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Trends in High-Intensity Billing for Emergency Care Accompanied by an Increase in Services Provided in the Emergency Department

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Data Sharing

No additional data available.

Details of Contributors

LB had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. LB and RH developed the study concept and LB, RW, EO and RH all substantially contributed to the study design. LB, RW and EO performed the statistical analyses and all authors interpreted the data. LB and RH drafted the manuscript. LB, RW, EO and RH revised the manuscript for important intellectual content. All authors approved the final version of the manuscript.

ABSTRACT (293 words; max 300 words)

Objective: To characterize the trends in billing for high-intensity emergency care among Medicare beneficiaries as well as trends in ED and inpatient services.

Design, Setting, and Participants: Observational study using traditional Medicare claims to identify ED visits at nonfederal acute care hospitals for elderly beneficiaries in 2006, 2009, and 2012.

Outcomes Measures: Billing intensity was defined by emergency physician evaluation and management (E&M) codes. We tested for overall trends in high-intensity billing (E&M Codes 99285, 99291 and 99292) and in services provided over time using linear regression models, adjusting for patient characteristics. Next we classified outpatient visits into one of 39 diagnosis categories and analyzed the change in proportion of high-intensity visits versus the change in number of services. Finally, we quantified the extent to which trends in high-intensity billing are explained by changes in patient demographics and services provided in the ED.

Results: High-intensity visits grew from 45.5% of 671,103 visits in 2006 to 57.7% of 629,010 visits in 2012 (2.0% absolute increase per year (95% CI 1.97% to 2.03%) as did the mean number of services provided for admitted (1.28 to 1.41; +0.02 increase in procedures per year (95% CI 0.018 to 0.021) and discharged ED patients (7.1 to 8.6; +0.23 increase in procedures per year, (95% CI 0.245 to 0.251). When we stratified by diagnosis category, there was a moderate correlation between change in visits billed as high intensity and the change in mean number of

services provided per visit (ρ=0.38, (95% CI 0.07 to 0.63). Trends in patient characteristics and services provided moderately accounted for the trend in practice intensity for outpatient visits (pseudo R^2 of 0.47).

Conclusions: Increase in services provided in the ED moderately accounts for the trends in billing for high-intensity emergency care for outpatient visits.

STRENGTHS AND LIMITATIONS OF THIS STUDY

Strengths

- Trends in billing for the highest intensity of emergency care (as determined by physician professional billing codes) as well as trends in admission rate and number of procedures were determined using longitudinal linear regression adjusting for patient age, race, sex, and Medicaid coverage for 1,883,650 emergency department visits by Medicare beneficiaries across in the United States in 2006, 2009 and 2012.
- To evaluate the extent to which trends in practice intensity are explained by changes in patient characteristics and practice patterns, we used generalized logistic regression modeling with the binary intensity variable as the outcome and time as the predictor sequentially incorporating beneficiary demographic characteristics, followed by number of services per visit and finally beneficiary chronic conditions and calculated a pseudo-R^2 for each model.

Limitations

- Key limitations of this study that are inherent to the use of administrative data include lack of clinical information such as vital signs, laboratory results, and total time spent in the emergency department undergoing treatment and observation.
- Additionally, there is substantially less detail regarding laboratory and radiology services provided for inpatient ED visits compared to visits that result in discharge from the ED.
- Also, while national in scope, our analysis is limited to elderly fee-for-service Medicare beneficiaries and may not be generalizable to other populations.

INTRODUCTION

The rising cost of healthcare in the United States has received increasing attention[1] as it has strained state and federal budgets[2 3] and directly impacted individuals via lost income and higher out-of-pocket costs.[4] Emergency care has often been portrayed as an expensive and inefficient contributor to the healthcare crisis.[5-7] Concerns about the cost of emergency care have led to a variety of initiatives seeking to steer patients away from the ED to lower cost settings during an acute illness.[8 9] Despite these concerns, the number of ED visits in the U.S. has continued to rise,[10 11] as have the numbers of visits billed at the highest level of intensity.[12] As billing for high-intensity emergency care has risen, some have questioned whether the growth of electronic health records (EHRs) has exacerbated the problem by allowing providers to more easily "upcode" or bill for services without changing the work performed.[13]

While prior work has suggested that EHRs have not led to upcoding for inpatient care,[14] relatively little is known about this phenomenon for emergency care. Some evidence suggests trend in high-intensity billing for emergency care reflects trends in actual practice[15 16] as the ED has assumed an increasingly prominent role in managing acute, unscheduled care[17] for a population that is aging and experiencing a growth in chronic diseases.[18] Prior studies have demonstrated that the average number of services provided during an ED visit, such as diagnostic testing and treatment, has also risen over time.[15 16] However, to our knowledge, no studies have used multivariable modeling at the visit level to examine the degree to which trends in high-intensity billing may be explained by trends in clinical practice and patient complexity.

Given the increasing importance of the ED in providing acute care[19] and its prominence in the healthcare cost debate, we sought to evaluate the trends in intensity of emergency care, as captured by billing codes emergency care by addressing three questions. First, what are the trends in billing for high-intensity care in the Medicare fee-for-service population and to what extent are these trends accompanied by changes in patient characteristics and other clinical markers of acuity and complexity? Second, do particular diagnoses or conditions have greater changes in intensity over time, and, if so, are these variations associated with trends in services? Finally, how much of the trend in high-intensity billing is explained by trends in services provided and patient characteristics?

METHODS

Study Design and Setting

We used a five percent sample of Medicare fee-for-service claims to identify ED visits in 2006, 2009, and 2012. We examined ED visits by beneficiaries who were continuously-enrolled, age 65 and over, not enrolled in private insurance, and presenting to nonfederal acute care hospitals. The billing intensity level was obtained by identifying all claims in the Carrier file with emergency physician Current Procedural Terminology (CPT) Healthcare Common Procedure Coding System (HCPCS) evaluation and management codes 99281-99285, 99291 and 99292. Patient characteristics were obtained from the Master Beneficiary Summary File. Information such as visit diagnosis and services provided were obtained from the Inpatient file for admitted patients and the outpatient file for discharged and observation patients. Since claims for substance abuse related visits were no longer available in Medicare data in 2012,[20] we dropped substance abuse claims from the prior years. We used the American Hospital

Association survey from 2012 to obtain data on hospital characteristics and linked this to ED claims using Medicare provider identification numbers.

Outcomes

Our primary outcome was ED visit practice intensity level, defined by CPT code as selected by the treating emergency physician or designee. CPT codes 99281 and 99282 represent low complexity, 99283 and 99284 represent moderate complexity, 99285 represents high complexity, while codes 99291 and 99292 are used to denote that critical care services were provided. We created a binary intensity outcome variable, categorizing visits with codes 99281-99284 as low-intensity and those with codes 99285, 99291, and 99292 as high-intensity.

Secondary outcomes included overall hospital admission rate, intensive care unit (ICU) rate, as well as mean number and type of procedures per visit. For ED visits resulting in an inpatient admission, we determined the principal admission diagnosis as well as the mean number and type of services, as represented by International Classification of Diseases, Ninth Revision (ICD9) procedure codes. Inpatient services may have been provided at any time during that hospitalization, including during treatment in the ED, as we were unable to distinguish the location of services provided for admitted patients in this dataset. For outpatient ED visits, we looked at principal diagnosis, the mean number and type of ED services per visit. Other markers of complexity and acuity were investigated as secondary outcomes including hospital admission rate and intensive care unit (ICU) admission rate.

We looked at the following beneficiary characteristics: age, race, sex, Medicaid-eligibility, and number of chronic conditions as indicated by the Hierarchical Condition

Categories (HCCs).[21] We also categorized the following hospital characteristics in each year: region, rural vs. urban location (RUCA), size and teaching, and profit and trauma center status.

Analysis

Trend in Practice Intensity

Changes in practice intensity were estimated by regressing a binary outcome (high or low intensity) as continuous on time and controlling for patient characteristics. Patient age, race, sex, and Medicaid coverage were used for the patient characteristics. Analysis occurred at the visit level with each visit coded as high or low intensity. Generalized estimating equations were used to account for clustering. The adjusted estimates of the proportion of high-intensity visits were graphed over time and rates of change over the study period were tested for statistical significance. In addition to examining the binary high-intensity outcome variable we examined the time trends for each of the seven intensity categories individually.

Visit Rate

We next examined how the rate of high-intensity visits and overall ED visits changed. An increase in the relative proportion of high-intensity visits could potentially reflect a reduction in low acuity visits over time,[5 22] so we calculated a per-beneficiary rate of overall high-intensity and low-intensity visits for each year and tested for a time trend using negative binomial regression.

Secondary Outcomes

We then calculated the overall hospital admission rate (percentage of ED visits leading to a hospital admission) and the ICU admission rate (percentage of ED visits leading to an ICU admission). We tested for a time trend using linear regression, adjusting for age, race, sex and Medicaid coverage. Time trends in mean number of inpatient services, and outpatient services were tested using linear regression, adjusting for age, sex, race, and Medicaid eligibility. We used the Clinical Classifications Software developed by the Agency for Healthcare Research and Quality (HCUP-CCS) to classify ICD-9 procedures codes for inpatient services and CPT codes for outpatient services into 39 clinically meaningful categories (see Appendix 1). Additionally, we looked at the Carrier professional fees claims file in our sample with CPT codes other than the practice intensity codes to determine the number and type of physician-performed services billed.

