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Preventable emergency admissions of older adults: an observational mixed-method study of rates, associative factors and underlying causes in two Dutch hospitals

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ABSTRACT

Objective Older adults are hospitalised from the emergency department (ED) without potentially needing hospital care. Knowledge about rates, associative factors and causes of these preventable emergency admissions (PEAs) is limited. This study aimed to determine the rates, associative factors and causes for PEAs of older adults.

Design A mixed-method observational study.

Setting The EDs of two Dutch hospitals.

Participants 492 patients aged >70 years and hospitalised from the ED.

Measurements Quantitative data were retrospectively extracted from the electronical medical record over a 1-month period. Admissions were classified (non) preventable based on a standardised approach. Univariate and multivariate multilevel logistic regression analyses were performed to identify possible associations between PEAs and demographic, clinical and care process factors. Qualitative data were prospectively collected by email and telephone interviews and analysed thematically to explore hospital physician's perceived causes for the identified PEAs.

Results Of the 492 included cases, 86 (17.5%) were classified as PEA. Patients with a higher age (adjusted OR 1.04, 95% CI 1.01 to 1.08; p=0.04), a low urgency classification (adjusted OR 1.89, 95% CI 1.14 to 3.15; p=0.01), and attending the ED in the weekend (adjusted OR 2.02, 95% CI 1.22 to 3.37; p<0.01) were associated with an increased likelihood of a PEA. 49 physicians were interviewed by telephone and email. Perceived causes for PEAs were related to patient's attitudes (eg, postponement of medical care at home), provider's attitudes (eg, deciding for admission after family pressure), health system deficiencies (eg, limited access to community services during out-of-hours and delayed access to inpatient diagnostic resources) and poor communication between primary care and hospital professionals about patient treatment preferences.

Conclusions Our findings contribute to existing evidence that many emergency admissions of older adults are preventable, thereby indicating a possible source of unnecessary expensive, and potentially harmful, hospital care.

Strengths and limitations of this study

- ► To our knowledge, this is the first study that assessed preventable emergency admission (PEA) rates, associated factors and physician's perceived causes at the individual older patient level.
- ► Findings show that many causes for PEAs of older adults exist at various levels (ie, patient, provider, emergency department, hospital, primary care and hospital–primary care interface), and that many causes are amendable for policy or managerial intervention.
- ► The factors associated with PEAs may be biased by the omission of confounding variables that were not included in our regression analyses.
- ► Including patient and community caregiver perspectives would have contributed to a more comprehensive and reliable understanding of causes for PEAs.

INTRODUCTION

Demographic changes have led to a worldwide increase of older adults attending the emergency department (ED) and subsequent hospitalisations.[1–4] The rise of hospital admissions after visiting the ED can be explained by the growing population of older adults requiring more frequent acute hospital care via the ED as the most common entry point to healthcare.[1 2] However, it also raises concerns about whether all admissions of older adults from the ED (ie, emergency admissions) are necessary or could have been prevented.

Preventable emergency admissions (PEAs) are those considered to be preventable or avoidable through timely and effective primary care or outpatient care.[5–7] PEAs

are often estimated by the measurement of admissions caused by ambulatory care-sensitive conditions (ACSCs).[8] Current literature suggests that the number of PEAs are substantial,[9 10] even though they may be overestimated because of insensitive measurements.[10 11] Preventable hospitalisation rates are especially high among frail older adults.[12–14] These patients often attend the ED with atypical signs and multimorbidity which complicate clinical decision-making and the physician's decision to admit the patient or not.[15] Apart from service provision in a resource-limited health system and high costs that could have been prevented,[16–18] PEAs can also be harmful. Especially older adults are at a high risk for loss of ADL function and facing complications—after or during hospitalisation—such as delirium, malnutrition, dehydration, infections and falling.[19–22] Reducing preventable admissions has therefore been a focus of policy-makers, commissioners and service providers for many years.

