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Trends in Mortality for Medicare Beneficiaries Treated in the Emergency Department From 2009 to 2016

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IMPORTANCE Emergency department (ED) visits are common and increasing. Whether outcomes associated with care in the ED are improving over time is largely unknown to date.

OBJECTIVE To examine trends in 30-day mortality rates associated with ED care among Medicare beneficiaries aged 65 years or older.

DESIGN, SETTING, AND PARTICIPANTS This cross-sectional study used a random 5% sample in 2009 and 2010 and a 20% sample from 2011 to 2016, for a total of 15 416 385 ED visits from 2009 to 2016 among Medicare beneficiaries aged 65 years or older.

EXPOSURES Time (year) as a continuous variable.

MAIN OUTCOMES AND MEASURES The primary outcome was 30-day mortality, overall and stratified by illness severity and hospital characteristics. Secondary outcomes included mortality rates on the day of the ED visit (day 0) as well as at 7 and 14 days. Changes in disposition from the ED (admission, observation, transfer, died in the ED, and discharged) over time were also examined.

RESULTS The sample included 15 416 385 ED visits (60.8% women and 39.2% men; mean [SD] age, 78.6 [8.5] years) at 4828 acute care hospitals. The percentage of patients discharged from the ED increased from 53.6% in 2009 to 56.7% in 2016. Unadjusted 30-day mortality declined from 5.1% in 2009 to 4.6% in 2016 (−0.068% per year; 95% CI, −0.074% to −0.063% per year; $P < .001$). After adjusting for hospital random effects, patient demographics, and chronic conditions, the adjusted 30-day mortality trend was −0.198% per year (95% CI, −0.204% to −0.193% per year; $P < .001$). The magnitude of this trend was greatest for patients with a high severity of illness (−0.662%; 95% CI, −0.681% to −0.644%; $P < .001$), followed by those with a medium severity of illness (−0.103% per year; 95% CI, −0.108% to −0.097% per year; $P < .001$) and those with a low severity of illness (−0.009% per year; 95% CI, −0.006% to −0.011% per year; $P < .001$). Declines in mortality were seen in each category of ED disposition, including visits resulting in admission (−0.356% per year; 95% CI, −0.368% to −0.343% per year; $P < .001$) as well as those resulting in discharge (−0.059% per year; 95% CI, −0.064% to −0.055% per year; $P < .001$). The decline was greater for major teaching hospitals (compared with nonteaching hospitals), nonprofit hospitals (compared with for-profit hospitals), and urban hospitals (compared with rural hospitals).

CONCLUSIONS AND RELEVANCE Among Medicare beneficiaries receiving ED care in the United States, mortality within 30 days of an ED visit appears to have declined in recent years, particularly for patients with the highest severity of illness, even as fewer patients are being admitted from an ED visit. This study's findings suggest that further study is needed to understand the reasons for this decline and why certain types of hospitals are seeing greater improvements in outcomes.

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As policymakers have focused on improving health care value, there has been increasing attention to emergency department (ED) care, which is often thought to be high cost and of variable quality.[1,2] Yet despite rising ED costs[3,4] and efforts to encourage alternative sources of acute care, 1 in 5 US citizens visits an ED annually,[5] a number that has continued to increase.[2,6,7] However, alongside rising ED use has been a national trend toward admitting fewer patients from the ED,[4,8] as alternative payment models have proliferated and hospital capacity has declined.[9] However, the association of these trends with clinical outcomes is unclear and there has been concern that these trends may lead to patient harm.[10]

In this context, examining outcomes for ED care is crucial. If patients are being inappropriately discharged, one may expect ED mortality rates to increase. Furthermore, if the standards for admission from the ED have become stricter, hospitalized patients may be sicker, leading to higher observed inpatient mortality. Although there has been substantial attention to ED costs, critical issues regarding ED outcomes remain largely unexamined. Given that EDs serve as the source for most unscheduled hospitalizations[11] and an important site of unscheduled outpatient care,[12] evidence on trends in emergency care is needed.

