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Early death after discharge from emergency departments: analysis of national US insurance claims data

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ABSTRACT

OBJECTIVE

To measure incidence of early death after discharge from emergency departments, and explore potential sources of variation in risk by measurable aspects of hospitals and patients.

DESIGN

Retrospective cohort study.

SETTING

Claims data from the US Medicare program, covering visits to an emergency department, 2007-12.

PARTICIPANTS

Nationally representative 20% sample of Medicare fee for service beneficiaries. As the focus was on generally healthy people living in the community, patients in nursing facilities, aged ≥90, receiving palliative or hospice care, or with a diagnosis of a life limiting illnesses, either during emergency department visits (for example, myocardial infarction) or in the year before (for example, malignancy) were excluded.

MAIN OUTCOME MEASURE

Death within seven days after discharge from the emergency department, excluding patients transferred or admitted as inpatients.

RESULTS

Among discharged patients, 0.12% (12 375/10 093 678, in the 20% sample over 2007-12) died within seven days, or 10 093 per year nationally. Mean age at death was 69. Leading causes of death on death certificates were atherosclerotic heart disease (13.6%), myocardial infarction (10.3%), and chronic obstructive pulmonary disease (9.6%). Some 2.3% died of narcotic overdose, largely after visits for musculoskeletal problems. Hospitals in the lowest fifth of rates of inpatient admission from the emergency department had the highest rates of early death (0.27%)—3.4 times higher than hospitals in the highest fifth (0.08%)—despite the fact that hospitals with low admission rates served healthier populations, as measured by overall seven day mortality among all comers to the emergency department. Small increases in admission rate were linked to large decreases in risk. In multivariate analysis, emergency departments that saw higher volumes of patients (odds ratio 0.84, 95% confidence interval 0.81 to 0.86) and those with higher charges for visits (0.75, 0.74 to 0.77) had significantly fewer deaths. Certain diagnoses were more common among early deaths compared with other emergency department visits: altered mental status (risk ratio 4.4, 95% confidence interval 3.8 to 5.1), dyspnea (3.1, 2.9 to 3.4), and malaise/fatigue (3.0, 2.9 to 3.7).

CONCLUSIONS

Every year, a substantial number of Medicare beneficiaries die soon after discharge from emergency departments, despite no diagnosis of a life limiting illnesses recorded in their claims. Further research is needed to explore whether these deaths were preventable.

WHAT IS ALREADY KNOWN ON THIS TOPIC

Hospitals vary widely in how often emergency department patients are admitted to hospital, but it is unclear how this relates to patient outcomes

Small studies point to non-trivial numbers of patients who die unexpectedly after discharge home from the emergency department, but these studies rely on individual chart reviews or data from single health systems

It is difficult to assess generalizability of these findings or to shed light on how variation across hospitals might shape the quality and safety of emergency care

WHAT THIS STUDY ADDS

A substantial number of Medicare patients, over 10 000 every year, die soon after discharge from US emergency departments, despite relatively young age and no evidence of previous life limiting illnesses

Hospitals with lower admission rates, lower costs, and lower patient volumes had significantly higher rates of death after discharge, despite serving healthier overall patient populations

There is a particular clinical "signature" of discharge diagnoses from emergency departments linked to short term deaths, especially syndromic diagnoses not involving pain, like altered mental status, dyspnea, and malaise and fatigue

Introduction

A growing number of patients visit emergency departments every year: nearly 20% of the US population each year,[1] or 400 visits per 1000 population in the UK.[2] As a result, the decision to admit or discharge a patient from the department is made hundreds of thousands of times a day.

Errors in this decision can take two forms, each with different implications for patients and the healthcare system. One error is avoidable admission to hospital—that is, admission of patients who could be managed safely and effectively in other settings. This issue has been studied extensively, given its importance for healthcare costs.[3-6] The other error is avoidable harm—that is, discharge of patients who would have benefitted from further monitoring or treatment as inpatients. This issue has received comparatively little attention, despite its importance for patient safety, outside of studies on specific diagnoses (such as myocardial infarction,[7-10] subarachnoid hemorrhage[11-13]) comprising a small percentage of emergency department populations.

Prior studies have suggested that the deaths of patients who die shortly after discharge from an emergency department could potentially be avoidable if they result from unanticipated deterioration. These efforts have yielded valuable insights into patient characteristics

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linked to early death, such as atypical presentations of acute illnesses[14 15] or injuries in the elderly.[16] This is timely given increasing attention to the issue of diagnostic error.[17-20]

Existing studies, however, rely on painstaking review of individual charts or data from single health systems. This makes it difficult to assess generalizability of findings or to understand the incidence of early death after discharge nationally. Nor can such studies shed light on how variation across hospitals might shape the quality and safety of emergency care. A key example here is variation in the rate of inpatient admission from an emergency department: while this metric is commonly used to assess the extent of low value hospital care,[6 21 22] it has not, to our knowledge, been shown to affect patient outcomes.