Despite awareness for the need to reduce PEAs of older adults,[4 12 14 21] insight lacks into the factors that help us predict and understand these admissions to happen. So far, research has mainly focused on finding possible associations between hospital admissions for ACSCs and sociodemographic (ie, deprivation, rurality, race), health system (ie, insurance coverage, access to services) and epidemiological (ie, prevalence of health problems and diseases) data in retrospective study designs at the regional or national level.[5 6 14 23–28] No studies have searched directly for risk factors or underlying causes for PEAs at the individual level of the older patient. By examining the social and clinical history of individual cases, and by exploring the clinical decision-making at the ED, we may be better able to identify PEAs of older adults. Moreover, we may better understand its associative factors and underlying causes, which may be amenable to policy or managerial intervention. The perspective of physicians involved in the decision-making process is thereby valuable input for understanding the context in which PEAs occur apart from the use of objective quantitative measures.[29 30]

Therefore, the aims of this study were to: (1) determine the prevalence of PEAs of older adults in two EDs, (2) to identify factors associated with PEAs and (3) to explore physicians' perceived causes of PEAs.

METHODS

Design

We performed a mixed methods observational study in two different EDs. We used quantitative data to determine the rates of PEAs and to identify associative factors, and qualitative data to explore possible causes for the identified PEAs.

Setting

The study was performed in the EDs of two hospitals in the urban region of Nijmegen in the middle-east of the Netherlands (online supplementary file 1). The Radboud University Medical Center (Radboudumc) is a Dutch level 1 trauma centre with an annual census of 22 000 ED visits, of which 26% are older adults. The Canisius-Wilhelmina (CWZ) hospital is a large regional hospital with an annual census of 27 000 visits, of which 27% are older adults. Together, both EDs cover the prehospital emergency care in the Nijmegen region (approximately 350 000 inhabitants). Both EDs are staffed by emergency medicine (EM) physicians and residents. They have admission privileges and usually discuss potential admissions with physicians on duty from other inpatient specialties. The EM physicians of both EDs are employed by the hospital and therefore have no financial gain in admitting patients.

Data collection

Study sample and sampling

For the period of 1 month (July and November 2018, respectively), patients were sampled consecutively in order of appearance. Patients were eligible if they: were aged 70 years or older and hospitalised from the ED. Patients with a high energetic trauma, admitted to the intensive care unit or transferred to another hospital were excluded from the study. Eligible candidates unwilling to participate in scientific research (expressed by a note in their medical chart) were excluded from the study as well. Patients attending the ED after being previously included were subsequently included as a new case. At both sites, residents with work experience in the ED (MV and SvdB) retrospectively extracted data on patient demographics, clinical factors and care process factors (see table 1 for all variables) from predefined information fields and notes made by physicians and nurses in the electronical medical record (EMR). Based on previous publications[2 4–6 29 30] and our own professional experiences at the ED, we assumed that these factors may be associated with the professional's decision to admit a patient. ED referral was dichotomised into 'self' and 'by physician or ambulance'. Marital status was dichotomized into 'single' and 'partner/spouse'. Polypharmacy was dichotomised into less than and five or more different medicines.[31] We used the Charlson Comorbidity Index[32] to determine the comorbidity level. We dichotomised ED arrival time into office hours (06:01 to 18:00) and out-of-office hours (18:01 to 06:00), and day of ED attendance into weekdays and weekend (ie, Friday 18:01 to Sunday 12:00)). The urgency triage level was dichotomised into 'low urgency' (U3–U5) and 'high urgency' (U1–U2) based on the urgency classification levels of the Netherlands Triage System (NTS).[33]

Assessment of emergency admissions

At both study sites, two residents (MV, NH, SvdB, LvW) reviewed the clinical and process reports in the EMR of the included cases, and independently classified each admission as: 'preventable' or 'not preventable'. Admissions were considered preventable if at the time of admission: (1) no somatic causes were identified for the patient's initial problem, (2) no

Table 1 Characteristics of included cases

Characteristics	Total (n=492)
Age, mean years (SD)	79.1 (6.7)
Sex	
Male, n (%)	230 (46.7)
Female, n (%)	262 (53.3)
ED referral	
By physician or ambulance, n (%)	349 (70.9)
By patient self, n (%)	143 (29.1)
Urgency classification	
High urgency*, n (%)	253 (51.4)
Low urgency†, n (%)	237 (48.2)
Unknown, n (%)	2 (0.4)
Time of ED arrival	
Office hours‡, n (%)	324 (65.9)
Out of hours§, n (%)	168 (34.1)
ED attendance	
Weekdays, n (%)	361 (73.4)
Weekend¶, n (%)	131 (26.6)
Polypharmacy**	
No, n (%)	106 (21.5)
Yes, n (%)	386 (78.5)
CCI, mean (SD)	5.96 (2.2)
ED length of stay, mean minutes (SD)	223.5 (96.8)
Marital status	
Partner/spouse, n (%)	228 (46.3)
Single, n (%)	196 (39.8)
Unknown, n (%)	68 (13.8)
Informal care at home, (%)	
No, n (%)	280 (56.9)
Yes, n (%)	212 (43.1)
Specialties involved in the ED, (%)	
1, n (%)	378 (76.8)
>1, n (%)	114 (23.2)