Trends in Practice Intensity by Diagnosis Category

We categorized the principal diagnosis for each outpatient visit into one of 39 diagnosis categories previously described in the emergency medicine literature[23] and used the analogous adjusted longitudinal linear regression model for each diagnosis to estimate the percentage of total visits in each year categorized as high-intensity as well as the absolute change in proportion of high-intensity visits. We limited this analysis to outpatient visits because we could not distinguish services provided in the ED from those provided in the inpatient setting for those visits leading to a hospital admission. For each diagnostic category, we calculated the change in high-intensity visit rate and the change in ED services between 2006 and 2012. The changes were graphed against each other and a correlation coefficient was calculated to capture the degree to which the two were associated with each other.

Mediation Analysis

We used generalized logistic regression modeling, controlling for repeated hospital measures, to investigate the extent to which trends in practice intensity are explained by concomitant changes in patient characteristics and other observable indicators of practice intensity (services performed). We specified four models with the initial model having the binary variable intensity as the outcome and time as the predictor. The second model incorporated beneficiary characteristics. The third model incorporated inpatient, outpatient, and physician-billed services. The fourth model further incorporated number of chronic conditions. We calculated a pseudo R^2 for each model[24 25] as a measure of the proportion of total variation explained by the model. We ran these models for all visits and for inpatient and outpatient visits separately.

Sensitivity Analysis

There has been a growth in use of observation services for Medicare beneficiaries[26 27] both in the ED and the inpatient setting.[28] There has been some concern that the concomitant growth in observation status and decline in hospital admissions may represent substitution in response to Medicare payment policies.[26] To evaluate if our results were sensitive to inclusion of observations visits in our sample, we recalculated the admission rate and mean number of inpatient and outpatient services and repeated our mediation analysis after reclassifying all observation claims as admissions,

Analyses were conducted using SAS version 9.3 (SAS institute). The Office of Human Research Administration approved this study.

RESULTS

Characteristics of Study Sample

We examined 1,883,650 ED total visits. Patient and hospital characteristics are summarized for all ED visits in Table 1. There was a decrease in the proportion of ED visits by women (66.1% to 60.6%; -0.94% absolute decrease per year [95%CI, -0.97% to -0.91%]; p<.001) and whites (85.9% to 84.1%; -0.29% absolute decrease per year [95%CI, -0.31% to -0.27%]; p<.001) while all other racial groups saw a slight increase. The proportion of visits by Medicaid beneficiaries rose from 22.4% in 2006 to 23.1% in 20012 (+0.12% absolute increase per year [95% CI, 0.09% to 0.14%]; p<.001). The average number of chronic conditions per beneficiary increased slightly from 4.61 in 2006 to 4.91 in 2012 (+0.05 conditions/ per year [95% CI, 0.050 to 0.054]; p<.001). When we stratified by high and low-intensity ED visits, the number of HCCs was higher for beneficiaries with a high-intensity visit than for those with a low-intensity visit (5.96 vs 3.93, respectively in 2012; Table 1). Over the study period there was an increase in proportion of visits to urban (71.5% in 2006 to 73.1% in 2012; +0.26% absolute increase per year [95% CI, 0.24% to 0.29%]; p<.001), large (23.6 to 26.4%; +0.48% increase per year [95% CI, 0.46% to 0.50%]; p<.001), minor teaching (26.4% to 30.8%; +0.74% per year [95% CI, 0.72% to 0.77%]; p<.001), for-profit hospitals (12.9% to 14.9%; +0.33% per year [95% CI, 0.31% to 0.35%]; p<.001), and trauma centers (38.2% to 43.7%; +0.91% per year [95% CI, 0.88% to 0.93%]; p<.001).

Trends in Practice Intensity

The most frequent intensity code in all three years was 99285, also known as a level 5 visit (Appendix 2). Level 5 visits represented 39.7% of all ED visits in 2006 and rose to 49.4% in 2012 (+1.6% per year [95% CI, 1.57% to 1.63%]; p<.001). There was also an increase in visits that were billed at a critical care level (CPT 99291) from 5.0% of all visits in 2006 to 7.6% in 2012 (+0.4% increase per year [95% CI, 0.39% to 0.41%]; p<.001). CPT 99292 comprised of less than 1% of all visits in both years and showed a small increase that was not statistically significant (+0.004% increase per year [95% CI, -0.0003% to +0.009]; p<.001). Thus, the combined proportion of high-intensity visits overall rose from 45.8% in 2006 to 57.9% in 2012 (+2.0% per year [95% CI, 1.97% to 2.03%]; p<.001; Figure 1). We observed a concomitant decrease over time in each of the four CPT codes categorized as low-intensity (Appendix 2).

Trends in Visit Rates per Beneficiary

We found an increase from 535 to 565 ED visits per 1,000 beneficiaries that was not statistically significant (0.9% increase per 1,000 beneficiaries per year [95%CI, -1.1% to 2.9%]; p=0.37, Figure 2). There was a significant increase in the high-intensity visit rate from 241 to 322 per 1,000 beneficiaries (4.9% increase in high-intensity visits per 1,000 beneficiaries per year, [95% CI, 2.0% to 7.8%]; p<.001) while the rate of low-intensity visits per beneficiary decreased (294 to 243 visits per 1,000 beneficiaries; -3.2% decrease in low-intensity visits per 1,000 beneficiaries per year [95% CI, -5.9% to -0.4%]; p=0.03).

Trends in Patient Acuity and Treatment Intensity

We found that there was a reduction in admission rate from the ED over time, with 35.9% of visits leading to admission in 2012 compared to 40.1% in 2006 (-0.68% per year [95% CI, -

0.71% to -0.65%]; p<.001; Table 2). The number of visits with an associated observation claim rose from 15,914 visits (3.9% of total) in 2006 to 22,226 visits (5.4% of total) in 2012. However, even after reclassifying observation claims as admissions, there was still a statistically significant decrease in admission rate from 42.1% in 2006 to 39.1% in 2012 (-0.48% per year [95% CI, -0.51% to -0.45%]; p<.001). In contrast, the proportion of all ED visits resulting in an ICU admission increased (11.7% to 12.3%; +0.11% per year, [95% CI, 0.09% to 0.12%]; p<.001). When we looked at inpatient services for admissions from the ED, we found an increase in the mean number of total services (1.28 to 1.41 per admissions; +0.02 procedures per year, [95% CI, 0.018 to 0.021]; p<.001), which persisted even after reclassifying observation claims as admissions (1.23 to 1.29; +0.011 procedures per year [95% CI, 0.009 to 0.012]; p<.001). High-intensity admissions had a greater number of services in each year and both groups saw an increase over time in the mean number of services (Table 2). The most frequent inpatient services by year are presented in Appendix 3. Several critical care procedures and services saw an increase over time including respiratory intubation and mechanical ventilation (9.9% of all admissions from the ED in 2006 compared to 12.6% in 2012 (+0.45% per year [95% CI, 0.41% to 0.49%]; p<.001), blood transfusion (12.4% to 15.4%; +0.52% per year [95% CI, 0.48% to 0.56%]; p<.001), and other vascular catheterization, not heart (7.6% to 10.6%; +0.41% per year [95% CI, 0.38% to 0.44%]; p<.001).

Outpatient ED visits saw a significant increase in total average number of services per visit from a mean of 7.1 in 2006 to 8.6 in 2012 (+0.25 increase in mean services per year [95% CI, 0.245 to 0.255]; p<.001). High-intensity visits, relative to low-intensity visits, had a greater number of services in each year. High-intensity visits saw a significant increase in services (12.9 to 13.7; +0.14 services per year [95% CI, 0.13 to 0.15]; p<.001) whereas low-intensity visits saw

a slight decrease (5.3 to 5.2; -0.008 services per year [95% CI, -0.121 to -0.003] p<.001; Table 2). After reclassifying observation claims as admissions, the mean number of outpatient services still saw an increase from 6.7 to 8.1 services per visit (+0.23 increase per year, [95% CI, 0.22 to 0.23]; p<.001). The most frequent services provided during an outpatient ED visit are presented in Appendix 4.

Trends by Diagnosis

Upon examining the thirty-nine condition categories individually (Appendix 1), diagnosis categories with the largest change in the proportion of high-intensity visits tended to have a mid-range baseline intensity (Appendix 5). Skin and subcutaneous infections had the lowest absolute change (5.9% of visits categorized as high-intensity in 2006 to 13.6% in 2012; +7.8% [95% CI, 6.4% to 9.3%]; p<.001) and intestinal infections had the greatest (25.2%; from 28.1% in 2006 to 53.3% in 2012; +25.2% [95% CI, 20.8% to 29.6%]; p<.001). We found that those diagnoses with greater increases in intensity tended to have an increase in mean number of services (Figure 3), with moderate correlation (r=0.38 [95% CI, 0.07 to 0.63]; p=0.02) between the change in percentage of high-intensity visits and the change in mean number of services provided per visit for each diagnosis category.