Therefore, we used national Medicare data from 2009 to 2016 to examine the following 3 questions. First, how have rates of 30-day mortality changed over time for Medicare beneficiaries visiting the ED and have these trends varied by patient disposition? Second, have these trends in mortality, if any, been observed across the spectrum of patient severity? Finally, have these trends been greater for particular hospital types?

Key Points

Question How has mortality changed over time among Medicare beneficiaries seeking emergency department care?

Findings In a cross-sectional study of more than 15 million emergency department visits from 2009 to 2016 among Medicare beneficiaries, there was a significant decline in mortality rates during or after an emergency department visit. This decline was greatest for patients with a high severity of illness compared with those with a medium severity or low severity of illness.

Meaning Mortality rates during or after an emergency department visit appear to have declined for Medicare beneficiaries in recent years, particularly for the sickest patients.

Methods

Data Source

We identified ED visits for a random 5% sample of Medicare beneficiaries in 2009 and 2010 and a 20% sample from 2011 to 2016 (eAppendix in the Supplement). We obtained beneficiary characteristics and death dates from the denominator file and hospital characteristics from the 2014 American Hospital Association annual survey and Medicare Impact File. We excluded ED visits to nonacute care hospitals, federal hospitals, those lacking American Hospital Association survey data, and those outside of the 50 US states and the District of Columbia. The Office of Human Research Administration at the Harvard T.H. Chan School of Public Health approved this study, and no written informed consent was required owing to deidentified patients.

ED Visits

For each visit, we assigned one of the following mutually exclusive dispositions (eAppendix in the Supplement): admitted, observation, transferred to another hospital, died in the ED, and discharged. We classified the principal diagnosis using the Healthcare Cost and Utilization Project Clinical Classification Software diagnosis categories. We limited our primary analysis to the 40 most frequent categories (74.8% of visits). We identified hospital size, geographical region, urban or rural location, teaching status (major vs minor vs nonteaching),[13] and ownership (for profit, private nonprofit, government nonfederal, and government federal). We designated hospitals in the top quartile of the disproportionate share index as safety-net hospitals,[14] while the remaining were considered non–safety-net hospitals.

Patients

Beneficiaries aged 65 years or older and continuously enrolled in fee-for-service Medicare were included and their age, sex, race/ethnicity (based on beneficiary self-report),[15] and Medicaid enrollment were identified. Chronic conditions (Hierarchical Condition Categories [HCCs]) were defined using Centers for Medicare & Medicaid Services software based on conditions coded on claims in the same year, using only the first 9 coded diagnoses.[16]

Outcomes

The primary outcome was mortality within 30 days of the ED visit. We also examined mortality rates on days 0 (the day of the ED visit), 7, and 14.

Statistical Analysis

Time Trends in ED Disposition

We calculated raw annual rates of admission, observation, transfer, in-ED death, and discharge from the ED. We calculated the adjusted rates (aggregating admitted and transferred patients into a single category) using a linear probability model with disposition category as the outcome and year as the predictor, adjusting for hospital random effects, visit diagnosis, and patient age, sex, race/ethnicity, Medicaid enrollment, and chronic conditions. Linear rather than logistic regression was chosen because absolute mortality reductions were considered more interpretable and policy relevant than were reductions on a relative-odds scale. All P values were from 2-sided tests and results were deemed statistically significant at $P < .05$.

Our main model examined mortality rates for all visits in aggregate rather than stratifying by disposition for 2 reasons. The first was to reduce the likelihood that mortality trends within each disposition category were simply a reflection of

the shift of patients across categories over time (eg, the average severity of admitted patients may have increased as more patients shifted to observation or were discharged). The second reason was to reflect tradeoffs inherent in the disposition decision that occurs for all ED patients, not just those who are discharged. The ED physician must balance the cost of hospitalization (to the patient and the health care system) against the risk that the patient will become sicker if discharged. We thus thought it was preferable to examine outcomes across the broader population of ED patients for whom this decision is made.

Time Trends in 30-Day ED Visit Mortality

We calculated yearly unadjusted 30-day mortality rates. To determine the unadjusted time trend, we specified a linear probability model with mortality as the outcome and year as the linear predictor. Our subsequent model further incorporated hospital random effects to account for patient clustering, principal diagnosis to account for trends in the presenting conditions, and patient age, sex, Medicaid enrollment, and race/ethnicity as covariates. The final model further incorporated chronic conditions. To examine the degree to which mortality trends were driven by within-hospital changes vs shifting the site of care, we repeated the model for 30-day mortality, incorporating hospital fixed effects instead of random effects.