To fill this gap, we performed the first nationally representative study of early death after discharge from an emergency department in patients living in the community, using US Medicare claims linked to death certificates. Clearly, administrative data cannot offer conclusive evidence on whether such deaths resulted from error. Instead, we hoped to identify clinical and health systems factors linked to potentially unexpected death as a starting point for future study. Understanding of these sentinel events will become increasingly important as policy and quality incentives drive health systems to reduce rates of admission to hospital from the emergency department.

Methods

Study population and outcome

From a nationally representative 20% sample of Medicare claims, we identified fee for service beneficiaries with visits to emergency department in 2007-12.[23] We excluded those with nursing facility claims in the month before their visit to focus on active patients living in the community who were attending the department for acute problems. Table A in appendix 1 provides further details.

Our primary outcome was death within seven days after discharge from emergency departments, as in prior studies.[14-16 24 25] People admitted as inpatients, transferred out of the department, or discharged to palliative care or a hospice were ineligible for the outcome. In many US emergency departments, patients who require a period of observation for diagnostic testing or monitoring are billed under a specific "observation status." These patients are subsequently discharged or formally admitted as inpatients, and, for the purposes of this study, we classified patients by this ultimate disposition (that is, admitted or discharged). Observation can happen either in units based in the emergency department or in other hospital departments; as Medicare claims did not distinguish by location, we considered these together. Seven day mortality was chosen based on the assumption that discharged patients were deemed to be at low risk of acute deterioration, such that no immediate testing or treatment was required, and they would be able to return to care if they worsened. Discharged patients should thus resemble generally healthy patients, with similarly low baseline risk of mortality, and early death would be a potentially unanticipated adverse event—though by no means evidence of error or poor care.

Life limiting illnesses

Of course, in patients with known life limiting illnesses diagnosed in the emergency department or before, death after discharge could have been fully anticipated: poor prognosis can limit utility of admission, or patients might simply prefer to avoid admission. We attempted to exclude such visits in several ways. First, we excluded beneficiaries aged ≥90, who often have incurable conditions[26] and DNR ("do not resuscitate") or "do not hospitalize" orders.[27] Second, we excluded those with any claims for hospice or palliative care over the year before visits. Given the fee for service structure of the US healthcare system, providers have a strong incentive to report all patient encounters to insurers; thus it is traditionally assumed[28] (though difficult to verify) that nearly all care is captured in claims. This assumption applies only to formally coded encounters and would not identify patients who were tacitly rather than formally receiving care oriented to palliation.

As a result, it is likely that such coarse criteria alone are insufficient for identifying patients with a poor prognosis. We thus also broadly excluded discharged patients with conditions that, when diagnosed, implied provider awareness of potentially poor near term prognosis and thus a deliberate decision to discharge despite known risk of mortality. To do so, we convened a panel of three emergency physicians to identify diagnoses indicating life limiting disease: chronic conditions diagnosed in the year before visits—for example, malignancies—and acute conditions diagnosed in the emergency department typically requiring inpatient management—for example, myocardial infarction (see table B in appendix 1). We did not exclude acute conditions for which outpatient management is reasonable in appropriately risk stratified patients—for example, pneumonia.[29 30] Initial inter-rater agreement (κ) was 0.81. Disagreements were resolved by consensus.

Descriptive analyses

After estimating incidence of early death after discharge over the study period, we determined cause of death by linking claims to death certificates. This was last possible in 2008, after which the Medicare administration disallowed linkage. We thus used the subset of 2007-08 visits (n=3 197 209) to tabulate cause of early deaths after discharge (n=4273); deaths from 2009-12 were excluded from these analyses. While these data are often inaccurate for assigning specific cause of death,[31 32] they can be useful for ascertaining broader categories of causes.[33]

Hypothesis testing

We explored several hypotheses regarding potential sources of variation in early mortality rates.

Temporal variation—We hypothesized that risk of mortality would vary over the year after visits to an department, with the influence of care most apparent

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soon after visits, and the influence of patients' underlying conditions more or less constant over the year. As observed evolution of risk might itself vary as a function of hospitals' admission rates (calculated as fraction of Medicare patients admitted, similar to previous studies that used Medicare data as a proxy for hospital level metrics[34-36]), we inspected trends separately by fifth of admission rate. We then calculated weekly mortality for discharged and admitted patients, excluding hospitals with <100 visits annually because of unstable rates.

Hospital level variation—We explored additional potential correlates of early mortality at the hospital level, focusing on the first week after discharge. We investigated correlation of risk with urban versus rural location and by academic status based on data from the American Hospital Association. As hospital case mix could affect both early death after discharge and early death after admission, we explored correlations of hospital factors with both.

To more systematically explore factors linked to early death after discharge, we regressed our outcome on two sets of variables: first, hospital level factors including location, annual Medicare volume of the emergency department (that is, by number of Medicare visits to emergency departments by hospital year, calculated from the 100% inpatient and outpatient files), and the amount charged by the hospital for the visit, as a measure of the complexity and amount of care delivered. Second, we controlled for case mix across hospitals by including demographics, eligibility for Medicaid (a proxy for low income), mean income at postal code level, patient comorbidities over the year before visits,[37] and fixed effects for year, season, and weekend. As only discharged patients could experience the outcome, we also controlled for hospital admission rate. We clustered standard errors by hospital.