Impact of Patient Characteristics and Services on High-Intensity Billing

We next used four separate logistic regressions to determine the extent to which the trends in practice intensity are explained by observable markers of practice intensity and patient characteristics (Appendix 5). Incorporating services into our model for ED practice intensity increased the variability explained by our model from 8.0% (with time, demographics and co-

morbidities) to 14.8%. However, the model performance varied greatly by disposition, with the pseudo R^2 increasingly from 4.3% to 46.5% for outpatient visits, while only increasing from 5.0 to 5.1% for inpatient visits. Incorporation of services in the model led to the greatest increase for both outpatient and inpatient visits. When we reclassified observation claims as admissions, our results were similar (pseudo R^2 of 0.14 for visits overall, 0.04 for inpatient visits, and 0.44 for outpatient visits).

DISCUSSION

In our study of elderly Medicare beneficiaries, we found that ED visits are increasingly billed at the highest levels of intensity, with nearly 60% of ED visits in our sample coded at a Level 5 or critical care in 2012. We found a concomitant increase in services provided in the ED and during an associated inpatient stay. While overall admission rate decreased over time, a greater fraction of ED visits resulted in admission to intensive care. We found that trends in high intensity billing varied by clinical condition; diagnoses with the greatest change in high-intensity billing also had the greatest increase in number of services. These findings persisted when we repeated our analyses reclassifying observation claims as admissions. Finally, using multivariable modeling, we found that trends in patient characteristics as well as in services provided during the visit moderately accounted for the increase in practice intensity for outpatient ED visits.

Our results are consistent with other work showing a growth in high-intensity emergency care. A study of all ED visits in California[29] also demonstrated a growth in physician billing for high-intensity visits, particularly among safety net hospitals. Other studies using national datasets have documented greater use of tests and treatments in the ED such as advanced

imaging, blood tests and IV fluids.[15 16] Exploring the idea that doing more in the ED can prevent hospitalizations, one study found that greater use of CT scans was associated with a reduction in admissions and transfers.[30] Our study adds to this literature by linking billed practice intensity to the procedures and services provided at the visit level for a national sample of Medicare beneficiaries and includes both outpatient and inpatient visits. We found the greatest increase in high-intensity billing among conditions with moderate baseline intensity for which the decision to admit may involve provider discretion; patients with conditions such as pneumonia and intestinal infections may safely avoid admission with a thorough ED work-up and adequate time for monitoring to ensure stability.

Our study of ED visits is consistent with other studies suggesting that the fears of upcoding due to EHRs may not be fully warranted.[14] Using multivariable modeling, we found that observable factors such as patient characteristics and numbers of services and procedures moderately explained the trends in billed practice intensity for outpatient visits. It is possible that part of the residual effect could be attributed to upcoding; our study, however, is unable to identify conclusively whether this is the case.

ED visits in the U.S. have continued to rise[10 31-33] despite health insurance expansion and cost control efforts that were predicted to reduce ED utilization. The role of emergency medicine in the acute care landscape has also expanded,[19] with the ED serving as the source of most unscheduled admissions.[17 34] EDs have assumed greater responsibility for managing complex problems while reserving limited and costly hospital capacity for those truly requiring inpatient care. With the growth of alternative payment models, reducing admissions for ED patients with moderate severity problems has been proposed as a strategy to reduce costs.[35] Initiatives aimed at reducing admissions, such as clinical pathways and ED observation units, depend on the

expertise of emergency providers in performing complex but efficient work-ups. Our findings are consistent with this new model of emergency care. We found an increase in services while admission rates fell, even after accounting for the growth in observation stays. While our study was not designed to assess the relationship between intensity of emergency care and admission rate, it is possible that doing more for patients in the ED may have allowed a greater number to be safely discharged. The rise in number of services, including critical care procedures, provided during hospital admission, including critical care procedures, suggests that the average acuity of patients who ultimately are admitted may be increasing over time.

Our study has a number of limitations. Given the use of administrative data, clinical markers of acuity such as vital signs and laboratory data were not available. Also, time spent observing and treating patients is another key component of practice intensity that we could not measure with our dataset. Additionally, it is not possible to distinguish ED observation status from ward observation status in Medicare data, although the former represents actual work done in the ED whereas the latter is functionally similar to an inpatient admission. If ED length of stay or observation status were observable in our data set, they might potentially account for some of the remaining time trend in practice intensity. Additionally, our modeling explained relatively little of the variation for inpatient visits and ED visits overall. This is likely due to the fact that, unlike for outpatient visits, services provided during an ED visit that ultimately results in an admission are not distinguishable from those provided during subsequent hospitalizations. Also, there is substantially less detail regarding laboratory and radiology services provided for inpatient ED visits. Thus, it is impossible to adequately characterize work done in the ED for admitted patients to the same degree as was done for those who were discharged. Also, while

national in scope, our analysis is limited to elderly fee-for-service Medicare beneficiaries and may not be generalizable to other populations.

In summary, the rise in billing for high-intensity emergency care has been portrayed as an unintended consequence of the growth of health information technology rather than reflecting a change in practice. However, this trend has been accompanied by an increase in the provision of services in the hospital as well as in the ED. Multivariable modeling incorporating patient characteristics, comorbidities and services provided moderately explained the trends in high-intensity billing. This rise in high-intensity emergency care has occurred while rates of admission from the ED have fallen, raising the possibility that a greater amount of work performed in the ED may have allowed more patients to avoid inpatient treatment during an acute episode. Further study may be useful in determining what impact the trend in high-intensity emergency care has had total costs of care as well as patient outcomes.

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TABLES

Table 1. Beneficiary and Hospital Characteristics as a Percentage of Total Emergency Department Visits by Year

		2006	2009	2012	Change, % per year (95% CI)*
Beneficiary Characteristics					
Age	Mean, yrs	79.3	78.9	78.8	-0.08 (-0.08 to -0.07)
	65-69	13.8%	16.1%	17.1%	+0.55 (0.53 to 0.57)
	70-79	37.6%	36.7%	36.9%	-0.12 (-0.15 to -0.09)
	>=80	48.7%	47.2%	46.1%	-0.43 (-0.46 to -0.40)
Gender	Female	66.1%	60.9%	60.6%	-0.94 (-0.97 to -0.91)
Race	White	85.9%	84.8%	84.1%	-0.29 (-0.31 to -0.27)
	Black	10.4%	10.7%	11.0%	+0.11 (0.10 to 0.13)
	Asian	0.9%	1.2%	1.3%	+0.06 (0.06 to 0.07)
	Hispanic	1.7%	2.0%	1.9%	+0.04 (0.03 to 0.05)
	Other	1.2%	1.4%	1.7%	+0.05 (0.04 to 0.06)
Medicaid Coverage	Yes	22.4%	23.2%	23.1%	+0.12 (0.09 to 0.14)
Average Number of HCCs per Beneficiary	Overall	4.6	4.9	4.9	+0.05 (0.049 to 0.054)
	Low Intensity Visits	3.9	4.0	3.9	+0.012 (0.0098 to 0.015)
	High Intensity Visits	5.5	5.7	5.7	+0.023 (0.0199 to 0.026)
Hospital Characteristics					
Region	Northeast	19.9%	19.5%	18.7%	-0.20 (-0.22 to -0.17)
	Midwest	25.2%	23.4%	23.0%	-0.38 (-0.36 to -0.41)
	South	39.9%	41.2%	41.9%	+0.33 (0.30 to 0.36)
	West	14.0%	15.3%	15.8%	+0.30 (0.28 to 0.32)
RUCA	Urban	71.5%	72.9%	73.1%	+0.26 (0.24 to 0.29)
	Suburban	3.0%	3.1%	3.1%	-0.13 (-0.15 to -0.11)
	Large Rural Town	16.1%	15.4%	15.3%	-0.13 (-0.15 to -0.11)
	Small Town/Isolated Rural	8.3%	7.6%	7.4%	-0.16 (-0.17 to -0.14)
Teaching Status	Major	12.3%	12.7%	12.3%	+0.11 (-0.02 to +0.02)
	Minor	26.4%	27.2%	30.8%	+0.74 (0.72 to 0.77)
	Non-Teaching	60.4%	59.5%	56.2%	-0.69 (-0.72 to -0.66)
Size	Small (1-99 beds)	16.9%	15.7%	16.2%	-0.12 (-0.15 to -0.10)
	Medium (100-399 beds)	58.6%	58.1%	56.8%	-0.30 (-0.33 to -0.28)
	Large (400+ beds)	23.6%	25.6%	26.4%	+0.48 (0.46 to 0.50)
Profit Status	For Profit	12.9%	13.5%	14.9%	+0.33 (0.31 to 0.35)
	Not For Profit	73.9%	73.3%	72.5%	-0.24 (-0.26 to -0.21)
	Government, nonfederal	12.3%	12.6%	12.0%	-0.04 (-0.06 to -0.02)
Trauma Center	No	49.2%	47.2%	44.2%	-0.83 (-0.86 to -0.80)
	Yes	38.2%	40.6%	43.7%	+0.91 (0.88 to 0.93)
	Missing	12.5%	12.2%	12.1%	-0.07 (-0.09 to -0.05)

All differences were statistically significant at p<.001 with the exception of proportion of visits to major teaching hospitals (p=0.92).

