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Scale, nature, preventability and causes of adverse events in hospitalised older patients

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Abstract

Objective: to gain insight into the scale, nature, preventability and causes of adverse events in hospitalised older patients.
Design: a three-stage retrospective, structured, medical record review study of 7,917 records of patients admitted in 21 Dutch hospitals in 2004.

Main outcome measures: incidence, preventability, clinical process category, consequences and causes of adverse events in hospitalised patients of 65 years and older, compared with patients younger than 65.
Results: adverse events and preventable adverse events occur significantly more often in older patients [6.9% (95% CI: 5.9–8.0%) and 2.9% (95% CI: 2.3–3.7%), respectively] than in younger patients [4.8% (95% CI: 4.0–5.7%) and 1.8% (95% CI: 1.3–2.4%), respectively]. In older patients, the adverse events were more often related to medication (20.1 versus 9.6%) ($P < 0.01$). An exploration of the causes revealed that the inability to apply existing knowledge to a new and complex situation contributes more often to the occurrence of adverse events in older patients than in younger patients (36.4 versus 24.3%) ($P < 0.05$).
Conclusion: to reduce the number of adverse events in older patients in the future, more particular training of hospital staff in geriatric medicine is required, with a specific focus on medication.

Keywords: *patient safety, older patients, retrospective record review, adverse events, causes*

Introduction

Insight into the occurrence and underlying causes of adverse events (AEs) in hospitalised patients is of great importance to improve patient safety. An AE is defined as an unintended injury among patients that results in disability, death or prolonged hospital stay, and is caused by health-care management [1]. AEs can, for example, be medication related, health-care-inquired-infections, diagnostic and surgical related [2]. In the Netherlands, as in many other countries, a retrospective medical record review study was conducted to establish the national incidence rate for AEs in hospitalised patients [3, 4]. This study showed that an AE occurred in 5.7% of all Dutch hospital admissions, 40% of these AEs were judged as preventable and 12.8% resulted in permanent disability or death [4].

The population in many Western countries is ageing. Consequently, the population of hospitalised patients is ageing as well. Previous research showed that the incidence rate for AEs in older patients is higher than in younger patients [5–9]. However, these studies did not report in detail on the causes of AEs in older patients. Many initiatives in the field of patient safety and hospital care for older patients have been undertaken. More detailed information on causes of AEs in older patients will provide insight into the areas in which improvement can be made. Therefore, the following two research questions will be answered in this paper: What are the differences in scale, nature and preventability of AEs in patients of 65 years and older compared with younger patients? What are the causes that contribute to the occurrence of AEs in patients of 65 years and older and are they different from the causes of AEs in younger patients?

Methods

A structured medical record review study of 7,926 hospital admissions in 2004 was carried out to assess the occurrence of AEs. The selected admissions were sampled in a random, stratified representative sample of 21 of the 101 Dutch hospitals: 4 university, 6 tertiary teaching and 11 general hospitals. In total, 3,943 admissions (>24 h stay) of discharged patients and 3,983 admissions of deceased hospital patients were examined, excluding admissions of psychiatry, obstetrics and children under the age of 1 year. After weighting for the relatively large number of deceased patients and of patients admitted to a university hospital in the sampling frame, the study sample was representative for the patient population in Dutch hospitals [4]. The design and methods of this study were based on previous AE studies in other countries and have been described in detail elsewhere [3]. In this article, we reanalysed the data with a focus on patients of 65 years and older at hospital admission, and compared them to the outcomes in hospitalised patients under 65 years of age.

The nursing, medical and, if available, outpatient record of the sampled admissions were systematically reviewed by 66 trained nurses and 55 trained physicians in a three stage review process between August 2005 and October 2006. In the first stage, all records were screened by a nurse for 18 triggers (clues) that indicate a potential AE, for example an unplanned readmission, unplanned return to the operating room or unexpected death (see Appendix 1 in the Supplementary data available in *Age and Ageing* online). This trigger list was developed for the Harvard Medical Practice Study and further evaluated and validated in other studies [9–15]. The nurse also recorded patient and admission characteristics. The medical records that were positive for one or more of the triggers in stage 1 were independently reviewed by two physicians in the second stage. Based on an extensive, standardised procedure they determined the presence, nature, consequences and degree of preventability of AEs. The determination of an AE was based on three criteria: (i) an unintended physical or mental injury, which (ii) resulted in the prolongation of hospital stay, temporary or permanent disability or death, and was (iii) caused by health-care management rather than the underlying disease [3].