*Based on the urgency levels 1 (life threatening) and 2 (emergent) of the Netherlands Triage System (NTS).
†Based on the urgency levels 3 (urgent), 4 (non-urgent) and 5 (advice) of the NTS.
‡Between 06:01 and 18:00.
§Between 18:01 and 06:00.
¶Between Friday 18:01 and Sunday 12:00.
**≥5 different types of medicines.
CCI, Charlson Comorbidity Index; ED, emergency department.

therapeutic or diagnostic interventions were planned for the patient's initial problem except from diagnostics normally conducted at the ED or (3) the patient's initial problem could have been prevented or avoided by timely recognition of needs and provision of care prior to admission. These three assessment criteria are derived from previous publications defining the concept of a preventable admission.[2 5 10 11] Individual assessments were compared by researchers and in any case of disagreement, a third researcher (ie, an experienced geriatrician) was consulted.

Identification of physicians' perceived causes for PEAs

For each identified PEA, MV and SvdB approached the physician responsible for the admission (eg, the resident or specialist) within 1–3 days after admission. A standardised set of open questions was used to identify perceived causes for admission: (1) What was the most important reason to admit this patient? (2) Could the patient have been send home safely/could hospitalisation have been prevented or avoided? (3) If so, what was needed to discharge the patient safely from the ED? Physicians were first approached and asked to answer the questions via email. Non-responders were subsequently contacted by telephone. Notes were made of the telephone conversations and relevant quotes were transcribed verbatim.

Data analysis

Descriptive analyses were performed to describe our study sample. Inter-rater reliability (Cohen's kappa) scores were calculated for the identified PEAs per study site. Because of the hierarchical structure of our study with patients nested within hospitals, we performed multilevel (mixed model) analyses. In this analyses, we take account of the variability associated with each level of nesting. We used a model with a random intercept and fixed parameters for all other variables. Multilevel univariate logistic regression analyses were performed to identify possible associations between PEAs and sociodemographic, clinical and care process factors. Fueled by previous literature questioning the validity of our third PEA assessment criterion,[34 35] we also performed similar analyses to identify associative factors for emergency admissions that were classified as preventable based on criterion one or two. Factors with a significance of $p \leq 0.20$ in the univariate regression analyses were then entered into a multilevel multivariate analysis. We then performed multivariate logistic regression with stepwise backward elimination. A p value of <0.05 was considered to be statistically significant, based on two sided tests.

Physician's answers to the open questions (ie, email content, interview notes and verbatim quotes) were analysed according to the principles of thematic content analysis.[36] At both study sites, relevant text fragments were coded. Codes were then grouped into conceptual (sub)themes on perceived causes. After multiple iterative rounds and reaching data saturation, researchers first identified (sub)themes per study site. Finally, overarching (sub)themes across both sites were identified.