Table 2. Trends* in selected markers of acuity or complexity for emergency department visits

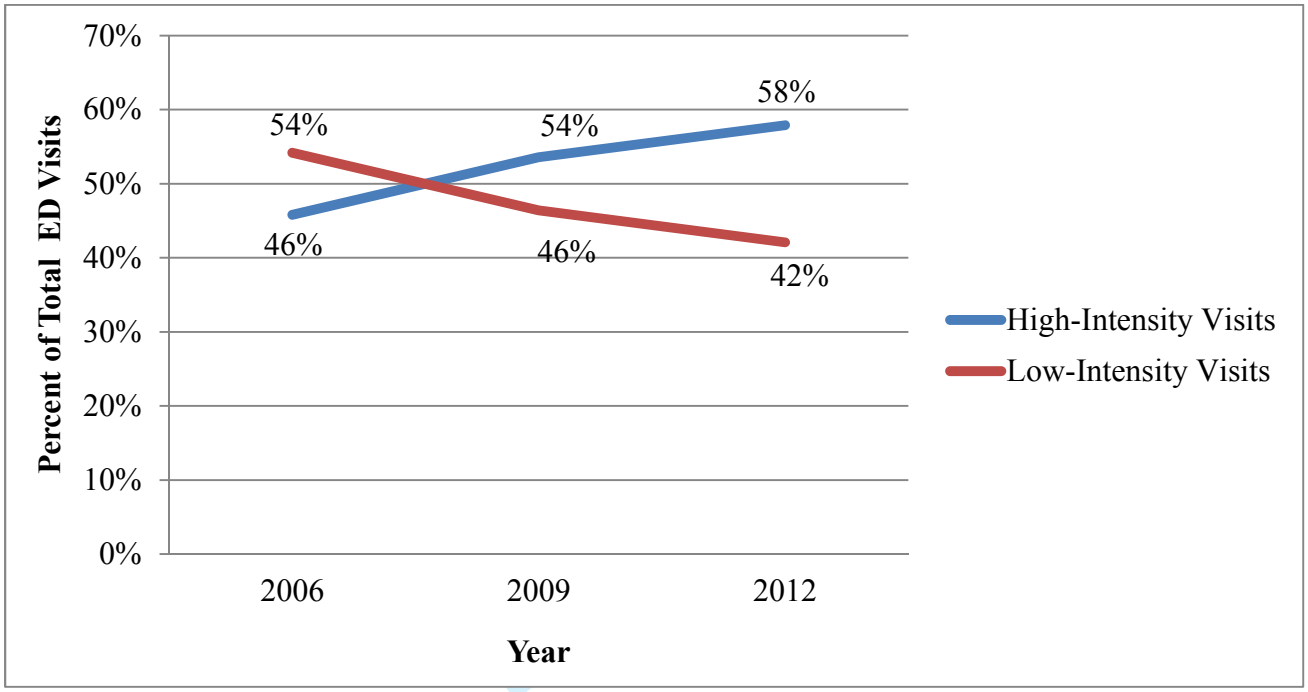
	2006	2009	2012	Time Trend per Year, % (95% CI)	P-Value
Hospital Admission Rate	40.1%	38.7%	35.9%	-0.68 (-0.71 to -0.65)	<.001
Intensive Care Unit Admission Rate	11.7%	12.6%	12.3%	+0.11 (0.09 to 0.12)	<.001
Mean Number of Services per Admission†				**Change in Services per Year, % (95% CI)**	
All Admissions	1.28	1.31	1.41	+0.02 (0.018 to 0.021	<.001
Low-Intensity	1.22	1.33	1.34	+0.02 (0.017 to 0.025)	<.001
High-Intensity	1.30	1.31	1.41	+0.017 (0.015 to 0.019)	<.001
Mean Number Services per Outpatient‡ ED Visit				**Change in Services per Year, % (95% CI)**	
All Outpatient Visits	7.11	8.05	8.60	+0.25 (0.25 to 0.26)	<.001
Low-Intensity Outpatient Visits	5.28	5.39	5.22	-0.008 (-0.01 to -0.003)	0.001
High-Intensity Outpatient Visits	12.85	13.37	13.68	+0.14 (0.13 to 0.15)	<.001

*Longitudinal linear regression models were used to estimate the time trend, adjusting for patient age, race, sex, and Medicaid eligibility. Generalized estimating equations were used to adjust for clustering.

†Inpatient services are ICD-9 procedures.

‡Outpatient services are represented using Current Procedural Terminology (CPT)/ Healthcare Common Procedure Coding System (HCPCS) codes.

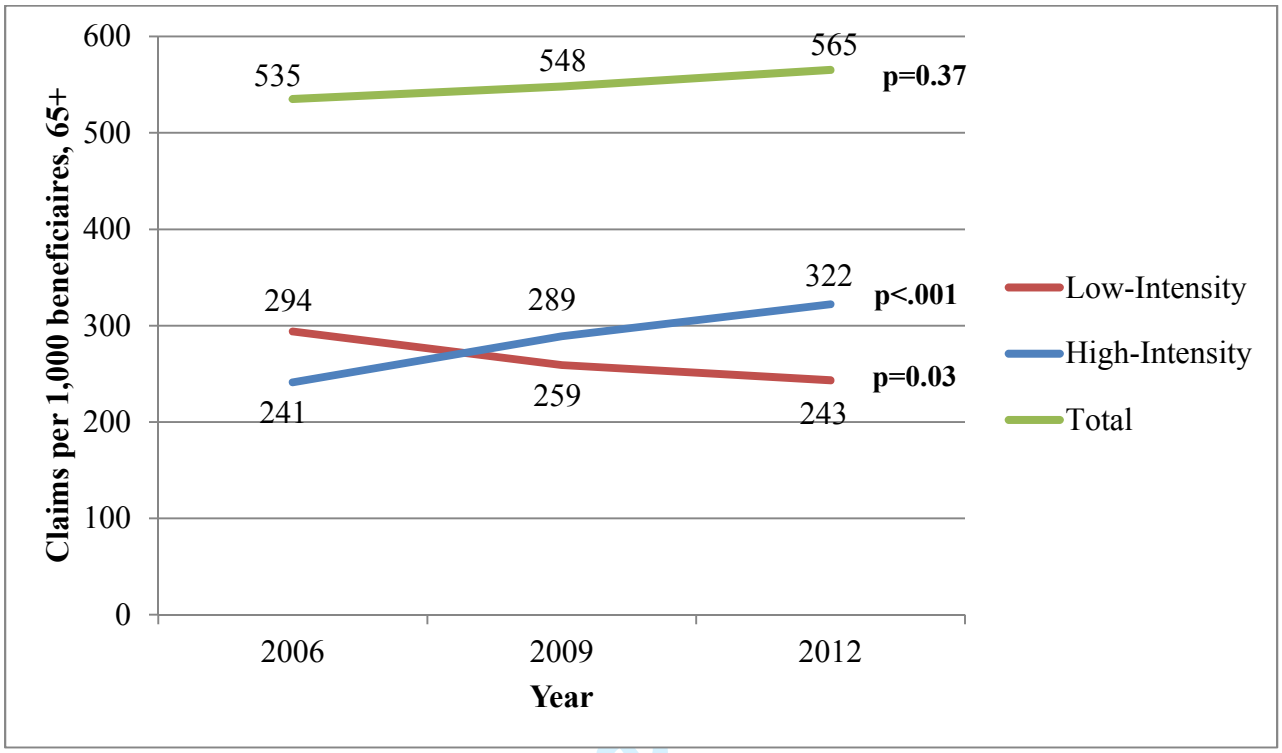
Figure 1. Adjusted Time Trends* in Billing for High- and Low- Intensity‡ Emergency Care



*Longitudinal linear regression was used to estimate the time trend, adjusting for patient age, race, sex, and Medicaid coverage. Generalized estimating equations were used to adjust for clustering.