When an AE was present, the physician reviewer judged whether the AE was preventable or not. A *preventable adverse event* is an AE resulting from an error in management due to failure to follow accepted practice at an individual or system level and was measured on a six-point scale. A score of 4 and higher was considered preventable.

Accepted practice was taken to be 'the current level of expected performance for the average practitioner or system that manages the condition in question'. *Potentially preventable hospital deaths* were defined as preventable AEs which contributed to death during hospital admission. If there was disagreement about the presence and/or preventability of an AE between the two physician reviewers, they started a consensus procedure (review stage 3). If they could not reach consensus, a third trained physician reviewer gave the final judgement [3].

After establishing the occurrence of an AE and the preventability, questions were asked about the AE, such as the consequences of the AE and the clinical process category (surgery, medical procedure, medication, other clinical management, diagnostic, discharge and other). The physician reviewers also judged the degree of co-morbidity of the patient that experienced an AE based on their clinical knowledge and the available information in the medical record about the number of co-morbidities and their severity. Finally, based on the information and their judgement of the situation, the reviewers had to select one or more causal factors for each AE. The reviewers had the option to select subcategories within five main causal factor categories [technical, human (health-care provider related), organisational, patient-related and other]. The causal factors are illustrated in more detail in the results section. The causal classification system was derived from a recognised taxonomy of root causes: the Eindhoven Classification Model of PRISMA-medical, a tool for root-cause analysis [16, 17]. All causes indicated by both reviewers were reported, they were counted once if both reviewers selected the same cause [18].

All statistical analyses were performed using SPSS 15.0. Weighted incidence rates of AEs and preventable AEs were calculated with 95% confidence intervals (CIs). These rates were corrected for the overrepresentation of patients admitted to a university hospital and for the overrepresentation of patients who died in hospital. The sample weight was the inverse of the probability of being included in the sample due to the sample design. The weighting factor was not used in the analysis of the causes, because confounding due to the sample design was shown to be absent here [19]. All differences between the older and younger patient group were tested with proportion tests for two independent groups, corrected for binomial distribution and continuity [20]. The difference in median length of hospital stay between older and younger patients was tested with an independent samples median test.

The study had been granted ethical approval by the VU University Medical Center in Amsterdam, The Netherlands.

Results

From the 7,926 reviewed medical records, nine patients were excluded because their age was not registered. Therefore, 7,917 records of hospitalised patients were included in this study: 4,744 records of patients 65 years and older and 3,173 records of patients younger than 65 years. The mean ages were 75.9 (SD = 7.1) years and 42.5 (SD = 17.3) years for the older and younger group, respectively. The median length of stay was significantly longer for the older patient group with 8 days, compared with 4 days for the younger patients ($P < 0.05$). There were more urgent admissions in the older patient group (59.5 versus 49.3%, $P < 0.05$) and older patients were less often admitted to a surgical department (19.4 versus 27.6%, $P < 0.05$) (see Table in Appendix 2 in the Supplementary data available in *Age and Ageing* online).

Among the records of older patients, the reviewers detected 510 AEs in 454 records. For the younger patients, 234 AEs were detected in 209 records (Table 1). After correcting for the sampling frame, the incidence rate of AEs for older patients [6.9% (95% CI: 5.9–8.0%)] was significantly higher than for younger patients [4.8% (95% CI: 4.0–5.7%)] ($P < 0.01$). The incidence rate for preventable AEs was also significantly higher in older patients compared with younger patients, 2.9% (95% CI: 2.3–3.7%) and 1.8% (95% CI: 1.3–2.4%), respectively ($P < 0.01$). The incidence rate of potentially preventable deaths is 0.4% (95% CI: 0.4–0.5%) in the older patient group and 0.1% (95% CI: 0.0–0.1%) in the younger patient group ($P < 0.01$). Table 1 also shows that the percentage of AEs in patients with severe co-morbidity was higher in the older patient group (39.4 versus 25.8%, $P < 0.01$). Extra outpatient care as a consequence of an AE occurred significantly more often in younger patients than in older patients (16.3 versus 24.2%, respectively, $P < 0.05$) and death occurred more often in older patients than in younger patients (12.7 versus 3.5%, respectively, $P < 0.01$).