Time Trends in 30-Day Mortality Stratified by Patient Disposition

Next, we examined mortality trends stratified by disposition. We calculated raw yearly rates for each disposition category. We specified linear probability models with 30-day mortality as the outcome and year as the predictor, adjusting for hospital random effects, diagnosis, patient demographics, and chronic conditions. We did this separately for each disposition category.

Time Trends by Visit Severity

Visit severity was defined by predicted 30-day mortality, derived from a logistic regression model using 2009-2010 data, with 30-day mortality as the outcome and visit diagnosis, patient characteristics, and chronic conditions as predictors, while adjusting for hospital random effects. The coefficients for each predictor were applied to visits in all years to calculate a predicted mortality rate for each visit. Visits in the top quartile of predicted mortality were considered high severity, visits in the middle 50% of predicted mortality were considered medium severity, and visits in the bottom quartile of predicted mortality were considered low severity. To calculate trends in 30-day mortality within each severity category, we specified a linear probability model separately for each category with 30-day mortality as the outcome, adjusting for hospital random effects, patient characteristics, and chronic conditions.

Time Trends by Hospital Characteristics

To examine if the mortality trends were greater for certain types of hospitals, we separately added in the following to our model for adjusted 30-day mortality: hospital size, region, teaching status, profit status, safety-net status, urban or rural location and an interaction term between year and the respective characteristic.

Sensitivity Analyses

We examined mortality on the day of the ED visit, as well as at 7 and 14 days. We also examined high-severity visits stratified by ED disposition. We performed logistic regression for time trends in adjusted 30-day mortality overall and stratified by patient severity. We repeated our main model for 30-day mortality further incorporating an indicator variable for each year of age from 65 to 70 years in addition to including age as a continuous covariate. We examined 30-day mortality trends stratified by visits among beneficiaries aged 65 to 74 years vs those aged 75 years or older. We examined all ED visits using broader diagnosis categories (eAppendix in the Supplement).[4,17,18] Furthermore, to address the concern that our findings may be explained by changing severity of patients' conditions, we calculated annual mean predicted 30-day mortality and quantified the decline in severity of a patient's condition that would be required to explain our observed time trends (eAppendix in the Supplement).

Results

Hospital and Patient Characteristics

There were 15 416 385 ED visits in our sample of 4828 EDs. Key patient, hospital, and visit characteristics are presented in **Table 1**. We excluded 609 304 of 20 672 162 (3.0%) visits because of a missing or nonclassifiable principal diagnosis code. The unadjusted ED rate for the 40 most frequent conditions increased from 360 visits per 1000 Medicare beneficiaries in 2009 to 367 visits per 1000 beneficiaries in 2016 (eTable 1 in the Supplement).

Trends in Disposition From the ED

The unadjusted admission rate declined from 39.1% of visits in 2009 to 32.7% in 2016 (**Figure 1**; eTable 1 in the Supplement), while the percentage of ED visits ending in observation increased from 5.5% in 2009 to 8.6% in 2016. The percentage of transfers increased from 1.7% in 2009 to 1.9% in 2016, while rates of in-ED death decreased from 0.11% to 0.07%. The percentage of ED visits ending in discharge increased from 53.6% in 2009 to 56.7% in 2016. Adjusted disposition trends are presented in eTable 2 in the Supplement. The adjusted rate of ED discharge increased by 0.63% per year (95% CI, 0.62%-0.64% per year; $P < .001$).