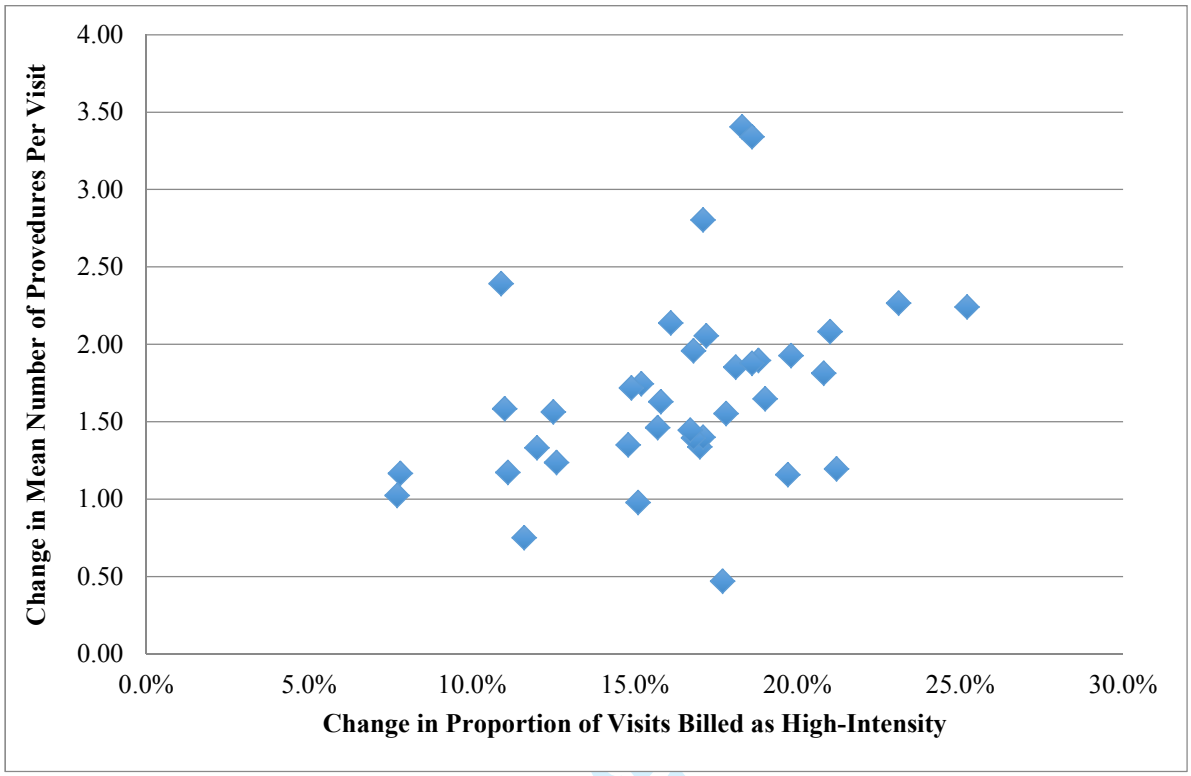
‡High-intensity visits are coded as 99285 or critical care (99291, 99292). Low-intensity visits are defined by emergency physician billed CPT/HCPCS codes 99281-99284.

Figure 2. Unadjusted Rate of Emergency Department Visits per 1,000 Medicare* Beneficiaries Overall and Stratified by Intensity



*Traditional Medicare beneficiaries age 65 and over with continuous coverage during the year.

Figure 3. Absolute Change in Visit Intensity Over Time versus Absolute Change in the Mean Number of Services by Diagnosis Category* for Outpatient Emergency Department Visits†



*Thirty-nine diagnosis categories previously defined in the emergency medicine literature (Gabayan, G.Z., et al. Ann Emerg Med, 2013. 62(2): p. 13).
†Changes in mean number of procedures and proportion of high intensity visits adjusted for patient age, sex, race and Medicaid eligibility.

Appendices for "Trends in High-Intensity Billing for Emergency Care Accompanied by an Increase in Services Provided in the Emergency Department"

Appendix 1. Proportion of Emergency Department Visits Billed as High-Intensity Visits by Diagnosis Category

Appendix 2. Trends in Billing* for High-Intensity Emergency Care

Appendix 3. Most Frequent Services among Emergency Admissions by Year

Appendix 4. Most Frequent Services among Outpatient Emergency Department Visits

Appendix 5. Absolute Change in Proportion of High-Intensity Visits versus Baseline Proportion of High-Intensity Visits by Diagnosis Category for Outpatient Emergency Department Visits

Appendix 6. Comparison of Pseudo R^2 for Sequential Models Incorporating Explanatory Variables for the Trend in Emergency Department (ED) Practice Intensity

Appendix 1. Proportion of Emergency Department Visits Billed as High-Intensity Visits* by Diagnosis Category†

		2006	2009	2012	Absolute Change, % (95% CI)
1	*Minor injuries*	8.5%	14.4%	20.5%	12.0 (11.6 to 12.9)
2	*Major injuries*	34.0%	42.3%	51.7%	17.7 (14.8 to 20.6)
3	*Other injuries*	7.3%	12.3%	18.9%	12.0 (11.5 to 12.5)
4	*Symptoms: abdominal pain*	31.3%	44.0%	52.4%	21.0 (20.1 to 22.0)
5	*Symptoms: chest pain*	65.2%	77.5%	82.4%	17.2 (16.4 to 17.9)
6	*Symptoms: dizziness, vertigo, and syncope*	42.9%	57.3%	66.1%	23.0 (22.1 to 23.8)
7	*Symptoms: headache*	21.7%	30.5%	39.7%	17.9 (16.3 to 19.5)
8	*Other symptoms*	25.3%	35.7%	44.1%	18.8 (17.9 to 19.7)
9	*Upper respiratory infections*	12.8%	20.5%	27.6%	14.7 (13.5 to 15.9)
10	*Intestinal infections*	28.1%	40.1%	53.3%	25.2 (20.8 to 29.6)
11	*Urinary tract infection*	18.4%	27.3%	34.1%	15.9 (15.0 to 16.9)
12	*Other infectious and parasitic diseases*	12.6%	20.4%	23.6%	11.0 (9.1 to 12.9)
13	*Skin and subcutaneous infection*	5.9%	10.0%	13.6%	7.7 (6.4 to 9.3)
14	*Endocrine, nutritional; immunity and metabolic disorders*	29.0%	38.7%	45.8%	16.8 (15.6 to 18.0)
15	*Diabetes mellitus*	25.3%	33.5%	40.5%	15.0 (13.3 to 16.6)
16	*Hypertension*	24.4%	35.1%	41.4%	16.9 (15.6 to 18.3)
17	*Nonatherosclerotic heart disease*	61.2%	71.3%	78.3%	17.0 (14.6 6o 19.4)
18	*Dysrhythmias*	52.7%	65.4%	72.4%	19.6 (18.4 to 20.9)
19	*Ischemic heart disease*	75.8%	82.6%	86.7%	11.0 (9.0 to 12.9)
20	*Congestive heart failure*	57.2%	68.7%	75.8%	18.3 (16.5 to 20.1)
21	*Circulatory disorders*	25.0%	35.6%	40.8%	15.8 (14.2 to 17.4)
22	*Cerebrovascular disease*	63.4%	74.5%	80.5%	16.8 (15.0 to 18.5)
23	*Diseases of the blood*	32.3%	43.7%	50.1%	17.7 (15.2 to 20.3)
24	*Neoplasms*	32.9%	47.1%	49.0%	16.0 (12.7 to 19.4)
25	*Mental illness*	27.1%	36.5%	43.9%	16.8 (15.5 to 18.1)
26	*Nervous system disorders*	23.5%	31.4%	36.0%	12.4 (11.4 to 13.5)
27	*Pneumonia*	36.6%	52.0%	57.6%	20.9 (19.1 to 22.6)
28	*Other respiratory disease*	27.3%	35.6%	42.4%	15.1 (14.2 to 16.0)
29	*Chronic obstructive pulmonary disease*	31.6%	43.0%	52.4%	20.6 (19.5 to 21.8)
30	*Asthma*	28.5%	38.8%	48.3%	19.8 (16.9 to 22.1)
31	*Noninfectious lung disease*	44.0%	60.2%	62.9%	18.8 (15.0 to 22.7)
32	*GI system diseases*	21.7%	32.2%	38.4%	16.7 (16.0 to 17.4)
33	*Other renal and GU diseases*	11.5%	18.3%	24.1%	12.6 (11.6 to 13.6)
34	*End-stage renal disease*	7.1%	10.1%	25.4%	17.8 (-3.2 to 38.9)
35	*Chronic renal disease*	47.4%	61.9%	66.1%	18.6 (14.3 to 23.0)
37	*Diseases of the musculoskeletal system, skin, and connective tissue*	10.3%	16.0%	21.4%	11.1 (10.5 to 11.7)
38	*Complications and adverse events*	10.5%	15.0%	18.3%	7.8 (6.4 to 9.3)
39	*Other residual codes*	21.2%	33.7%	36.1%	14.9 (13.8 to 16.1)

* Proportion of high-intensity visits is adjusted for patient age, sex, Medicaid eligibility and race.
†Category 36, pregnancy and childbirth related disorders, is omitted as it is not applicable to the elderly, Medicare population.

Appendix 2. Trends* in Billing for High-Intensity Emergency Care

		2006	2009	2012	Trend, % change per year (95% CI)	P-Value
Proportion of ED Visits by Intensity Level CPT Code‡	*99281*	0.60%	0.40%	0.40%	-0.03 (-0.04 to -0.03)	<.001
	99282	3.70%	2.60%	2.00%	-0.30 (-0.31 to -0.29)	<.001
	99283	22.20%	17.50%	14.80%	-1.25 (-1.27 to -1.22)	<.001
	99284	27.10%	25.60%	24.70%	-0.42 (-0.45 to -0.40)	<.001
	99285	39.70%	45.90%	49.40%	+1.60 (1.57 to 1.63)	<.001
	99291	5.00%	6.60%	7.60%	+0.40 (0.39 to 0.41)	<.001
	99292	0.70%	0.80%	0.70%	+0.004 (-0.0003 to 0.009)	.07

* Longitudinal linear regression models were used to estimate the time trend, adjusting for patient age, race, sex, and Medicaid coverage. Generalized estimating equations were used to adjust for clustering.
‡Current Procedural Terminology Healthcare Common Procedure Coding System codes 99281-99285 denote increasing levels of intensity of emergency physician evaluation and management. Codes 99291 and 99292 indicate critical care services were provided.