Patient and public involvement

There were no patients involved in the design of this study

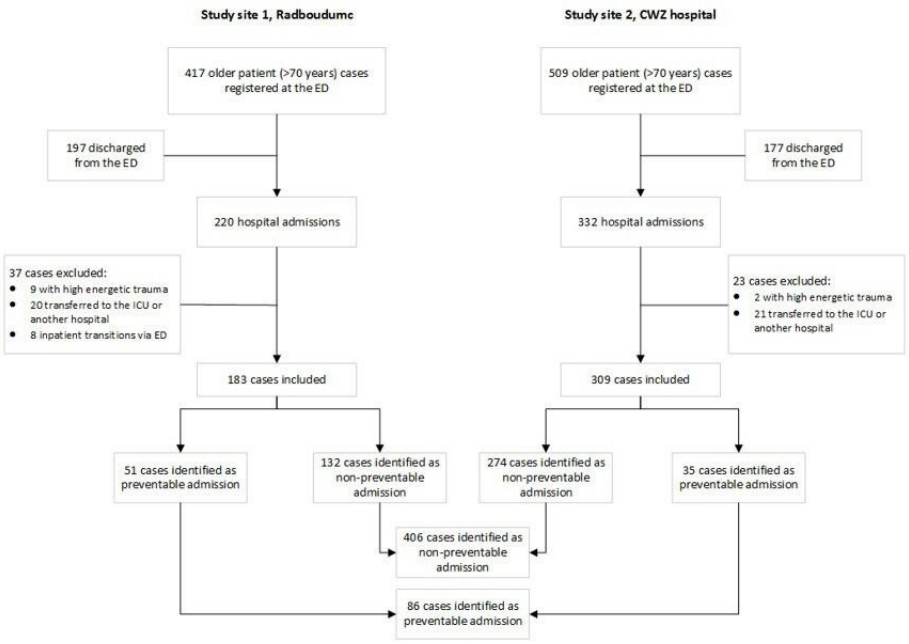

Figure 1 Flow chart of the study sample selection process. ED, emergency department; ICU, intensive care unit.

RESULTS

Study sample

In total 492 cases were included in the study: 183 in the Radboudumc and 309 in the CWZ hospital. A relatively small proportion of the cases, 4% and 5%, respectively, consisted of patients who visited the ED twice. Overall, 60 cases were excluded from the study due to various reasons (figure 1). Sample characteristics are described in table 1.

Prevalence of and associative factors for PEAs

Prevalence

Overall, 86 (17.5%) of the emergency admissions of older adults were identified as preventable (table 2). Most emergency admissions were identified as preventable, because the patient's initial problem could have been prevented or avoided by timely recognition of needs and provision of care prior to admission (criterion 3), and because no therapeutic or diagnostic intervention took place during hospitalisation (criterion 2). Inter-rater agreement of identified PEAs was moderate with a kappa of 0.5 at both study sites.

Associative factors

Univariate regression analysis showed that patients with a higher age (OR 1.04, 95% CI 1.01 to 1.08; p=0.02) and a low urgency classification (OR 1.78, 95% CI 1.08 to 2.92; p=0.02) were significantly associated with an increased likelihood of experiencing a PEA (table 3). Attending the ED in the weekend (OR 1.89, 95% CI 1.15 to 3.11; p=0.01) and being single (OR 1.70, 95% CI 1.02 to 2.83; p=0.04) were also significantly associated with an increased likelihood of a PEA. The multivariate regression found three associative factor for PEAs: patients with higher age (adjusted OR 1.04, 95% CI 1.01 to 1.08; p=0.04), patients with a low urgency classification (adjusted OR 1.89, 95% CI 1.14 to 3.15; p=0.01), and patients attending the ED in the weekend (adjusted OR 2.02, 95% CI 1.22 to 3.37; p<0.01). Except for a low urgency classification, the same associative factors were found for the admissions classified as preventable only on the basis of assessment criterion one or two: patients with a higher age (adjusted OR 1.04, 95% CI 1.01 to 1.08; p=0.02) and patients attending the ED in the weekend (adjusted OR 1.86, 95% CI 1.13 to 3.07; p=0.02; supplement 2).

Table 2 Proportion of preventable emergency admissions (n=86) per definition criteria

Criterion	N (%)
1. No somatic causes	8 (9.3)
2. No diagnostic or therapeutic interventions	26 (30.2)
3. No timely recognition of needs and care provision	52 (60.5)

Perceived causes for PEAs

Forty-nine physicians—varying in gender, specialty, function and professional experience (online supplementary file 3)—were interviewed for one or multiple admission cases. In total, 86 unique PEA cases were discussed. Perceived causes for PEAs were categorised into six themes: (1) patient self-management, (2) decision for admission based on patient's social context and moral grounds (ie, what is right and wrong to do), (3) poor anticipation to health problems by professionals in the outpatient setting, (4) delayed access to diagnostic resources in the hospital, (5) limited access to community care resources out of hours, and (6) lack of patient-specific information at the ED.