Our first analysis included all patients presenting to emergency departments—that is, both discharged or admitted—to determine which factors, among all patients seen in the department, were associated with early death after discharge? We also present an alternative strategy, in which we included only discharged patients. This answers a different question: among patients whom doctors decided to discharge, which factors are associated with higher risk? This is appealing because only discharged patients are eligible for the outcome; its disadvantage lies in selecting patients for inclusion based on physician judgment, which might vary across hospitals. This limits generalizability to all emergency department patients and also means that departments with higher rates of admission were under-represented, which could bias coefficients. We thus view the first model as preferable.

Diagnostic variation—Finally, we hypothesized that risk of death after discharge would vary across grouped[38] diagnoses in the emergency department. We calculated risk ratios by diagnosis (primary discharge diagnosis for discharged patients, admitting diagnosis for admitted patients), comparing diagnosis incidence among early deaths after discharge with incidence among all other visits.

Statistical packages

All analyses were performed in Stata (version 14.0; StataCorp) and R (version 3.2.3; Foundation for Statistical Computing).

Patient involvement

No patients were involved in setting the research question or the outcome measures, nor were they involved in developing plans for design or implementation of the study. No patients were asked to advise on interpretation or writing up of results. There are no plans to disseminate the results of the research to study participants or the relevant patient community. Our interest in poor short term outcomes after ED visits, however, was informed by patients' priorities, experiences, and preferences.

Results

Descriptive analyses

In a nationally representative 20% sample Medicare beneficiaries, we identified 28 086 293 visits to an emergency department over 2007-12. We excluded 12 091 966 (43%), mostly because of life limiting illnesses diagnosed in the department (such as acute myocardial infarction) or illness diagnosed in the year before the visits (such as malignancy); age ≥90; and non-fee for service (see fig A in appendix 2). Table 1 shows baseline characteristics of remaining visits, of which 37% involved admission or transfer of the patient.

Among those discharged, 0.12% (12 375/10 093 678, in the 20% sample over 2007-12) died within seven days or 10 093 per year nationally. Average age at death was 69; 50.3% were men, and 80.9% were white. There were small decreases in rates of early death after discharge from 2007-12, 4-5% annually (fig B in appendix 2).

Death certificates identified atherosclerotic heart disease (13.6%), acute myocardial infarction (10.3%), and chronic obstructive pulmonary disease (9.6%) as most common causes of death. Figure 1 shows top causes of death and their antecedent diagnoses on discharge. Narcotic overdose was the eighth most common cause of death (2.3%); the most common antecedent discharge diagnoses were back pain (15%) and superficial injuries (10%).

Temporal variation

Figure 2 shows the evolution of weekly risk of mortality over the year after emergency department visits, by fifth of rate of admission from department to inpatient. Among admitted patients, mortality was highest in the first weeks in all hospitals, then declined rapidly. Among discharged patients, by contrast, evolution of risk varied by admission rate. In hospitals in the highest fifth of admission rates, discharged patients had low mortality soon after discharge compared with the remainder of the year. In hospitals in the lowest fifth of admission rates, conversely, discharged patients had higher—not lower—early mortality; rates then declined over the course of the year.

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Table 1 | Basic demographic and medical characteristics of Medicare patients' visits to emergency department, 2007-12, by disposition (admitted or transferred versus discharged), with 95% confidence intervals