Table 1. Incidence and characteristics of adverse events by age group

	Patients ≥65 years	Patients <65 years
Number and incidence (%) AEs		
Unweighted no. of patients with AEs	454	209
Incidence AEs (95% CI)[a]	6.9 (5.9–8.0)*	4.8 (4.0–5.7)
Incidence preventable AEs (95% CI)[a]	2.9 (2.3–3.7)*	1.8 (1.3–2.4)
Incidence AEs resulting in potentially preventable death[a] (95% CI)	0.4 (0.4–0.5)*	0.1 (0.0–0.1)
Co-morbidity within AEs		
% of AEs in which the co-morbidity of the patient was judged to be severe[a]	39.4*	25.8
Consequences of AEs: % of AEs in which the consequence occurred		
Intervention/treatment[a]	83.3	86.2
Disability at hospital discharge[a]	25.2	28.9
Prolonged hospital stay[a]	44.9	46.3
Readmission to hospital[a]	25.0	22.3
Extra outpatient care[a]	16.3**	24.2
Death[a]	12.7*	3.5
Other[a]	15.8	16.0

[a]Percentages were weighted for oversampling of deceased patients and of patients admitted to a university hospital.
*Differs significantly between older and younger patients ($P < 0.01$).
**Differs significantly between older and younger patients ($P < 0.05$).

Table 2. Frequency of adverse events over clinical process categories by age group

	Patients ≥65 years		Patients <65 years	
	Distribution of AEs (%)[a] (n = 510)	Of which were preventable (%)[a]	Distribution of AEs (%)[a] (n = 234)	Of which were preventable (%)[a]
Surgery (events, such as infection or accidental tissue damage which are related to an operation or occurring within 30 days after an operation)	44.4*	36.1	65.8	33.8
Medication (events such as side effects, allergic reactions, anaphylaxis)	20.1*	34.5	9.6	22.7
Medical procedure (events related to a medical procedure, e.g. central catheters, endoscopies, pacemakers, intervention radiology)	19.4	26.4	14.2	30.3
Other clinical management[b] (events such as pressure wounds or inadequate wound treatment which are related to nursing care and allied healthcare)	5.9	93.8	1.1	—
Diagnostic (events related to missed, delayed or inappropriate diagnostic procedures)	5.8	100.0	6.8	73.3
Discharge[b] (events such as inappropriate discharge)	2.6	100.0	—	—
Other[b] (other events such as falls)	1.8	60.0	2.5	100
Total	100	42.9	100	36.2

[a]Percentages were weighted for oversampling of deceased patients and of patients admitted to a university hospital.
[b]Statistical tests were not performed due to the small percentage of AEs.
*Differs significantly between older patients and younger patients ($P < 0.01$).

Table 2 shows the distribution of AEs by clinical process for both age groups. The proportion AEs related to surgical procedures was significantly lower in older patients (44.4 versus 65.8%) ($P < 0.01$) compared with younger patients. An example of a preventable surgical AE is a technical inadequate hip prosthesis, resulting in two repositions and reoperation. AEs related to medication were found more often in the older patient group (20.1 versus 9.6%) ($P < 0.01$). An example of a preventable medication-related AE is providing penicillin to a patient with a known penicillin allergy. In older patients, 2.6% of AEs was related to discharge and all were considered preventable.

For 8 of the 744 AEs, no causal factors were selected by either of the reviewers. Consequently, these AEs were excluded from the analyses of the causal factors. Owing to the small number of technical causes, the subcategories within this category were added and presented as a whole.