Appendix 3. Trends* in the Most Common Services† among Admitted Patients

Service	2006 (%)‡	2009 (%)	2012 (%)	Absolute Change/Year, % (95% CI)§
Blood transfusion	12.4	14.3	15.4	+0.52 (0.48 to 0.56)
Diagnostic cardiac catheterization	10.4	9.3	9.7	-0.11 (-0.16 to -0.06)
Respiratory intubation and mechanical ventilation	9.9	11.1	12.6	+0.45 (0.41 to 0.49)
Other vascular catheterization; not heart	7.6	8.9	10.0	+0.41 (0.38 to 0.44)
Upper gastrointestinal endoscopy; biopsy	6.5	6.1	5.9	-0.11 (-0.13 to -0.08)
Other therapeutic procedures	5.8	5.7	7.1	+0.21 (0.18 to 0.24)
Other OR procedures on vessels other than head and neck	4.8	4.7	6.2	+0.24 (0.21 to 0.27)
Hemodialysis	5.9	6.3	6.5	+0.10 (0.08 to 0.12)
Colonoscopy and biopsy	3.2	2.8	2.6	-0.11(-0.13 to -0.10)
Diagnostic ultrasound of heart (echocardiogram)	2.9	3.4	4.0	+0.17 (0.16 to 0.19)

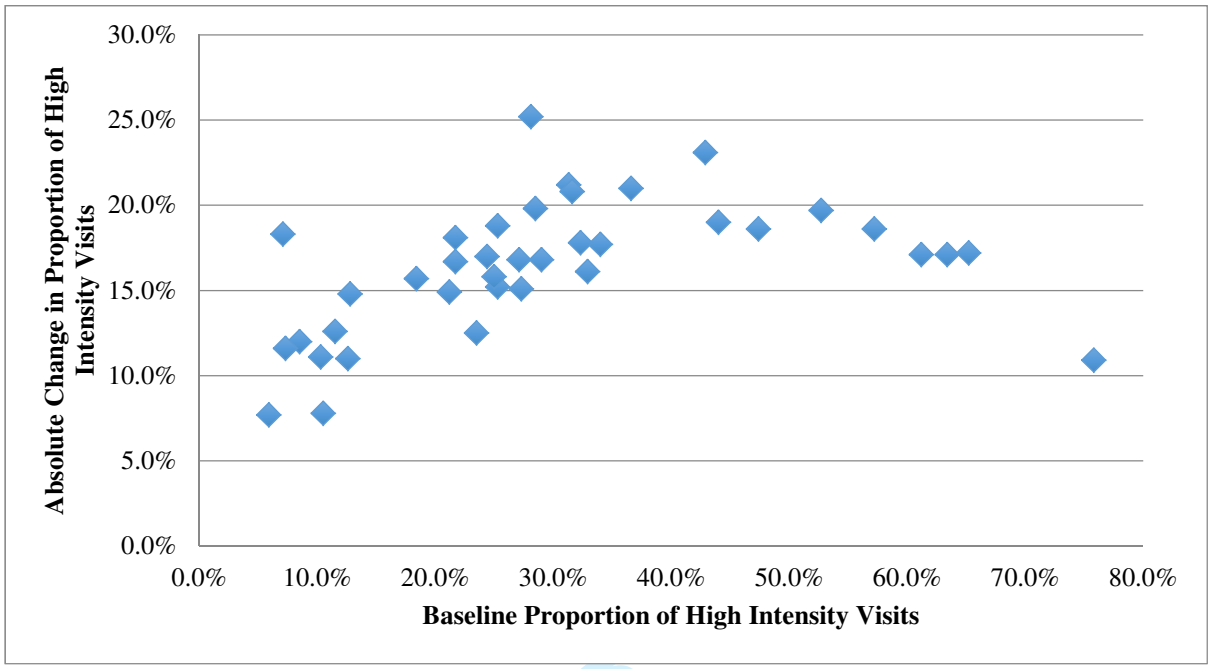
* Longitudinal linear regression models were used to estimate the time trend, adjusting for patient age, race, sex, and Medicaid coverage and stratified by outpatient and inpatient visits.
†Most common services among patients admitted from the ED occurring in the ED or during an inpatient stay. Services were defined by ICD9 procedure codes and categorized using the Clinical Classifications Software for Services and Procedures software.
‡ Percentage of all admissions including the service.
§ All changes were statistically significant at p<.001

Appendix 4. Mean Number of Services per Visit for the Ten Most Frequent Services* among Outpatient Emergency Department Visits

Service	2006	2009	2012	Trend, %† (95% CI)	P-Value
Laboratory-chemistry and hematology	3.35	3.68	3.85	0.083 (0.080 to 0.086)	<.001
Medications	0.60	0.42	0.56	-0.007 (-0.008 to -0.007)	<.001
Other therapeutic procedures	0.48	0.97	1.06	0.096 (0.095 to 0.097)	<.001
Microscopic examination (bacterial smear, culture, toxicology)	0.49	0.58	0.63	0.023 (0.023 to 0.024)	<.001
Electrocardiogram (ECG)	0.38	0.38	0.39	0.001 (0.000 to 0.0001)	.003
Other diagnostic radiology and related techniques	0.34	0.32	0.30	-0.007 (-0.0007 to -0.0006)	<.001
Routine chest X-ray	0.37	0.37	0.38	0.002 (0.002 to 0.003)	<.001
Other laboratory	0.17	0.19	0.22	0.008 (0.007 to 0.008)	<.001
Computerized axial tomography (CT) scan of the head	0.14	0.17	0.18	0.03 (0.026 to 0.027)	<.001
Durable Medical Equipment and supplies	0.10	0.18	0.26	0.026 (0.026 to 0.027)	<.001

* Services were defined by the Current Procedural Terminology (CPT) Healthcare Common Procedure Coding System codes (HCPCS) and categorized using the Clinical Classifications Software for Services and Procedures software.
†Longitudinal linear regression models were used to estimate the time trend, adjusting for patient age, race, sex, and Medicaid coverage. Generalized estimating equations were used to adjust for clustering.

Appendix 5. Absolute Change* in Proportion of High-Intensity Visits versus Baseline Proportion of High-Intensity Visits by Diagnosis Category* for Outpatient Emergency Department Visits†



*Longitudinal linear regression models were used to estimate the time trend, adjusting for patient age, race, sex, and Medicaid coverage. Generalized estimating equations were used to adjust for clustering. †Thirty-nine diagnosis categories previously defined in the emergency medicine literature (Gabayan, G.Z., et al. Ann Emerg Med, 2013. 62(2): p. 13)‡Proportion of high-intensity visits is adjusted for patient age, sex and Medicaid eligibility.

Appendix 6. Comparison of Pseudo R2* for Sequential Models† Incorporating Explanatory Variables for the Trend in Emergency Department (ED) Practice Intensity

Model	Explanatory Variables	All Visits	Inpatient Visits	Outpatient Visits
1	Time	0.013	0.034	0.027
2	Time, Patient Demographics‡	0.021	0.034	0.028
3	Time, Patient Characteristics, Comorbidities§	0.080	0.050	0.463
4	Time, Patient Characteristics, Comorbidities, Services¶	0.148	0.051	0.465

* Pseudo R^2 determined using method described by Cragg, J and Uhler, RS. The Demand for Automobiles. Canadian Journal of Economics. 1970;3(3): 386-406.
† Generalized logistic regression modeling was used to control for repeated hospital measures.
‡Patient demographics included age, race, gender, and Medicaid eligibility.
§Comorbidities were characterized by the mean number of Hierarchical Condition Categories (HCCs). ¶ Services refers to ICD9 procedures for inpatient visits, HCPCS procedures for outpatient visits, and physician-billed HCPCS procedures in the carrier file for all visits.

Trends in High-Intensity Billing for Emergency Care Accompanied by an Increase in Services Provided in the Emergency Department

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STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract **This has been done on the abstract (page 3)**
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found **This is in the abstract section on page 3 & 4.**
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported **This has been done. Rationale for investigation is explained on page 6.**
Objectives	3	State specific objectives, including any prespecified hypotheses **Specific objectives are listed out as three separate questions on page 7.**
Methods		
Study design	4	Present key elements of study design early in the paper. **This has been done both in the abstract and in the Methods section on page 7-11.**
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection **This has been done in the Methods section (pages 7-11).**
Participants	6	*Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants **The description of data can be found in the "Study Design and Setting" subsection of the Methods section (page 7 & 8).**
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable **All these data have been included in the Methods section (pages 7-11).**
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group. **This has been done in the Methods section (pages 7-11).**
Bias	9	Describe any efforts to address potential sources of bias **This has not been done specifically, but Limitations of the study are clearly described on page 18.**
Study size	10	Explain how the study size was arrived at **The study population can be found in the "Study Design and Setting" subsection of the Methods section (page 7 & 8).**
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why.