Variable	Admitted or transferred (n=5 867 649)	Discharged (n=10 093 678)	Difference (admitted *v* discharged)*
Demographics			
Mean age on day of visit (years)	69.8 (69.7 to 69.8)	62.2 (62.2 to 62.2)	7.6 (7.5 to 7.6)
Women (%)	55.2 (55.2 to 55.2)	59.5 (59.5 to 59.6)	−4.3 (−4.3 to −4.3)
White (%)†	79.7 (79.7 to 79.7)	76.2 (76.2 to 76.2)	3.6 (3.5 to 3.6)
Rural (%)	3.7 (3.7 to 3.8)	6.7 (6.7 to 6.7)	−2.9 (−3.0 to −2.9)
Mean income ($)‡	67 389 (67 368 to 67 410)	64 394 (64 379 to 64 408)	2995 (3020 to 2970)
Comorbidities (% unless marked otherwise)			
Mean summed score§	3.7 (3.7 to 3.7)	2.0 (2.0 to 2.0)	1.7 (1.7 to 1.7)
Alcohol abuse	4.0 (3.9 to 4.0)	4.6 (4.6 to 4.7)	−0.7 (−0.7 to −0.7)
Any tumor	40.2 (40.1 to 40.2)	25.1 (25.1 to 25.1)	15.0 (15.0 to 15.1)
Cardiac arrhythmias	22.7 (22.7 to 22.7)	38.7 (38.6 to 38.7)	−16.0 (−16.0 to −15.9)
Chronic pulmonary disease	39.7 (39.7 to 39.7)	31.5 (31.4 to 31.5)	8.2 (8.2 to 8.3)
Coagulopathy	9.9 (9.9 to 9.9)	5.2 (5.1 to 5.2)	4.7 (4.7 to 4.8)
Complicated diabetes	21.5 (21.4 to 21.5)	12.9 (12.9 to 12.9)	8.5 (8.5 to 8.6)
Congestive heart failure	40.6 (40.6 to 40.7)	20.0 (20.0 to 20.0)	20.6 (20.6 to 20.7)
Deficiency anemias	40.2 (40.1 to 40.2)	25.1 (25.1 to 25.1)	15.0 (15.0 to 15.1)
Dementia	0¶	0¶	0¶
Fluid and electrolyte disorders	36.7 (36.7 to 36.7)	22.1 (22.1 to 22.1)	14.6 (14.5 to 14.6)
Hemiplegia	4.2 (4.2 to 4.2)	2.2 (2.2 to 2.2)	2.0 (1.9 to 2.0)
HIV/AIDS	0.8 (0.8 to 0.8)	1.0 (1.0 to 1.0)	−0.2 (−0.2 to −0.2)
Hypertension	79.3 (79.3 to 79.4)	68.2 (68.2 to 68.3)	11.1 (11.0 to 11.1)
Liver disease	5.9 (5.9 to 6.0)	5.7 (5.7 to 5.8)	0.2 (0.2 to 0.2)
Metastatic cancer	0¶	0¶	0¶
Peripheral vascular disease	29.0 (29.0 to 29.1)	15.7 (15.6 to 15.7)	13.4 (13.3 to 13.4)
Psychosis	18.0 (18.0 to 18.0)	22.5 (22.5 to 22.6)	−4.6 (−4.6 to −4.6)
Pulmonary circulation disorders	29.0 (29.1 to 29.0)	15.6 (15.6 to 15.7)	13.4 (13.3 to 13.4)
Renal failure	26.7 (26.6 to 26.7)	12.6 (12.6 to 12.7)	13.9 (13.9 to 13.9)
Weight loss	5.9 (5.9 to 5.9)	2.2 (2.2 to 2.2)	3.7 (3.7 to 3.7)
Healthcare use in year before visit (%)			
Inpatient admission	40.1 (40.1 to 40.1)	18.6 (18.6 to 18.6)	22.1 (22.1 to 22.1)
Emergency department visit	15.5 (15.5 to 15.6)	17.9 (17.9 to 18.0)	−2.4 (−2.5 to −2.4)
Clinic visit	75.5 (75.4 to 75.5)	75.4 (75.4 to 75.4)	0.7 (0.6 to 0.7)
Hospice	0¶	0¶	0¶
Palliative care	0¶	0¶	0¶

*Given large sample size, some 95% confidence intervals are so small that they are not different from point estimate at reasonable number of significant digits.
†Defined based on race variable in Medicare claims.
‡Based on home postal code.
§Combined comorbidity index combining Elixhauser and Charlson scores.[37]
¶By construction, based on exclusion criteria.

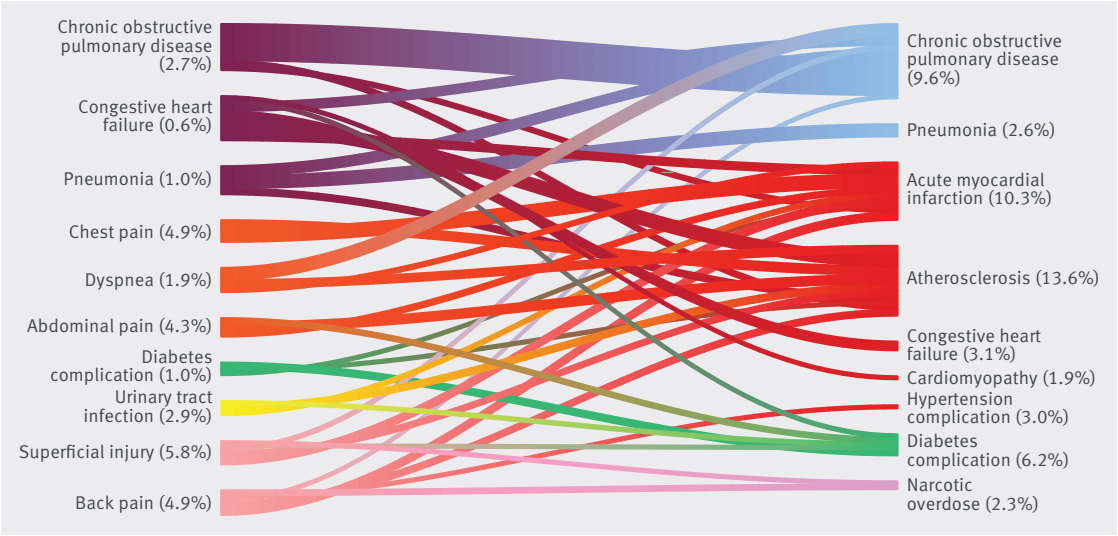

Fig 1 | Cause of death and antecedent discharge diagnoses from emergency departments. Association between most common primary discharge diagnoses and most common causes of death from death certificates, for subset of deaths from 2007-08 when death certificate data were available. Thickness of line is proportional to number of beneficiaries with given discharge diagnosis who later died of given cause (see table D in appendix 1 for further details)