Trends in 30-Day Mortality for ED Visits

Unadjusted 30-day mortality declined from 5.1% in 2009 to 4.6% in 2016 (eTable 3 in the Supplement), or −0.068% per year (95% CI, −0.074% to −0.063% per year; $P < .001$; eTable 4 in the Supplement). This trend was similar after adjusting for hospital random effects, visit diagnosis, and patient demographics (−0.064% per year; 95% CI, −0.069% to −0.059% per year; $P < .001$; eAppendix in the Supplement). After adjusting for chronic conditions, we found that the time trend for mortality was −0.198% per year (95% CI, −0.204% to −0.193% per

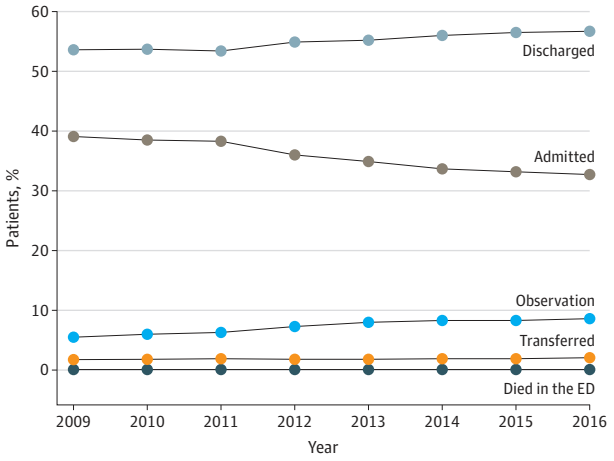
Table 1. Patient and Hospital Characteristics for ED Visits Among Medicare Beneficiaries From 2009 to 2016[a]

	% of Medicare Beneficiaries		
Patient Characteristics	2009[b]	2016	All Visits
Age, mean (SD), y	78.7 (8.3)	78.2 (8.6)	78.6 (8.5)
Age category, y			
65-69	17.2	20.0	18.5
70-74	17.9	19.6	18.5
75-79	18.2	17.9	17.8
80-84	19.5	16.5	17.7
≥85	27.3	26.1	27.5
Female sex	61.1	59.2	60.8
Race/ethnicity			
White	85.2	84.4	84.8
Black	10.2	10.5	10.4
Hispanic	2.0	1.9	1.9
Other	2.6	3.2	2.9
Medicaid eligible	23.1	21.7	22.4
Comorbidity			
Specified heart arrythmias	28.3	30.9	29.6
Congestive heart failure	32.2	31.1	31.1
Chronic obstructive pulmonary disease	27.1	26.1	26.2
End-stage renal disease	2.5	3.6	2.9
Major depressive disorder, bipolar disorder, and paranoid disorder	3.3	4.3	3.6
Principal diagnosis category (5 most frequent)			
Chest pain	8.1	7.3	7.6
Other low respiratory tract disease	6.5	6.3	6.6
Superficial injuries	5.0	4.7	4.7
Abdominal pain	4.8	4.5	4.8
Urinary tract infections	4.2	4.8	4.5
Hospital Characteristics, % of ED Visits			
No. of ED Visits	2 246 792	2 465 210	15 416 385
Region			
Northeast	18.8	17.9	18.3
Midwest	25.0	23.0	23.8
South	40.3	41.3	41.2
West	15.9	17.8	16.7
Size (No. of beds)			
Small (1-99)	19.7	19.5	19.7
Medium (100-399)	54.7	54.3	54.4
Large (≥400)	25.6	26.2	25.9
Profit status			
Nonprofit	72.4	72.4	72.4
For profit	14.8	14.6	14.7
Government, nonfederal	12.9	13.0	12.9
Teaching status			
Major	11.3	11.9	11.5
Minor	32.5	32.2	32.2
None	56.2	55.9	56.3
Rural hospital	7.9	7.1	7.5
Safety-net hospital	18.6	18.4	18.6

[a] Among Medicare beneficiaries aged 65 years or older enrolled in traditional Medicare to the emergency department (ED) at US acute care hospitals in 2009-2016.