		This is addressed in the subsection "Analysis" in the Methods section (pages 9-11).
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding **This has been done in the subsection "Analysis" in the Methods section (pages 9-11).**
		(*b*) Describe any methods used to examine subgroups and interactions **This has been done in the Methods section (pages 7-11).**
		(*c*) Explain how missing data were addressed **This has been done in the "Study Design and Setting" subsection of the Methods section (page 7 & 8).**
		(*d*) *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy **This has been done in the Methods section (pages 7-11).**
		(*e*) Describe any sensitivity analyses **This has been done in the subsection "Analysis" in the Methods section (pages 9-11).**
Results		
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed **This is done in the first paragraph of the Results section (page 12).**
		(b) Give reasons for non-participation at each stage
		(c) Consider use of a flow diagram
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders **This is done in the first paragraph of the Results section (page 12) and Table 1.**
		(b) Indicate number of participants with missing data for each variable of interest
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time
		Case-control study—Report numbers in each exposure category, or summary measures of exposure
		Cross-sectional study—Report numbers of outcome events or summary measures **All these data have been included in the Results section (pages 12-16) and relevant tables.**
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included **All these data have been included in the Results section (pages 12-16) and relevant tables.**
		(*b*) Report category boundaries when continuous variables were categorized
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses **All these data have been included in the Results section (pages 12-16) and relevant tables, as well in the Appendix.**
Discussion		
Key results	18	Summarise key results with reference to study objectives **Key results are summarized in the first paragraph of the Discussion (page 16).**

Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias **Limitations are clearly outlined in the "Limitations" subsection (page 18).**
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence **An interpretation and implications are discussed (pages 16-19).**
Generalisability	21	Discuss the generalisability (external validity) of the study results **The external validity of this study is discussed in the "Limitations" subsection (page 19).**
Other information		
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based **This study had no funding source.**

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Are trends in billing for high-intensity emergency care explained by changes in services provided in the emergency department? An observational study among US Medicare beneficiaries

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Data Sharing

No additional data available.

Details of Contributors

LB had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. LB and RH developed the study concept and LB, RW, EO and RH all substantially contributed to the study design. LB, RW, and EO performed the statistical analyses and all authors interpreted the data. LB and RH drafted the manuscript. LB,

RW, EO, and RH revised the manuscript for important intellectual content. All authors approved the final version of the manuscript.

ABSTRACT (409 words)

Objective: There has been concern that an increase in billing for high-intensity emergency care is due to changes in coding practices facilitated by electronic health records. We sought to characterize the trends in billing for high-intensity emergency care among Medicare beneficiaries and to examine the degree to which trends in high-intensity billing are explained by changes in patient characteristics and services provided in the emergency department (ED).

Design, Setting, and Participants: Observational study using traditional Medicare claims to identify ED visits at nonfederal acute care hospitals for elderly beneficiaries in 2006, 2009, and 2012.

Outcomes Measures: Billing intensity was defined by emergency physician evaluation and management (E&M) codes. We tested for overall trends in high-intensity billing (E&M codes 99285, 99291 and 99292) and in services provided over time using linear regression models, adjusting for patient characteristics. Additionally, we tested for time trends in rates of admission to the hospital and to the intensive care unit. Next we classified outpatient visits into 39 diagnosis categories and analyzed the change in proportion of high-intensity visits versus the change in number of services. Finally, we quantified the extent to which trends in high-intensity billing are explained by changes in patient demographics and services provided in the ED using multivariable modeling.

Results: High-intensity visits grew from 45.8% of 671,103 visits in 2006 to 57.8% of 629,010

visits in 2012 (2.0% absolute increase per year; 95% CI, 1.97% to 2.03%) as did the mean number of services provided for admitted (1.28 to 1.41; +0.02 increase in procedures per year; 95% CI, 0.018 to 0.021) and discharged ED patients (7.1 to 8.6; +0.23 increase in procedures per year; 95% CI, 0.245 to 0.251). There was a reduction in hospital admission rate from 40.1% to 35.9% (-0.68% per year; 95% CI, -0.71% to -0.65%; p<.001), while the ICU rate of admission rose from 11.7% to 12.3% (+0.11% per year; 95% CI, 0.09% to 0.12%; p<.001). When we stratified by diagnosis category, there was a moderate correlation between change in visits billed as high intensity and the change in mean number of services provided per visit (ρ=0.38; 95% CI, 0.07 to 0.63). Trends in patient characteristics and services provided accounted moderately for the trend in practice intensity for outpatient visits (pseudo R^2 of 0.47) but very little for inpatient visits (5.1%) and visits overall (14.8%).

Conclusions: Increases in services provided in the ED moderately account for the trends in billing for high-intensity emergency care for outpatient visits.

STRENGTHS AND LIMITATIONS OF THIS STUDY

Strengths

- Trends in billing for the highest intensity of emergency care (as determined by physician professional billing codes) as well as trends in admission rate and number of services (including laboratory, radiology, and other diagnostic tests as well as clinical procedures) were determined using longitudinal linear regression adjusting for patient age, race, sex, and Medicaid coverage for 1,883,650 emergency department visits by Medicare beneficiaries across in the United States in 2006, 2009 and 2012.
- To evaluate the extent to which trends in practice intensity are explained by changes in patient characteristics and practice patterns, we used generalized logistic regression modeling with the binary intensity variable as the outcome and time as the predictor sequentially incorporating beneficiary demographic characteristics, followed by number of services per visit as an indicator of intensity of practice and finally beneficiary chronic conditions and calculated a pseudo-R^2 for each model. This was performed for visits overall and stratified by patient disposition (admitted versus discharged).

Limitations

- Key limitations of this study that are inherent to the use of administrative data include lack of clinical information such as vital signs, laboratory results, and total time spent in the emergency department undergoing treatment and observation.

- Additionally, there is substantially less detail regarding laboratory and radiology services provided for inpatient emergency department (ED) visits compared to visits that result in discharge from the ED.
- Also, while national in scope, our analysis is limited to elderly fee-for-service Medicare beneficiaries and may not be generalizable to other populations.

INTRODUCTION

The rising cost of healthcare in the United States has received increasing attention[1] as it has strained state and federal budgets[2 3] and directly impacted individuals via lost income and higher out-of-pocket costs.[4] Emergency care has often been portrayed as an expensive and inefficient contributor to the healthcare crisis.[5-7] Concerns about the cost of emergency care have led to a variety of initiatives seeking to steer patients away from the emergency department (ED) to lower cost settings during an acute illness.[8 9] Despite these concerns, the number of ED visits in the U.S. has continued to rise,[10 11] as have the numbers of visits billed at the highest level of intensity.[12] As billing for high-intensity emergency care has risen, some have questioned whether the growth of electronic health records (EHRs) has exacerbated the problem by allowing providers to more easily "upcode" or bill for services without changing the work performed.[13] While prior work has suggested that EHRs have not led to upcoding for inpatient care,[14] relatively little is known about this phenomenon for emergency care.

Research has demonstrated that the average number of diagnostic and treatment services provided during an ED visit has also risen over time,[15 16] suggesting that upcoding alone is unlikely to explain the growth in billing for high-intensity emergency care. Such an increase in the intensity of care provided may reflect efforts to improve quality, reduce costs of care by avoiding a more expensive hospital admission, or to reserve limited availability of inpatient space for the highest acuity patients.[15] To our knowledge, no studies have used multivariable modeling at the visit level to examine the relative contribution of patient characteristics and clinical practice patterns to trends in billing for high-intensity emergency care or whether the trend in high-intensity billing has been uniform across various conditions treated in the ED.

Thus, we sought to evaluate the trends in billing for high-intensity emergency care and the underlying mechanism for these trends by addressing three questions. First, what are the trends in billing for high-intensity care in the Medicare fee-for-service population, and to what extent are these trends accompanied by changes in patient characteristics and practice patterns? Second, do particular diagnoses or conditions have greater changes in intensity over time, and, if so, are these variations associated with trends in services? Finally, how much of the trend in high-intensity billing is explained by trends in services provided and patient characteristics when using multivariable modeling?

METHODS

Study Design and Setting

We used a five percent sample of national Medicare fee-for-service claims to identify ED visits in 2006, 2009, and 2012. We examined ED visits by beneficiaries age 65 and older who were continuously-enrolled in traditional Medicare and presented to nonfederal acute care hospitals. The billing intensity level was obtained by identifying all emergency physician professional claims in the Carrier file for Current Procedural Terminology (CPT) Healthcare Common Procedure Coding System (HCPCS) evaluation and management codes 99281-99285, 99291 and 99292. Patient characteristics (age, sex, race, Medicaid eligibility) were obtained from the Master Beneficiary Summary File. Patient chronic conditions were assigned using software from the Centers for Medicare and Medicaid Services that allows for the creation of Hierarchical Condition Categories (HCCs)[17] based on conditions coded in claims for that year. Information such as visit diagnosis and services provided were obtained from the inpatient file for admitted patients and the outpatient file for visits resulting in discharge or observation status.

Procedures were denoted by International Classification of Diseases, Ninth Revision (ICD9) procedure codes for inpatient visits and CPT/HCPCS codes for outpatient visits and physician professional claims. Since claims for substance abuse related visits were no longer available in Medicare data in 2012,[18] we dropped substance abuse claims from the prior years. We used the American Hospital Association survey from 2012 to obtain data on hospital characteristics (region, rural vs. urban location [RUCA], size, as well as trauma center, profit, and teaching status) and linked this to ED claims using Medicare provider identification numbers.