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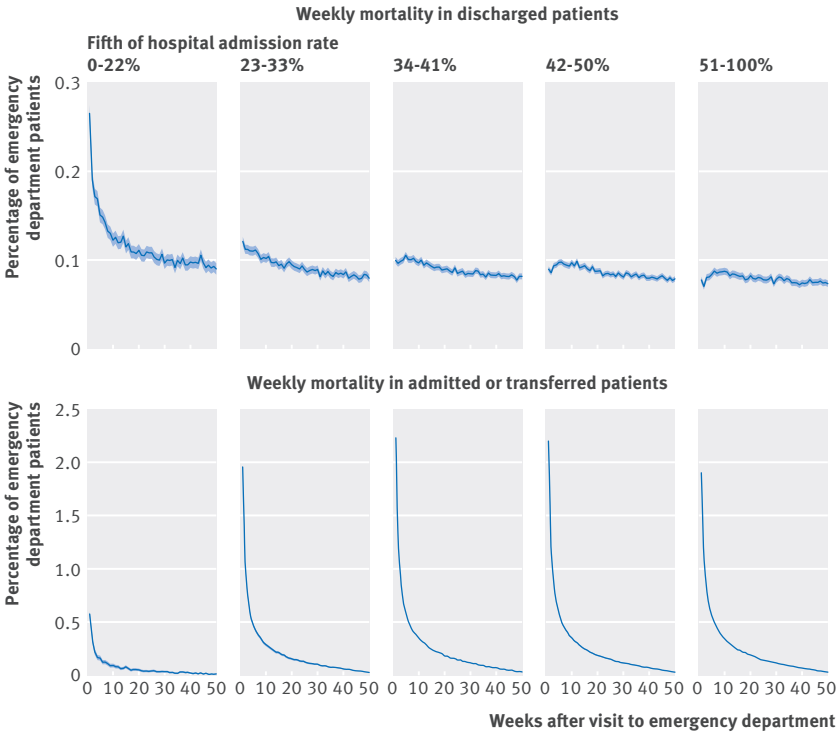

Fig 2 | Evolution of weekly mortality risk after emergency department visits. Visit is denoted as week 0 (left). Rates calculated separately, by fifth of rate of emergency department to inpatient admission for Medicare patients, shown in columns from lowest fifth (left) to highest fifth (right). Shaded area around lines shows 95% confidence interval for mortality rates

Hospital level variation

Figure 3 focuses just on mortality in the first week after visits to an emergency department and its association with hospital level admission rate. Among discharged patients, mortality declined non-linearly with increasing admission rate. Hospitals in the lowest fifth of admission rates discharged 85% of patients, compared with 44% in the highest fifth (1.9 times more, 95% confidence interval 1.9 to 1.9). But the seven day mortality rate after discharge in hospitals in the lowest fifth was far higher: 3.4 times (0.27% *v* 0.08%; 95% confidence interval 3.3 to 3.3). Rural hospitals were over-represented in the lowest fifth of admission rates (33% *v* 17% of all hospitals), but most hospitals in this fifth were simply urban or suburban non-academic hospitals. Academic hospitals had high median admission rates (39%) and lower early death rates (0.06%).

Was this trend simply caused by bias? If emergency departments with low admission rates served sicker populations, discharged patients would have higher mortality rates—but this would reflect higher overall mortality rates from baseline patient factors, not because of care in the emergency department. Crucially, in this scenario, admitted patients in these hospitals should also have higher mortality. Thus inpatient mortality rates can help detect potential biases among discharged patients.

Figure 3 shows that inpatient mortality followed the exact opposite trend than expected if results were driven by baseline mortality rates. Hospitals with the lowest admission rates had inpatient mortality 3.4 times lower (95% confidence interval 3.2 to 3.7) than the highest. When we combined admitted and discharged patients, overall seven day mortality rates for all comers to emergency departments were 71% lower in the hospitals with the lowest versus highest admission rates (0.3 *v* 1.0, 95% confidence interval 69% to 71%). Thus it seems unlikely that baseline population differences alone explained higher early death rates among hospitals with low admission rates.

Table 2 shows factors linked to our outcome via multivariate logistic regression, adjusted for demographics, comorbidities, time trends, and hospital admission rate (table C in appendix 1 gives the full results). Those who died early were older, more likely to be white and male, and lived in poorer areas. Hospitals with higher Medicare volumes had significantly fewer deaths (odds ratio 0.82, 95% confidence interval 0.80 to 0.85). Patients who visited hospitals with higher emergency department charges were significantly less likely to die (0.75, 0.74 to 0.77) versus all other visits; this coefficient was reversed (1.39, 1.32 to 1.36) in model 2 (including only discharged patients), probably reflecting higher complexity of deaths versus other discharged patients. Otherwise, models were similar.