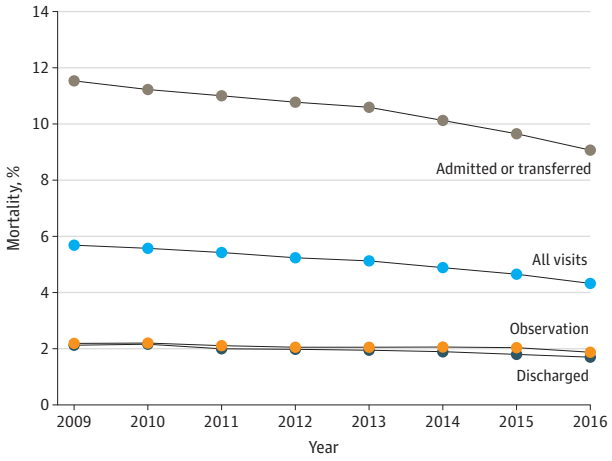
[b] A 5% random sample of Medicare beneficiaries was available for 2009, with 561 698 ED visits for the top 40 condition categories in our sample. The projected sample size for a 20% sample is presented for ease of comparison.

Figure 1. Changes in Disposition From the Emergency Department (ED) Among Medicare Beneficiaries Treated in the United States From 2009 to 2016



Beneficiaries aged 65 years or older seeking care in the ED at an acute care hospital in the 50 United States and the District of Columbia were assigned a disposition from the ED according to the following mutually exclusive hierarchy of categories: admitted (inpatient ED visit), observation (outpatient ED visit with an associated observation claim), died in the ED (outpatient ED visit with a same-day death date), or discharged from the ED.

Figure 2. Adjusted 30-Day Mortality Rates Among Medicare Beneficiaries Treated in US Emergency Departments (EDs) Overall as Well as Stratified by Disposition



Model adjusts for principal diagnosis, hospital random effects, and beneficiary age, sex, race/ethnicity, Medicaid eligibility, and chronic conditions (Hierarchical Condition Categories). Beneficiaries aged 65 years or older seeking care in the ED at an acute care hospital in the 50 United States and the District of Columbia were assigned a disposition from the ED according to the following mutually exclusive hierarchy of categories: admitted (inpatient ED visit), observation (outpatient ED visit with an associated observation claim), died in the ED (outpatient ED visit with a same-day death date), or discharged from the ED.

year; $P < .001$; eTable 4 in the Supplement). The adjusted 30-day mortality rate declined from 5.7% in 2009 to 4.4% in 2016 (**Figure 2**). Our findings were similar after incorporating hospital fixed effects (−0.198% per year; 95% CI, −0.203% to −0.193% per year; $P < .001$), suggesting that the observed trends were driven by within-ED or within-hospital reductions in mortality rather than changing sites of care.

Trends in 30-Day Mortality for ED Visits Stratified by Patient Disposition

For admitted patients, unadjusted mortality increased from 9.5% in 2009 to 9.9% in 2016 (0.079% per year; 95% CI, 0.067%-0.092% per year; $P < .001$; eTables 5 and 6 in the Supplement). However, after adjusting for patient characteristics only, there was a significant decrease in 30-day mortality (−0.033% per year; 95% CI, −0.046% to −0.021% per year; $P < .001$), which was even greater after further adjusting for chronic conditions (−0.356% per year; 95% CI, −0.368% to −0.343% per year; $P < .001$; Figure 2; eTable 6 in the Supplement). A similar pattern was observed for visits ending in transfer and observation. Among discharged patients, there was a decrease across all models examined (−0.059% per year in the final model; 95% CI, −0.064% to −0.055% per year; $P < .001$).

Trends in 30-Day Mortality for ED Visits Stratified by Severity

The model for predicted 30-day mortality had a C statistic of 0.85. The 30-day mortality threshold for defining high-severity visits was 5.1% or greater and the threshold for low-severity visits was less than 1.1%. There was a decline in adjusted 30-day mortality of −0.662% per year (95% CI, −0.681 to −0.644 per year; $P < .001$; **Figure 3**) for high-severity visits, while medium-severity visits (−0.103% per year; 95% CI, −0.108% to −0.097% per year; $P < .001$) and low-severity visits (−0.009% per year; 95% CI, −0.006% to −0.011% per year; $P < .001$) also saw reductions in adjusted 30-day mortality.

Trends in 30-Day Mortality for ED Visits by Hospital Characteristics

We excluded 175 629 visits (1.1%) with missing hospital characteristics from this analysis. Although decreases in 30-day mortality were observed for all hospital types (**Table 2**), the magnitude of the decrease was greater for major teaching hospitals (compared with nonteaching hospitals), nonprofit hospitals (compared with for-profit hospitals), and urban hospitals (compared with rural hospitals).