Table 3 Univariate and multivariate logistic regression analysis of variables associated with preventable emergency admissions

Independent variable	Preventable admissions	Non-preventable admission	Univariate analysis		Multivariate analysis	
			OR (95% CI)	P value	OR (95% CI)	P value
Age, mean years (SD)	80.2 (6.7)	78.9 (6.7)	1.04 (1.01 to 1.08)	0.02	1.04 (1.00 to 1.08)	0.04
Sex (%)				0.04		
Male (ref)	13.9	86.1	1			
Female	20.6	79.4	1.69 (1.04 to 2.77)			
ED referral (%)						
By physician or ambulance	16.0	79.0	1	0.24		
By patient self	21.0	84.0	1.35 (0.81 to 2.24)			
Urgency, (%)				0.02		
High urgency* (ref)	15.3	84.7	1		1	
Low urgency†	19.9	80.1	1.78 (1.08 to 2.92)		1.89 (1.14 to 3.15)	0.01
Time of arrival, (%)				0.78		
Office hours‡ (ref)	17.6	82.4	1			
Out of hours§	17.3	82.7	0.93 (0.56 to 1.54)			
Day of arrival, (%)				0.01		
Weekdays (ref)	14.4	85.6	1		1	
Weekend¶	25.5	74.5	1.89 (1.15 to 3.11)		2.02 (1.22 to 3.37)	<0.01
Polypharmacy**, (%)				0.25		
No (ref)	14.2	85.8	1			
Yes	18.4	81.6	1.43 (0.77 to 2.66)			
CCI, mean (SD)	5.93 (1.8)	5.97(2.2)	0.99 (0.89 to 1.11)	0.89		
ED length of stay, mean minutes (SD)	243.6 (95.0)	219.2 (96.7)	1.00 (1.00 to 1.00)	0.32		
Marital status, (%)				0.04		
Partner/spouse (ref)	15.0	85.0	1			
Single	22.2	77.8	1.70 (1.02 to 2.83)			
Informal care at home, (%)				0.24		
No (ref)	11.8	88.2	1			
Yes	25.0	75.0	1.47 (0.77 to 2.79)			
Specialties involved at the ED, (%)				0.13		
1 (ref)	15.9	84.1	1			
>1	22.8	77.2	1.51 (0.89 to 2.56)			

*Based on the urgency levels 1 (life threatening) and 2 (emergent) of the Netherlands Triage System (NTS).
†Based on the urgency levels 3 (Urgent), 4 (Non-urgent) and 5 (Advice) of the NTS.
‡Between 06:01 and 18:00.
§Between 18:01 and 06:00.
¶Between Friday 18:01 and Sunday 12:00.
**Five different types of medicines.
CCI, Charlson Comorbidity Index; ED, emergency department.

Theme 1: patient self-management

Many of the treating physicians argued that patients who were discharged from the hospital often lacked important information about regulating their disease and managing their life-style at home. According to the physicians, admissions from the ED could have been avoided if patients were better instructed at discharge on self-care tasks.

Physicians also mentioned that several PEAs were rooted in the patient's late request for medical help or care support at home. Patients postpone their visit to their general practitioner (GP) and the GP out of hours

service until hospitalisation is unavoidable. These admissions could have been avoided if the initial problem was addressed earlier.

> If this patient [suffering from progressive dyspnoea due to decompensated heart failure] had visited his GP or called our outpatient clinic, we could have made timely alterations in his medication and prevent the admission.—Cardiologist, CWZ hospital

Theme 2: decision for admission based on patient's social context and moral grounds

Physicians felt that they were sometimes persuaded by the explicit wish or pressure from patients and relatives to admit the patient from the ED while admission was not needed from a medical point of view.

> There was an explicit wish of the patient [with suspected hemoptysis and abdominal pain] and her relatives to observe her health condition overnight and to perform more diagnostics via a thoracic CT. The patient could have been discharged from the ED to home if she and her relatives hadn't had this wish.—Pulmonologist, Radboudumc

It also occurred that physicians chose for admission based on moral grounds. Empathy with the personal situation of patients and relatives (eg, lack of transport to home, and stress about managing self-care and home support), and with patients attending the ED in the evening and at night made them decide to admit patients, even if there was no medical need.

Theme 3: poor anticipation to health problems by professionals in the outpatient setting

According to several physicians, the admissions of patients attending the ED with acute chronic health problems (eg, chronic anaemia) could have been prevented if deteriorations and exacerbations were recognised in time by providers in the community and treated in outpatient day-care settings (eg, blood transfusions for patients with chronic anaemia).