Diagnostic variation

Figure 4 shows risk ratios for early death after discharge for the 20 most common diagnoses in the emergency department, calculated as the ratio of incidence of diagnosis among deaths versus all other visits (admitted and discharged). Patients with syndromic diagnoses like altered mental status (relative risk 4.4, 95% confidence interval 3.8 to 5.1), dyspnea (3.1, 2.9 to 3.4), and malaise and fatigue (3.0, 2.9 to 3.7) had the highest risks, followed by diagnoses for which patients at low risk can be managed as outpatients: congestive heart failure (1.8, 1.7 to 2.0), chronic obstructive pulmonary disease (1.6, 1.5 to 1.8), and pneumonia (1.6, 1.5 to 1.8). Interestingly, those with chest pain had among the lowest risks (0.8, 0.8 to 0.9).

Discussion

In this national analysis, we found that over 10 000 Medicare beneficiaries each year died within seven days after being discharged from emergency departments, despite mean age of 69 and no obvious life limiting illnesses. For context, these deaths accounted for 1.7% of all non-hospice deaths in the Medicare fee for service population annually (see table D in appendix 1). Variability in mortality rates across hospitals was striking: hospitals with low patient volumes and lower admission rates had the highest rates of early death, and small increases in admission rates were linked to large decreases in risk—despite the fact that hospitals with low admission rates served emergency department populations with lower overall near term mortality.

These data should not be viewed as evidence of error. Indeed, some of the variation in outcomes we identified could be linked to the geographic and socioeconomic context of emergency care. First, access to resources

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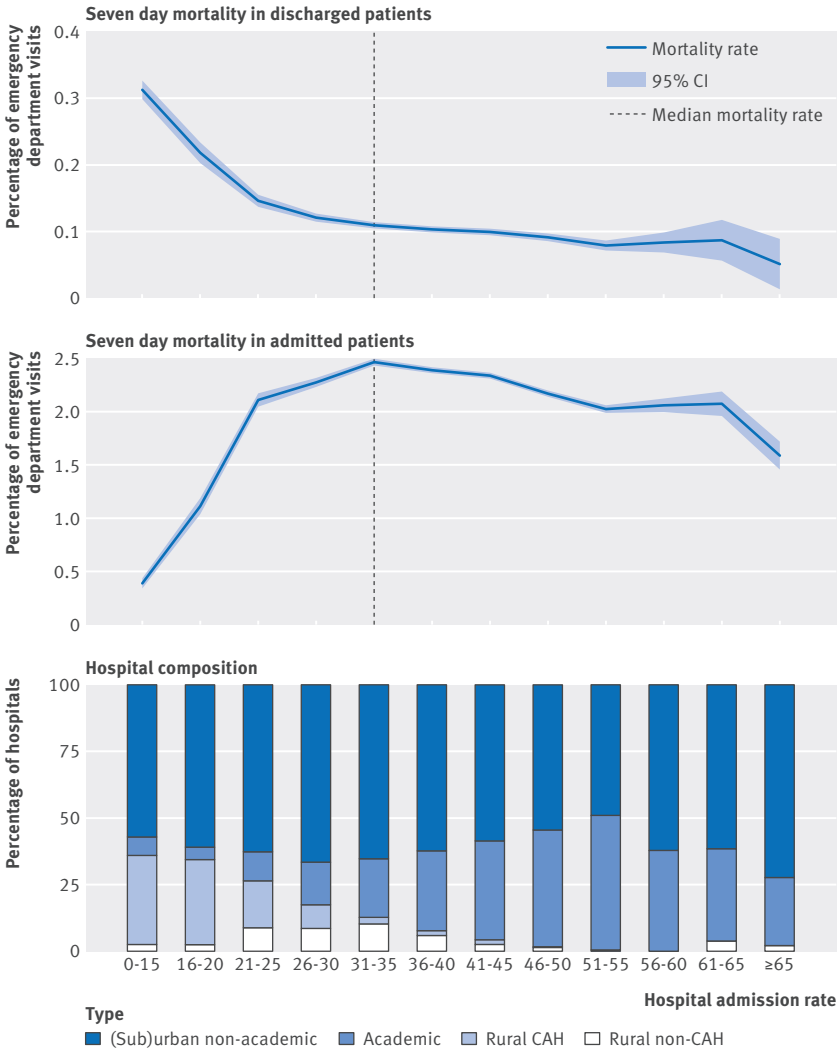

Fig 3 | Association between seven day mortality rates and rates of inpatient admission from emergency departments. Rates calculated separately by hospital admission rate. Types of hospital based on data from American Hospital Association. CAH=critical access

varies dramatically across hospitals. For example, to admit patients from the emergency department in hospitals without dedicated internists staffing inpatient beds (hospitalists), emergency physicians must identify willing primary care physicians. These clinicians in turn must take time away from their busy schedules to make rounds on inpatients. The barriers imposed by such arrangements, in addition to a lack of consistent access to specialist consultation or diagnostic resources in the emergency department (such as cardiac ultrasonography, computed tomography), could contribute to worse outcomes in poorer hospitals and patients (T Putnam, personal communication, 2015). Second, patients attending emergency departments with higher mortality after discharge probably differed in important ways that we could not measure. For example, poor beneficiaries eligible for Medicaid can access taxi vouchers to facilitate follow up, but such transportation is generally far less accessible in rural areas, making patients less likely to obtain any scheduled follow-up care (T Putnam, personal communication, 2015). Importantly, while these factors can make sudden death more likely, they do not make it either unavoidable or any less tragic for patients and families.