Sensitivity Analyses

We also observed statistically significant decreases in mortality on the day of the ED visit, as well as at 7 and 14 days in all models examined (eTable 4 in the Supplement) and across all disposition categories for high-severity visits (eTable 7 in the Supplement). Our findings were similar when examining all ED visits (eTables 8 and 9 in the Supplement), when further adjusting for age and stratifying by age category (eTable 8 in the Supplement), and when using logistic regression (eTable 10 in the Supplement). Time trends by diagnosis are presented in eTable 11 in the Supplement. Predicted 30-day mortality increased from 5.2% in 2009 to 6.1% in 2016 (eTable 12 in the Supplement). The mean HCC score increased from 1.96 in 2009 to 2.14 in 2016 (9.6% increase). When we repeated our models maintaining HCC scores at 2009 levels, our decline in 30-day mortality remained statistically significant. It was not un-

til we assumed that the mean HCC score actually decreased by 2% per year from 1.96 in 2009 to 1.70 in 2016 (a 13% decrease) that the decrease in mortality became nonsignificant.

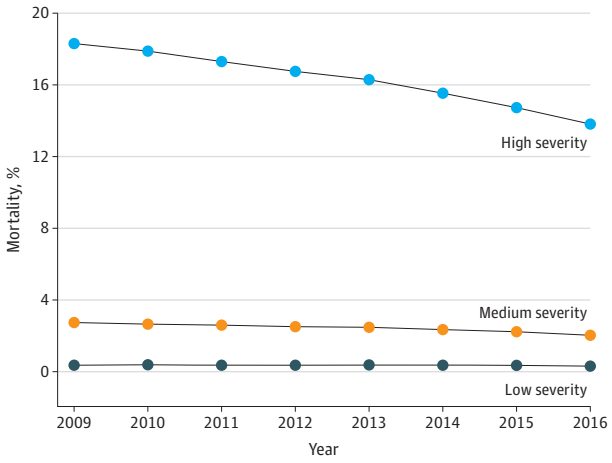
Discussion

Between 2009 and 2016, adjusted 30-day mortality rates for Medicare beneficiaries visiting an ED decreased by 1.4 percentage points, a relative decrease of 23%. These decreases occurred as fewer patients were admitted and a greater proportion were discharged home. Fewer patients died during the ED visits and mortality rates decreased among patients who remained in the hospital for further care as well as among those who were discharged from the ED. This trend was observed across the range of visit severity but was largest for the sickest patients. Although the mortality decline was seen across most types of EDs, it was most pronounced for those at teaching, nonprofit, and urban hospitals. Taken together, these findings suggest that overall outcomes of patients visiting the ED have improved.

It is not fully clear why mortality rates after an ED visit are decreasing. We know that the intensity of ED care is increasing, with more tests and procedures being performed in the ED now than before.[3,4] It is possible that this increased intensity is leading to more accurate diagnosis and more appropriate treatment. Another potential explanation is the growing emphasis on standardizing ED care to ensure best practices and reduce unnecessary variation in quality.[19,20] National quality improvement efforts have often targeted ED care and several, including those implemented as part of the Patient Protection and Affordable Care Act, often focused on high-risk, time-sensitive, and emergency conditions.[21-24] The fact that the mortality decrease was greatest for the sickest patients seems to be consistent with the hypothesis that efforts to improve care for specific, high-risk conditions may have been particularly effective.

One possible explanation for our findings is that patients visiting the ED were healthier in later years. We took multiple approaches to address this concern, including stratifying by specific age and severity groups. Our model quantifying predicted mortality suggested that the population using the ED in later years was actually sicker than the population in earlier years. Of course, it is also possible that changes in coding may have contributed to the observed mortality trends. If the increase in comorbidities over time represents true changes in patient severity as patients with lower-acuity conditions are increasingly managed in alternative settings, which would be consistent with other data,[25] then the fully adjusted mortality trends are accurate. However, if the increase in comorbidities is partly artifactual owing to upcoding, or an increase in documented illness severity on claims without an increase in the true severity of illness, then the true trends lie between the partially and fully adjusted mortality trend estimates. Our analyses suggest that the entire population using the ED would have needed to have become dramatically healthier (as opposed to becoming sicker, which we observed) to fully explain our findings, which seems unlikely.