> The patient suffered from chronic anaemia, which was progressive over time. More timely recognition or more frequent monitoring could have prevented the symptomatic anaemia for which this patient was admitted.—Internist, CWZ hospital.

Theme 4: delayed access to diagnostic resources in the hospital

The delayed access to diagnostics and imaging resources, such as performing a CT angiography, also triggered several physicians from both hospitals to admit patients from the ED. These situations occurred especially during evening hours. Patients were then hospitalised in anticipation of further diagnostics on the next day, while the overnight hospital stay was not needed from the physician's medical point of view.

> We are often confronted with cases where we don't seriously suspect a pulmonary embolism, but we do see an elevated d-dimer and therefore need to scan these patients. If this cannot be done in the evening hours, patients are admitted to receive scans the next day. ED physician and resident Pulmonology, CWZ hospital

Theme 5: limited access to community care resources out of hours

Physicians experienced difficulties with arranging timely and adequate follow-up (eg, rehabilitation care, home care, nursing home care) during out of hours. During these hours, they are often confronted with a limited number of available beds and professional support in the community. Physicians also mentioned having limited access to counterpart colleagues in the community during out of hours to discuss options for care support at home and to coordinate follow-up. As a result, they were more hesitant to discharge patients from the ED during these hours.

> A lot of extra home care, revalidation or even nursing home care can be arranged during office hours. On the contrary, these options are severely limited in the evening and night.—Emergency Physician, CWZ hospital

Theme 6: lack of patient-specific information at the ED

Poor information about the living conditions and the available support at home hindered physicians at the ED in determining whether or not the patient could return to home. This lack of information often made them choose for the 'safest' option and admit the patient. Especially inexperienced residents were more inclined to admit patients in such situations.

> Because of absence of family or friends at the ED or because of limited available time to investigate the patient's home situation, we cannot determine if the patient can return to home safely. (…) Such cases definitely result into admissions.—Internist, CWZ hospital

Physicians expressed that emergency admissions, particularly during out of hours, could have been avoided if preferences and wishes of terminally ill and frail older patients regarding hospital treatment and end-of-life care would have been formalised and accessible at the ED.

DISCUSSION

To our knowledge, this is the first study that assessed PEA rates, investigated factors associated with PEAs and explored physician perceived causes of PEAs at the individual older patient level. Overall, nearly one in five emergency admissions was classified as preventable. For nearly 1 in 10 cases, no somatic cause was found or medical interventions were performed during the time of admission. This corresponds with similar proportions of

PEAs found in previous studies.[10 29] We found significant associations between PEAs and demographic, clinical and care process factors, which have not been identified as objective indicators for PEAs among older adults before. In contrast to previous studies,[29 37] higher age of older patients, a low urgency classification and ED attendance in the weekend was associated with an increased likelihood of a PEA after adjusting for confounding factors. We assume that a higher age, and an increased chance of comorbidities and atypical symptoms, may complicate the physician's clinical assessment,[15] and make decisions to admit the patient possibly more sensitive for error. As older age is significantly associated with more emergency admissions we know that physicians often need to make such decisions.[38] Previous studies showed that the mode (ie, ED attendance resulting from the lack of continuity with primary care physicians) and time of ED arrival are associated with an increased risk of admission.[39–46] However, no studies have identified these characteristics as risk factors for PEAs of older adults before.

The context that hospital physicians described at the individual patient-level provided valuable in-depth insight into the causes for PEAs which cannot be retrieved by database or survey research. Most of our quantitative findings are supported and further explained by the qualitative findings. For example, the lack of caregiver support and community resources needed to maintain patients at home, and the limited access to community care resources during out of office hours were often described as important causes for admitting the older patient. While these are well-known causes for preventable admissions,[2 11 15 30 47] other causes found in this study have not been described before (ie, pressure by relatives to admit the patient during ED attendance) or were only described in a limited number of studies with little evidence (ie, postponement of medical care or support at home,[48] delayed access to inpatient diagnostic resources or services,[30] and poor communication about treatment preferences of terminally ill and frail older patients at the primary care and hospital care interface.[49 50] These findings complement existing literature describing other potential causes for PEAs, such as: work pressure, lack of professional experience, the pressure of not exceeding ED waiting targets and limited access to community care liaisons.[29 30] Findings also show that causes for PEAs of older adults exist at various levels (ie, patient, provider, ED, hospital, primary care and hospital–primary care interface)[29 30] and that many causes are manageable by policy-makers and providers.