For the 736 AEs with one or more causal factors, 1,274 specific subcategory causal factors were selected, indicating that for most AEs more than one cause contributed to the AE. Table 3 describes the unweighted numbers and percentages for each specific cause, it shows that the causes of AEs are mainly human for both age groups. Patient-related factors contributed to almost the same proportion of AEs in both age groups. One specific cause occurred more frequently in older patients than in younger patients; human-knowledge-based behaviour (36.4 versus 24.3%) ($P < 0.05$). Two other causal factors that contributed to AEs relatively often in older patients were failure in verification and violations, although the differences between the age groups were not significant. The Table in Appendix 3 (Supplementary data are available in *Age and Ageing* online) describes some examples of AEs, their preventability and causal factors that occurred in the older patient group.

Discussion

This article shows that the rates of AEs and preventable AEs in older hospitalised patients are significantly higher than in younger patients and the consequences are more severe for older patients. Also, it was shown that the percentage of AEs in which the patient had severe comorbidity was higher in older patients. The AEs in older patients were more often related to medication. A previous study showed that the areas with highest risks of medication-related AEs were anti-bacterials, cancer treatment, anti-coagulant treatment and drug therapy in older patients. Also, excess length of stay and costs of preventable medication AEs were significantly higher in older patients [21]. The comparison of causal factors showed that knowledge-based errors contribute more often to the causation of an AE in older patients. An example of such an AE is inadequate care for a patient with dementia and hip fracture; it resulted in urine retention and no antibiotics for urosepsis. Dementia and hip fracture in itself are common, but treatment becomes more difficult when they occur together; warning signals can be more difficult to identify, many medications are used and the patient often has a complex medical history. Professional knowledge often relates to individual diseases rather than multiple simultaneous diseases, and may therefore be insufficient for optimal treatment of many older patients.

Table 3. Causes of adverse events by age group

Causes of AEs: Main category	Subcategory and description	Frequency (%) AEs ≥65 years (n = 506)	Frequency (%) AEs <65 years (n = 230)
Technical	All technical causes: design, construction, materials and external	19 (3.8)	5 (2.2)
Human: knowledge based	Knowledge-based behaviour: the inability of an individual to apply his/her existing knowledge to a novel situation. Example: a trained physician who is unable to solve a complex medical problem	184 (36.4)*	56 (24.3)
Human: rule based	Qualifications: an incorrect fit between an individuals training or education and a particular task. Example: expecting a general technician to solve the same type of difficult problems as a highly specialised technician	21 (4.2)	11 (4.8)
	Coordination: a lack of task coordination within a health-care team in an organisation. Example: an essential task is not being performed because everyone thought that someone else had completed the task	34 (6.7)	14 (6.1)
	Verification: the correct and complete assessment of a situation including related conditions of the patient and materials to be used *before* starting the intervention. Example: failure to correctly identify a patient by checking the wristband	80 (15.8)	25 (10.9)
	Intervention: failures that result from faulty task planning and execution. Example: washing red cells by the same protocols as platelets	59 (11.7)	25 (10.9)
	Monitoring: monitoring a process or patient status. Example: a trained technologist operating an automated instrument but not realising that the instrument is not functioning correctly	69 (13.6)	27 (11.7)
Human: skill based	Slips: failures in performance of highly developed skills. Example: a computer entry error	9 (1.8)	13 (5.7)
	Tripping: failures in whole body movements. These errors are often referred to as 'slipping, tripping, or falling'. Examples: a blood bag slipping out of one's hand and breaking or tripping over a loose tile on the floor	1 (<1)	4 (1.7)
Human	External: human failures originating beyond the control and responsibility of the investigating organisation. This could apply to individuals in another department	3 (<1)	2 (<1)
	Violation: failures by deliberate deviations from rules or procedures	94 (18.6)	32 (13.9)
	Other	31 (6.1)	14 (6.1)
Organisational	Protocols: failures relating to the quality and availability of the protocols within the department (when a protocol is too complicated, inaccurate, unrealistic, absent or poorly presented)	24 (4.7)	8 (3.5)
	Transfer of knowledge: failures resulting from inadequate measures taken to ensure that situational or domain-specific knowledge or information is transferred to all or inexperienced staff	28 (5.5)	17 (7.4)
	Management priorities: internal management decisions in which safety is relegated to an inferior position when faced with conflicting demands or objectives. This is a conflict between production needs and safety. Example: decisions that are made about staffing levels	4 (<1)	3 (1.3)
	Culture: failures resulting from a collective approach and its attendant modes of behaviour to risks in the investigating organisation	22 (4.3)	8 (3.5)
	External: failures at an organisational level beyond the control and responsibility of the investigating organisation, such as in another department	2 (<1)	4 (1.7)
Patient related	Patient related factor: failures related to patient characteristics or conditions, which are beyond the control of staff and influence the treatment. Examples: co-morbidity, communicative skills of patient, treatment compliance	221 (43.7)	101 (43.9)
Other	Other: failures that cannot be classified in any other category—e.g. complication, abstain policy, rare disease	3 (<1)	1 (<1)