Figure 3. Rates of Adjusted 30-Day Mortality From 2009 to 2016 for Traditional Medicare Beneficiaries Treated in US Emergency Departments (EDs) for All ED Visits as Well as Stratified by High-, Medium- and Low-Severity Visits



Model for 30-day mortality with time (in years) as the primary predictor and adjusting for principal diagnosis, hospital random effects, and beneficiary age, sex, race/ethnicity, Medicaid eligibility, and chronic conditions (Hierarchical Condition Categories). Beneficiaries aged 65 years or older seeking care in the ED at an acute care hospital in the 50 US states and the District of Columbia had visit severity defined according to predicted 30-day mortality using 2009-2010 data years and applying the coefficients for each predictor (visit diagnosis, patient age, sex, Medicaid enrollment, race/ethnicity, and chronic conditions) to visits in all years to calculate a predicted mortality rate for each visit. High-severity visits were those in the top quartile of predicted mortality, low-severity visits were those in the bottom quartile of predicted mortality, and medium-severity visits were those in the middle 50% of predicted mortality.

Our findings also suggest that certain types of EDs seem to have improved more than others. It is possible that lack of availability of emergency physicians[26] and on-call specialists[27] during the ED visit or follow-up outpatient care after discharge[28-31] may have limited gains in certain types of hospitals. Our finding that rural EDs had higher baseline mortality rates and lesser mortality declines is consistent with the known disparities in urban vs rural health outcomes and challenges facing rural hospitals.[32,33] Given that rural hospitals have seen a disproportionate rise in ED visits, particularly among vulnerable populations,[34] a greater focus on optimizing ED outcomes in rural settings is needed.[35,36]

Our finding of declining rates of hospital admission from the ED is consistent with the shift in health care delivery away from the inpatient setting.[8,37,38] Alternative payment models have incentivized the use of outpatient care[39,40] and some evidence has suggested that reducing the number of admissions from the ED may improve the value of acute care.[4,8,41,42] However, there has also been concern that decreasing admission rates could worsen outcomes if patients who would benefit from a hospitalization are instead discharged home.[10,43,44] Our findings suggest that ED outcomes for Medicare beneficiaries have improved in recent years, even as admission rates have decreased. Thus, it is possible that EDs are improving at identifying which patients can be discharged safely and which individuals need to remain in the hospital for further care.

Table 2. Adjusted Time Trends in 30-Day Mortality Associated With an Emergency Department Visit by Hospital Characteristics From 2009 to 2016[a]

Characteristic	Adjusted Mortality, %		Adjusted Time Trend, %[b]	*P* Value for Interaction[c]
	2009	2016		
Region				
West	5.5	4.0	−0.21	<.001
Midwest	5.8	4.4	−0.21	
Northeast	5.5	4.2	−0.19	
South	5.8	4.5	−0.19	
Size (No. of beds)				
Small (1-99)	5.9	4.6	−0.20	.78
Medium (100-399)	5.6	4.2	−0.20	
Large (≥400)	5.4	4.0	−0.20	
Profit status				
Nonprofit	5.6	4.2	−0.20	.007
For profit	5.6	4.4	−0.18	
Government, nonfederal	6.1	4.8	−0.19	
Teaching status[d]				
Major	5.3	3.9	−0.22	.01
Minor	5.4	4.1	−0.19	
None	5.9	4.5	−0.20	
Safety-net status[e]				
Safety-net	5.6	4.3	−0.20	.31
Non–safety-net	5.7	4.4	−0.19	
Urban vs rural location				
Urban	5.6	4.2	−0.18	.02
Rural	6.2	5.0	−0.20	

[a] Linear regression model with 30-day mortality as the outcome and time (year) as the primary predictor and incorporating hospital random effects, principal visit diagnosis (Clinical Classifications Software category), beneficiary age, sex, Medicaid enrollment, race/ethnicity, and chronic conditions (Hierarchical Condition Categories), and hospital characteristics (hospital region, size, profit status, teaching status, safety-net status, and urban/rural location), as well as an interaction between time and each hospital characteristic as covariates. The model for hospital characteristics was performed separately for each characteristic.