Our study had several limitations. First, the relatively small sample size from two different types of EDs within one Dutch region limits the generalisability of our findings. Although this was a limiting factor, we deliberately chose to use research time and capacity to perform a multi-method in-depth inquiry. This allowed us to capture case experiences, understand underlying causes for PEAs, cross-check quantitative and qualitative data and increase the trustworthiness of our findings.[51 52] Moreover, the estimation of PEAs was fairly accurate with only a margin of error of 3%. Second, findings on associative factors may be biased by the omission of relevant confounding variables that were unknown to us or because variable data were inaccessible (eg, social status) or difficult to retrieve. For example, we did not collect data on several variables related to ED crowding (eg, bed occupancy) and time pressure (eg, ED waiting time), while these variables are considered potentially important risk factors for PEAs.[29 30] Third, data were collected during specific season periods (eg, summer and fall). The number of admissions in this study may be underestimated as admission rates are generally higher in the winter. Fourth, classifications of PEAs were based on reviewer's judgements using case-specific information. This subjective approach introduces risk of individual bias, which may be reflected in the moderate inter-rater agreement scores and the 16.6% rate difference of PEA between study sites. In addition, reviewers were aware of the study purpose and may have been biased in terms of perceiving a need to reduce PEAs. This may have affected the found PEA rates. However, in the absence of validated protocols to identify PEAs,[50 53] a consensus-based judgement of individual cases by multiple reviewers with a clinical background was considered most appropriate to classify the admissions. Fifth, reviewers were emergency residents. Other (experienced) clinical perspectives therefore may have been under-represented in the classification process. Sixth, although derived from previous operationalisations, our definition of a PEA was not validated. Classifying admissions as preventable or avoidable remains subject of constant debate as there is no uniform and validated definition to directly identify such admissions.[5 8 53] The PEA rates found in this study may therefore be difficult to compare with rates found in other studies. Seventh, physicians' perceptions were collected in a consecutive order. Physicians were not purposively sampled on characteristics that could impact the risk of a PEA (eg, medical specialty, seniority and working experience) and these may therefore have been unremarked.[29 30] Lastly, including the perspectives of community care providers and patients themselves could also have contributed to a better understanding and trustworthiness of our findings. Via patients and community care providers (eg, the GP), we could have learnt much more about the added value or adverse consequences of the admission apart from whether or not is was preventable from a clinical perspective. Future studies investigating the magnitude and origin of PEAs therefore should include the perspective of patients, caregivers and their community health professionals.

Despite these limitations, we believe that the found PEA rates show that there is ample room to improve healthcare for older adults, in the right place and at lower costs. The identified associative factors and underlying causes for PEAs may guide policy-makers and providers in achieving these goals. Strategies must be further developed and disseminated that are helpful for hospital physicians in

their everyday assessment of and decision to hospitalise older patients from the ED. For example, the introduction of ED-based liaison services responsible for exploring and coordinating outpatient care alternatives, educational programmes in geriatric EM, transmural protocols for timely organisation of (out of hours) rehabilitation care in the community and effective management of end-of-life care, and tools for coping with ethical dilemmas, family pressure and time pressure in the ED. The involvement of the geriatrician in the decision-making process of admission in the ED could also help to reduce inappropriate admissions. Moreover, GPs, especially those working out of hours, need to be stimulated in finding outpatient solutions for older patients in need of social support and with exacerbations of chronic conditions that do not require specialist care.

In conclusion, our study findings contribute to existing evidence that many emergency admissions of older adults are preventable, thereby demonstrating a possible source of unnecessary expensive, and potentially harmful, hospital care. Found insights into physician perceived causes may provide clues for reducing PEAs among the ever-increasing older patient population. Further research is however warranted to extrapolate these findings and test the effectiveness of strategies aimed at reducing PEAs of older adults.

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Contributors GH and YS designed the study. MV and SvdB acquired the data. SvdB and GH performed the analyses. NH and LvW performed secondary assessment of data. All authors were involved in interpretation of data. SvdB and GH wrote the first draft of the manuscript. All authors were involved in revisions and approving the final manuscript for publication. SvdB is guarantor for the manuscript.