*Differs significantly between older and younger patients ($P < 0.05$).

Previous studies that looked at causes of AEs in general hospital populations concluded that these are mainly human, in line with our results [22–24]. But, as far as we know, the comparison of causes of AEs between older and younger patients has not been studied in this detail before.

Medical record review is a sensitive method to detect the occurrence of AEs [25]. In the present study, a large number of medical records were reviewed in a population-based study in 21 hospitals in The Netherlands. The results are therefore representative for the Dutch hospital population and can be extrapolated.

There are, however, some limitations when using medical record reviews. This method relies exclusively on the data available in the record for the detection of an AE; this information may not always be sufficient [26]. This is especially true for the determination of the causes of AEs. The reviewer has to decide in hindsight which causes contributed to the AE based on the information in the record and their own clinical experience and judgement, which will introduce bias. Also, the subcategories of causes may be difficult to identify with medical record review and within different hospitals. In addition, even though human causes are often reported in the medical record, it is likely that organisational and technical causes are underreported. Most hospitals have other systems in which these, often more general problems, can be reported. A possible solution to overcome this lack of information is to combine record review with interviews with clinical staff [27]. Previous studies concluded that preventable AEs are more common among older patients, but also showed that this effect is probably attributable to the complexity of care they need [5, 8]. Our results also imply that the care for this older patient group was more complex than for the younger group; the level of co-morbidity within the AEs, the length of hospital stay and percentage of urgent admissions were higher in older patients. But the contribution of complexity was not reflected in the causation of AEs; patient related factors, which included co-morbidity, did not contribute more often to the causation of an AE in older patients.

Specific training to address the gap in knowledge needed for the treatment of older patients is important to improve safety for this complex patient group. Another improvement strategy could be the standard use of multidisciplinary teams for older hospitalised patients, including geriatricians and specialised nurses [28]. A recent meta-analysis showed that comprehensive geriatric assessment increases patients' likelihood of being alive and in their own homes after an emergency admission to hospital [29]. This team approach has the possibility to improve care for older patients because the focus can be more on the patient as a whole, with sufficient attention for possible co-morbidities that may influence the treatment and medication use.

To conclude, this study shows that a lack of appropriate knowledge about treatment of older hospitalised patients is the main cause of the higher incidence of AEs in older patients. More particular training with a focus on medication and experience in geriatric medicine is needed to prevent future AEs in this population.

Key points

- Adverse events and preventable adverse events occur more often in hospitalised patients of 65 years and older.
- The consequences of adverse events in older patients are more often severe and adverse events are more often related to medication.
- The inability to apply existing knowledge to a new and complex medical problem is more often the cause of an adverse event in older hospitalised patients.
- More training and education on the needs and requirements for the treatment of older hospitalised patients is needed.

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Conflicts of interest

None declared.

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Ethics approval

The project and methods had been granted ethical approval by the VU University Medical Center in Amsterdam, The Netherlands.

Supplementary data

Supplementary data mentioned in the text is available to subscribers in *Age and Ageing* online.

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