEs in patients with an UIA between 17% and 77%. The wide variation was due to the methodological heterogeneity and clinical diversity due to population mix and the use of different definitions on outcomes. In order to provide full detail on the study methodology, the research protocol of this study was published earlier (32).

Preventing AEs is a complex process with organizational factors, such as safety policy, hospital resources, safety protocols, training, and supervision. The six participating hospitals all had a safety management system with an incident report system with retrospective analysis, evidence-based protocols, regular measurement of safety culture, and training opportunities. The hospitals had electronic patient records to some extent; however, none of them had a hospital-wide electronic patient record that facilitates the exchange of patient information among all caregivers. In the hospitals with electronic drug ordering, there was no decision support system to prevent ADEs. Three hospitals had a stroke unit and only one participating hospital had a step-down unit. These organizational factors most likely have an impact on the results.

The observed AEs were mainly associated with drug therapy (25.6%), surgery (23.7%), diagnosis (12.4%), system issues (12.4%), and procedures (9.4%). The classification of AEs in earlier studies was not uniform, which makes comparison difficult. However, categories such as incorrect (drug) therapy, surgical, procedural, and diagnosis were the main categories in earlier studies on AEs requiring ICU admission (27) and

TABLE 3. Overview of the Types of Adverse Events

AE Classification	AEs, *n* (%)	Highly Preventable AE, *n* (%)
Drug therapy: an AE arising when a correct diagnosis was made, but there was incorrect medication therapy or a delay in the medication treatment (preventable adverse drug events)	134 (25.6)	134 (100)
Surgery: an AE related to a surgical procedure	124 (23.7)	34 (27.6)
Diagnostic: an AE arising from a delayed or wrong diagnosis	65 (12.4)	58 (89.2)
System issue: an AE in relation to problems with hospital processes such as nosocomial infection or equipment malfunction	65 (12.4)	8 (12.3)
Procedural: an AE in relation to a procedure such as insertion of a central venous catheter, nasogastric tube, cardiac catheterization, etc.	49 (9.4)	7 (14.3)
Therapeutic (other than drug therapy/surgery/medical procedure): an AE arising when a correct diagnosis was made but there was incorrect therapy or a delay in the treatment	30 (5.7)	24 (80.0)
Drug/fluid: side effects, allergic reactions, anaphylaxis (adverse drug reactions)	26 (5.0)	0
Anesthesia: an AE related to the given anesthesia	14 (2.7)	4 (28.6)
Other clinical management including nursing care and allied healthcare	10 (1.9)	6 (60.0)
Other (e.g., fall)	6 (1.1)	2 (33.3)

AE = adverse event.

in-hospital AEs (1–4, 12, 44). In our research, the causality between AE and mortality was not specifically investigated. However, 25.5% of the deceased patients had a highly preventable AE. The proportion of deaths in the group of patients with an AE was 25.2%. These observations are consistent with a systematic review (27) on AEs in patients with an UIA with mortality percentages between 0% and 58%. The patients in our study had a mean age of 70. Almost all of them suffered from multiple comorbidities and had polypharmacy. This group of frail patients was found to have high risk of in-hospital AEs resulting in a transfer to a higher level of care. This has an important impact on patient outcome. Furthermore, it puts additional burden on ICU resources and increases the cost of hospitalization. Healthcare professionals have to bear in mind the vulnerability in this group of patients. Specific improvement projects should aim for a better follow-up system for these patients in order to avoid the occurrence of AEs.

Besides the methodological strengths, the study also has limitations. First, there is the lack of an actual gold standard for AE detection (28). Therefore, the judgment of presence of AEs is difficult and always susceptible to subjectivity. A retrospective record review is currently the best method available to assess the prevalence of AEs (29). An important limitation is that the method of medical record review itself might lead to an underestimation of AEs (32). A conservative approach was chosen to detect AEs: if any doubt existed, the event was not classified as an AE. Therefore, the results presented might be an underestimation of the actual figure. Second, the quality of the records was often suboptimal, which could also lead to an underestimation. We tried to prevent both limitations by working with an experienced multidisciplinary team consisting of a research nurse, a physician, and a clinical pharmacist. In addition, there was an expert panel available when necessary. Third, the registration of the MET interventions in the participating hospitals might not have been complete. Fourth, for feasibility purposes, the hospitals of the province of Limburg were selected in this study. The included hospitals can be considered comparable to other hospitals in Belgium. Two of the six hospitals were teaching hospitals. It was not the objective of this study to provide results which can be generalized to all settings worldwide. However, this study can certainly trigger further research in other countries. To create transparency in the methods and improve comparability, we published the study protocol (32).

Our findings on the impact of AEs should create a greater awareness of the occurrence of AEs and should lead to the optimization of healthcare procedures and multidisciplinary care management in order to achieve better prevention. Medical record review and analysis of the (preventable) AEs may trigger important system changes within hospitals. Based on this study, several quality improving interventions, such as Inpatient Anticoagulation Management System with seven key areas (protocols and guidelines, implementation of a trigger tool method, implementation of a new computer order entry system, education of healthcare providers, patient education, care transitions, and outcomes and risk management), early warning systems with Situation Background

Assessment Recommendation communication, and review of in-hospital reanimations have already been implemented in some of the participating hospitals. Further study is planned to assess the costs of care for the patients that were identified in this study. Insights from such study can provide information for healthcare professionals, hospital management, and policy makers on how improvement actions can substantially reduce healthcare costs.

One of the challenges in safety improvement in healthcare is the measurement of AEs. Retrospective record review is one of the methods to measure the prevalence of AEs. As this is a labor intensive and therefore costly method, the use is mostly restricted within the context of a study. This study used the trigger "unplanned transfer to a higher level of care" and estimated the PPV at 56% (95% CI, 52.6–59.4). This means an AE was related to the unplanned transfer to a higher level of care in 56% of the cases. The number of unplanned transfers to a higher level of care itself is relatively easy to measure and could be proposed as a proxy indicator for the number of AEs related to unplanned transfers, at least within similar settings as the hospitals involved in this study. Based on the finding of this study, the number of unplanned transfers to a higher level of care relative to the number of patient days will be proposed as a safety indicator for Belgian hospitals.

CONCLUSIONS

In this retrospective record review study, AEs leading to unplanned transfers to higher level of care are common. One fourth of unplanned transfers are associated to highly preventable AE highlighting the need for dedicated quality improvement programs.

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