What are the practical implications of these results? Clearly, not all patients can or should be admitted. But in low volume hospitals with low admission rates, and in patients with specific discharge diagnoses, seven day mortality levels were not trivial. While our study could not determine whether admission would prevent these deaths, it is possible that additional testing or monitoring—whether via admission, monitoring at home, or expedited outpatient follow-up—could have benefitted at least some patients.

This observation perhaps raises more questions than answers and thus suggests several important directions for future research. First, focused clinical audit studies of high risk patients at high risk hospitals could identify opportunities to improve systems of care—rather than to

Table 2 | Results of multivariate logistic regression investigating association between death in seven days after discharge and patient, emergency department, and visit level factors. Model 1 shows results with all patients presenting to departments included in analysis, irrespective of whether they were discharged or admitted. Model 2 includes only discharged patients. Both models control for hospital admission rate, patient comorbidities, and seasonal and temporal factors (see table C in appendix 1). Standard errors were clustered by hospital. Figures are odds ratios with 95% confidence interval and P values

Variable	Model 1: all patients, admitted and discharged(n=15 961 327)	Model 2: discharged patients only (n=10 093 678)
Patient factors		
Age	1.02 (1.02 to 1.02); <0.001	1.03 (1.02 to 1.03); <0.001
Female	0.71 (0.68 to 0.74); <0.001	1.39 (0.62 to 0.67); <0.001
Non-white	0.90 (0.85 to 0.95); <0.001	0.84 (0.80 to 0.89); <0.001
Mean income* (log)	0.78 (0.73 to 0.83); <0.001	0.72 (0.68 to 0.77); <0.001
Medicaid dual eligible	1.01 (0.96 to 1.06); 0.792	1.01 (0.97 to 1.06); 0.607
Emergency department and visit factors		
Visit charges (log)	0.75 (0.74 to 0.77); <0.001	1.39 (1.36 to 1.42); <0.001
Annual volume (log)	0.82 (0.79 to 0.85); <0.001	0.84 (0.81 to 0.87);<0.001
Rural location	1.10 (0.98 to 1.24); 0.10	1.07 (0.96 to 1.20);0.226

*Based on home zip code.

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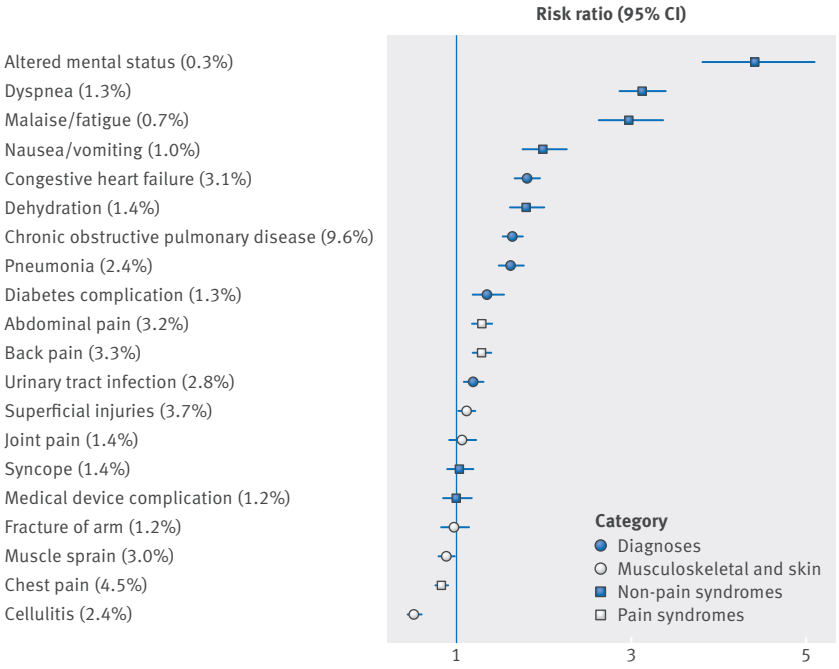

Fig 4 | Risk ratios (and 95% confidence intervals) for early death for 20 most common diagnoses in emergency departments. Incidence of each diagnosis among all patients (admission diagnosis for admitted patients, primary discharge diagnosis for discharged patients) shown in parentheses. Risk ratios calculated as ratio of incidence of diagnosis among early deaths after discharge *v* frequency among all other emergency department visits (admitted and discharged). Diagnoses grouped into four categories: formal pathophysiological diagnoses of disease (such as pneumonia); syndromic diagnoses, either involving pain (such as chest pain) or not involving pain (such as dyspnea); and diagnoses related to injuries, skin conditions (such as cellulitis) or musculoskeletal pain (such as muscle sprain)