[b] Change in 30-day mortality per year from 2009 to 2016.

[c] Interaction between time and respective hospital characteristic.

[d] Major teaching hospitals were defined by having membership in the Council of Teaching Hospitals, minor teaching hospitals were not members of the Council of Teaching Hospitals but had other medical school affiliation, and all others were considered nonteaching.

[e] Safety-net hospitals were defined as being in the top quartile of the Disproportionate Share Index percent, while all other hospitals were considered non–safety-net hospitals.

This work is consistent with other studies demonstrating that variation remains in the quality of emergency care,[44-46] but that there has been a broad trend toward better outcomes.[47-51] Prior work has suggested that hospital profit status, teaching status, and urban vs rural location are associated with differences in outcomes for patients in the ED[44,45] and that higher-performing hospitals have seen greater improvements in outcomes over time. Others have also found that admission rates from the ED are decreasing over time,[8] while care intensity in the ED is rising.[3,4]

Limitations

This study has several limitations. Although it is national in scope, this study is limited to Medicare fee-for-service beneficiaries. However, Medicare is the primary payer for nearly one-fourth of all ED visits and nearly 90% of visits among adults aged 65 years or older,[7] suggesting that these findings provide a useful window into the evolution of emergency care in the United States. Our sample lacks ED visits among beneficiaries with Medicare Advantage, which has continued to enroll a greater fraction of Medicare beneficiaries. However, for our findings to be explained by the increase in Medicare Advantage penetration, Medicare Advantage would have to be disproportionately enrolling patients with a higher severity of illness in later years in ways that we could not measure, which is unlikely.[52] Finally, it is unclear how much of the observed mortality decrease is attributable to emergency care itself vs subsequent inpatient or outpatient treatment, although the percentage of patients dying in the ED also decreased across the study period.

Conclusions

A Medicare beneficiary visiting an ED in 2016 had a 1.4-percentage point lower risk of dying within 30 days than a comparable patient visiting an ED in 2009. In the context of decreasing admission rates, these findings appear to suggest that ED care in the United States may be improving meaningfully over time.

ARTICLE INFORMATION

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Invited Commentary

Reflections on Mortality and Uncertainty in Emergency Medicine

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Could emergency medicine (EM), which often is characterized as overutilized by patients, criticized as excessive in performing tests, labeled as unjustifiably expensive, and susceptible to diagnostic error, be doing something right? Burke and colleagues[1] found that the mortality rate declined considerably among Medicare beneficiaries who had visited an emergency department (ED) from 2009 to 2016, particularly in patients with high-severity conditions. Given the limits of observational studies, the cause of the lower mortality rate is unknown. We suspect that both EM proponents and detractors will use the study's analysis to validate their own health care policy conclusions.

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Proponents will argue that the decline in mortality among this population reflects technological, organizational, and philosophical improvements in emergency care. Emergency medical services, EM's often neglected partner, has increased regionalization of trauma, stroke, myocardial infarction, and other care. Emergency department door-to-care concepts (eg, balloon, needle, antibiotics) have matured, shifting the threshold to prehospital "first medical contact," to improve earlier disease recognition and resuscitation. These initiatives have aligned specific hospital capabilities and the collaborative teams needed to address time-critical illnesses. Telemedicine has diminished geographic barriers to EM and specialist support. These important gains should be further studied and advanced.

Emergency department approaches to critical conditions have been standardized. A proliferation of escalation teams (airway, behavioral response, labor, pulmonary embolism, sepsis, shock, stroke, ST-elevation myocardial infarction, trauma) and polished processes (eg, massive transfusion) support multidisciplinary collaboration for critical interventions. For those patients presenting without a definitive diagnosis, a plethora of decision tools and advances in laboratory and imaging services have led to more precise risk stratification and conclusions for cardiovascular, neurovascular, traumatic, and venous thromboembolic diseases. Emergency medicine can initiate relevant care, whatever the disposition, and exclude life-threatening diagnoses, limiting uncertainty for inpatient teams and outpatient health care professionals. Emergency