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Data availability statement The data that support the findings of this study (database with variables in SPSS) are available from the corresponding author, upon reasonable request.

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Supplement 1. Characteristics of study sites

	ED, Radboudumc	*ED, CWZ*
Census		
Annual ED visits, n	22,000	27,000
Annual ED visits by older adults (aged ≥70 years), n (%)	5,740 (26.1)	7,150 (26.5)
Capacity		
Beds, n	23	19
EM physicians, n	7	12
Care process		
Geriatrician available (24 hours) for consultation in the ED	Yes	No
Discharge liaison nurse embedded in the ED	No	Yes
ED, Emergency Department; EM, Emergency Medicine.		

Table. Univariate and multivariate logistic regression analysis of variables associated with preventable emergency admissions based on criterium 1 and 2

			Univariate analysis		Multivariate analysis	
Independent variable	**Preventable admissions**	**Non-preventable admission**	**OR (95% CI)**	**p-value**	**OR (95% CI)**	**p-value**
Age, mean years (sd)	80.97 (6.31)	79.01 (6.75)	1.05 (1.00-1.10)	0.06	1.04 (1.01-1.08)	0.02
Sex (%)				0.08		
Male (ref)	4.8	95.2	1			
Female	8.8	91.2	1.97 (0.93-4.15)			
ED Referral (%)						
Physician or ambulance (ref)	5.7	94.3	1	0.11		
By patient self	9.8	90.2	1.76 (0.86- 3.64)			
Urgency, (%)				0.23		
High Urgency (ref)*	6.0	94.0	1			
*Low urgency***	7.9	92.1	1.56 (0.76-3.19)			
Time of arrival, (%)				0.66		
*Office hours*** (ref)*	6.5	93.5	1			
*Out-of-hours****	7.7	92.3	1.18 (0.57-2.43)			
Day of arrival, (%)				0.07		
Weekdays (ref)	4.8	95.2	1		1	
*Weekend*****	12.4	87.6	2.67 (1.31-5.43)		1.86 (1.13-3.07)	0.02
Polypharmacy******, (%)				0.54		
No (ref)	5.7	94.3	1			
Yes	7.3	92.7	1.34 (0.54-3.33)			
CCI, mean (sd)	5.97 (1.83)	5.96 (2.18)	1.00 (0.85-1.18)	0.98		
ED length of stay, mean minutes (sd)	259.68 (107.71)	220.79 (95.48)	1.00 (1.00-1.01)	0.07		
Marital status, (%)				0.17		
Partner/spouse (ref)	5.3	94.7	1			
Single	8.6	91.4	1.73 (0.80-3.74)			
Informal care at home, (%)				0.24		
No (ref)	4.6	95.4	1			
Yes	9.9	90.1	1.85 (0.94 -3.62)			
Specialties involved at the ED, (%)				0.02		
1 (ref)	5.3	94.7	1			
>1	12.3	87.7	2.44 (1.18-5.03)			

OR, Odds Ratio; ED, Emergency Department; CCI, Charlson Comorbidity Index.

*Based on the urgency levels 1 (Life threatening) and 2 (Emergent) of the Netherlands Triage System (NTS).

**Based on the urgency levels 3 (Urgent), 4 (Non-urgent) and 5 (Advice) of the Netherlands Triage System (NTS).

***Between 6:01am and 6.00pm

****Between 6:01pm and 6:00am.

***** Between Friday 6:01pm and Sunday 12 noon.

*****≥5 different types of medicines.

Supplement 3. Characteristics of interviewed physicians per study site

	ED, Radboudumc (n=25)	**ED, CWZ (n=24)**
Gender, n (%)		
Female	15 (60)	15 (62.5)
Male	10 (40)	9 (37.5)
Specialty, n (%)		
Internal medicine	9 (36)	7 (29.2)
Neurology	3 (12)	1 (4.2)
Cardiology	3 (12)	-
Geriatric medicine	4 (16)	1 (4.2)
Urology	3 (12)	1 (4.2)
Surgery	1 (4)	1 (4.2)
Pulmonology	2 (8)	2 (8.3)
Emergency medicine	-	11 (45.8)
Function, n (%)		
Resident	22 (88)	19 (75)
Specialist	3 (12)	6 (25)
Years of experience as a physician, mean (sd)	5.3 (2.1)	5.1 (3.1)
ED, Emergency Department.		