assign blame to individual providers.[39] Second, prospective clinical studies of specific presenting symptoms could be conducted, modeled on the original literature on missed myocardial infarction in patients with chest pain.[7-10] We identified a particular "signature" of clinical diagnoses linked to early death after discharge: those with non-pain syndromes (such as dyspnea) were at highest risk, especially compared with pain syndromes (such as chest pain), as those with were cardiopulmonary diagnoses (such as pneumonia). It is tempting to engage in speculation here: patients in pain might command more physician attention than patients with vague symptoms, or specific low cost diagnostic tests (such as troponin concentration) or clinical pathways (as for chest pain) might play a role. Ultimately, however, careful prospective studies are the only way to elucidate the mechanisms underlying these findings. A third important line of research concerns gaps in knowledge on the value of hospital admission itself. Despite clinical decision rules for deciding on inpatient versus outpatient management of specific illnesses,[29] there is little evidence on the benefits of admission for nearly all emergency department patients. Economic analyses are needed to gauge the cost effectiveness of admission, balancing potential improvements in outcomes against cost. Generating such evidence need not involve randomized trials, but rather could exploit existing, plausibly random variation in the healthcare system to measure the benefit and cost of admission for different patient groups.[40] The role of financial incentives must also be explored: while all patients in this study were insured, supplementary insurance could increase the likelihood of admission and thereby decrease the risk of early death after discharge.

Finally, our results also have implications for ongoing policy efforts to reduce unnecessary admissions from the emergency department.[41] Unless extreme care is taken with selection of patients, these well intentioned efforts could put patients at risk. Policies designed to reduce overuse, whether in the setting of National Health Service budget constraints in the UK or the Affordable Care Act in the US, could exacerbate this problem. Novel metrics to track patient safety and diagnostic error—which are otherwise under-represented in existing quality measures[17]—are urgently needed to aid policy makers in evaluating how changes in the broader healthcare system impact patient outcomes.

Limitations

We used Medicare claims because of their broad coverage of US hospitals and the populations they serve. But claims data cannot conclusively identify preventable errors in care. Rather, our aim was to present the first national data on early death after discharge and to identify clinical and health systems factors linked to higher risk. We see this effort as a starting point for future research on patient safety in emergency departments, which has been surprisingly under-researched outside of specific diagnoses comprising a small minority of patients (such as myocardial infarction, stroke, subarachnoid hemorrhage, appendicitis).

We attempted to focus on potentially unexpected deaths by restricting our study to younger generally healthy patients living in the community with good overall prognoses. A particularly difficult task was exclusion of beneficiaries with diagnosed life limiting illnesses, in whom death was not unexpected. As there was, to our knowledge, no prior literature on this topic, we developed a list of ICD codes for this study: acute life threatening conditions diagnosed in the emergency department or chronic conditions diagnosed in the year before visits. While it was based on the judgment of experienced emergency physicians, this list was necessarily subjective. We attempted to be conservative, but some life limiting comorbidities might be omitted; alternatively, excluded diagnoses could be viewed as overly broad. For example, we excluded any beneficiaries with claims indicating any malignancy in the year before emergency department visits because cancer stage cannot be reliably determined from claims[42]; but this might exclude patients with good overall prognoses. Likewise, exclusion of pulmonary embolism might exclude seemingly low risk patients deliberately sent home from emergency departments. Finally, given differences in coding intensity and access to end of life care, patients in less well resourced areas might have been less likely to be excluded by these criteria; this is symptomatic of a broader, and as yet unsolved, problem with risk adjustment in administrative data.[43]

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Some deaths might have reflected "baseline" mortality after discharge from the emergency department. We view this as unlikely given observed variation in risk of mortality over time and across hospitals. Hospitals with higher admission rates seemed better able to triage high risk patients into hospital admission, rather than discharging them home: discharged patients had lower early mortality rates after visits than over the remainder of the year, while inpatients had higher early mortality. In lower admission rate hospitals, conversely, high risk patients were less likely to be admitted and more likely to be sent home. Such discharged patients had a far higher mortality in the days after visits than subsequently, while inpatients had a far lower early mortality than other hospitals. Together, these trends argue that early death after discharge was not simply a reflection of baseline mortality rates. Interestingly, this also suggests that hospitals with high admission rated do not admit indiscriminately: if high acuity inpatients were diluted with healthy patients who could have been discharged, inpatient mortality would fall, not rise, with admission rate (unless these hospitals were also killing their inpatients at dramatically higher rates).

Conclusion

Many Medicare beneficiaries die shortly after discharge from emergency departments, despite no obvious life limiting illnesses recorded in their claims. Hospitals with low admission rates and low patient volumes, and patients with high risk diagnoses at discharge, could represent targets for clinical research and quality improvement efforts.

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Competing interests: All authors have completed the ICMJE uniform disclosure form at www.icmje.org/coi_disclosure.pdf and declare: no financial relationships with any organizations that might have an interest in the submitted work in the previous three years; no other relationships or activities that could appear to have influenced the submitted work.

Ethical approval: This study was approved by the institutional review boards of Partners HealthCare and the National Bureau of Economic Research.

Data sharing: No additional data available.

Transparency: The lead author affirms that the manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned have been explained

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Appendix 1: Supplementary tables
Appendix 2: Supplementary figures

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