Conceptual Model and Outcomes

High-Intensity Billing

Our primary outcome was the ED visit level of billing intensity, defined by CPT codes as selected by the treating emergency physician or designee. CPT codes 99281 and 99282 represent low complexity, 99283 and 99284 represent moderate complexity, 99285 represents high complexity, while codes 99291 and 99292 are used to denote that critical care services were provided. While prior studies have used 99285 alone to define high-intensity ED visits,[19 20] we chose to also define ED visits with critical care billing as high intensity as these were available in our dataset and have been evaluated in prior research on ED visit acuity.[21] Thus, we created a binary intensity outcome variable, categorizing visits with codes 99281-99284 as low-intensity and those with codes 99285, 99291, and 99292 as high-intensity.

Clinical Services Provided

If a rise in high-intensity billing was due to upcoding alone rather than trends in actual practice, we might expect relatively little change in the frequency and type of services provided

in the ED. As such, we determined the mean number of services provided per visit according to the ED facility claims. For discharged patients, we identified all services on outpatient ED facility claims (outpatient services) such as laboratory and radiology tests and clinical procedures that occurred in the ED. For admitted patients, services from inpatient facility claims (inpatient services) may have been provided at any time during that hospitalization, including during treatment in the ED, as we could not readily distinguish the location of services provided for admitted patients in this dataset. We also determined the mean number of physician professional claims for services other than evaluation and management for all visits (physician services).

Hospital and Intensive Care Unit Admission Rate

We also evaluated trends in rates of admission to the hospital and to the intensive care unit (ICU) as additional indicators or clinical practice and patient acuity. Hospital utilization rates in the United States have fallen[22] as the number of inpatient beds per capita has declined. Thus, temporal trends in hospital admission may reflect changing practice patterns in response to a variety of incentives to admit fewer patients rather than patient acuity alone. More intensive ED evaluation and treatment may allow emergency physicians to safely discharge a greater number of patients of moderate acuity or complexity. ICU admission, however, is generally reserved for the most seriously ill patients and less likely to be avoided by completing an intensive ED work-up. Thus, we hypothesized that any increase in high-intensity billing would be accompanied by a reduction in hospital admission and stable or increasing rates of ICU admission.[23]

Analysis

Trend in High-Intensity Billing

Changes in billing for high-intensity emergency care were estimated by regressing a binary outcome (high or low intensity) as continuous over time and controlling for patient characteristics. Patient age, race, sex, and Medicaid coverage were used for the patient characteristics. Analysis occurred at the visit level with each visit coded as high or low intensity. Generalized estimating equations were used to account for patient clustering at the level of the ED. The adjusted estimates of the proportion of high-intensity visits were graphed over time and rates of change over the study period were tested for statistical significance. In addition to examining the binary high-intensity outcome variable, we examined the time trends for each of the seven intensity categories individually.

Visit Rate

We next examined how the rate of high-intensity visits and overall ED visits changed. An increase in the relative proportion of high-intensity visits could potentially reflect a reduction in low acuity visits over time rather than an increase in population rates of high-acuity visits.[5 24] Thus, we calculated a per beneficiary rate of overall high-intensity and low-intensity visits for each year and tested for a time trend using negative binomial regression.

Secondary Outcomes

We used the Clinical Classifications Software developed by the Agency for Healthcare Research and Quality (HCUP-CCS) to classify procedures codes for inpatient, outpatient, and physician services into clinically meaningful categories and determined the frequency of each procedure type. We tested for time trends in mean number and type of services per visit for

admitted and discharged patients using linear regression adjusting for age, sex, race, and Medicaid eligibility. We then calculated the overall hospital admission rate (percentage of ED visits leading to a hospital admission) and the ICU admission rate (percentage of ED visits leading to an ICU admission), again using linear regression, adjusting for age, race, sex, and Medicaid coverage.

Trends in Practice Intensity by Diagnosis Category

Next, we evaluated if trends in billing for high-intensity emergency care varied by condition treated and if those conditions with the greatest changes in high-intensity emergency care also saw the greatest changes in services over time. We categorized the principal diagnosis for each outpatient visit into one of 39 diagnosis categories, previously described in the emergency medicine literature (Appendix 1),[25] and used the analogous adjusted longitudinal linear regression model for each diagnosis to estimate the percentage of total visits in each year categorized as high-intensity as well as the absolute change in proportion of high-intensity visits. We limited this analysis to outpatient visits because of the limited detail regarding ED services for admitted patients. For each diagnostic category, we calculated the change in high-intensity visit rate and the change in ED services between 2006 and 2012. The changes were graphed against each other and a correlation coefficient was calculated to capture the degree to which the two were associated with each other. Additionally, for each diagnosis category, we graphed the change in proportion of high-intensity visits against the baseline proportion of high-intensity visits in 2006. We did this in order to determine if high- or low-complexity conditions saw greater changes over time.

Multivariable Modeling

We used generalized logistic regression modeling, controlling for repeated hospital measures, to investigate the extent to which trends in practice intensity are explained by concomitant changes in patient characteristics, chronic conditions, and services provided in the ED. We specified four models with the initial model having the binary variable intensity as the outcome and time as the predictor. The second model incorporated beneficiary characteristics. The third model incorporated number of chronic conditions. The fourth model further incorporated inpatient, outpatient, and physician-billed services (CPT codes) for all visits. We calculated a pseudo R^2 for each model[26 27] as a measure of the proportion of total variation explained by the model. We ran these models for all visits and for inpatient and outpatient visits separately.

As a complementary analysis examining the degree to which trends in coding are explained by the variables in our model, we ran two logistic regression models separately for 2009 and 2012 and obtained the coefficients for each variable in the model for those years. We then applied those coefficients to ED visits in 2006 to obtain an expected number of visits in 2006. The difference between the observed and predicted number of visits billed as high-intensity in 2006 using coefficients from the later years represents the degree to which high-intensity billing has changed in ways that cannot be explained by the variables in our model. We performed this analysis for outpatient and inpatient visits separately.

Sensitivity Analysis

There has been a growth in use of observation services for Medicare beneficiaries[28 29] both in the ED and the inpatient setting.[30] There has been some concern that the concomitant

growth in observation status and decline in hospital admissions may represent substitution in response to Medicare payment policies.[28] To evaluate if our results were sensitive to inclusion of observations visits in our sample, we recalculated the admission rate and mean number of inpatient and outpatient services and repeated our mediation analysis after reclassifying all observation claims as admissions.

Analyses were conducted using SAS version 9.3 (SAS institute). The Office of Human Research Administration approved this study.

RESULTS

Characteristics of Study Sample

We examined 1,883,650 ED total visits. Patient and hospital characteristics are summarized for all ED visits in Table 1. There was a decrease in the proportion of ED visits by women (66.1% to 60.6%; -0.94% absolute decrease per year [95%CI, -0.97% to -0.91%]; p<.001) and whites (85.9% to 84.1%; -0.29% absolute decrease per year [95%CI, -0.31% to -0.27%]; p<.001) while all other racial groups saw a slight increase. The proportion of visits by Medicaid beneficiaries rose from 22.4% in 2006 to 23.1% in 2012 (+0.12% absolute increase per year [95% CI, 0.09% to 0.14%]; p<.001). The average number of chronic conditions per beneficiary increased slightly from 4.61 in 2006 to 4.91 in 2012 (+0.05 conditions/per year [95% CI, 0.050 to 0.054]; p<.001). When we stratified by high- and low-intensity ED visits, the number of chronic conditions (HCCs) was higher for beneficiaries with a high-intensity visit than for those with a low-intensity visit (5.96 HCCs vs. 3.93 HCCs, respectively in 2012; Table 1). Over the study period there was an increase in proportion of visits to urban (71.5% in 2006 to 73.1% in 2012; +0.26% absolute increase per year [95% CI, 0.24% to 0.29%]; p<.001), large

(23.6 to 26.4%; +0.48% per year [95% CI, 0.46% to 0.50%]; p<.001), minor teaching (26.4% to 30.8%; +0.74% per year [95% CI, 0.72% to 0.77%]; p<.001), and for-profit hospitals (12.9% to 14.9%; +0.33% per year [95% CI, 0.31% to 0.35%]; p<.001), as well as trauma centers (38.2% to 43.7%; +0.91% per year [95% CI, 0.88% to 0.93%]; p<.001).

Trends in Practice Intensity

High-intensity visits overall rose from 45.8% in 2006 to 57.8% in 2012 (+2.0% per year [95% CI, 1.97% to 2.03%]; p<.001; Figure 1).The most frequent intensity code in all three years was 99285, also known as a level 5 visit (Appendix 2). Level 5 visits represented 39.7% of all ED visits in 2006 and 49.4% in 2012 (+1.6% per year [95% CI, 1.57% to 1.63%]; p<.001). There was also an increase in visits that were billed at a critical care level (CPT 99291) from 5.0% of all visits in 2006 to 7.6% in 2012 (+0.4% increase per year [95% CI, 0.39% to 0.41%]; p<.001). CPT 99292 comprised of less than 1% of all visits in both years and showed a small increase that was not statistically significant (+0.004% increase per year [95% CI, -0.0003% to +0.009]; p=.07). We observed a concomitant decrease over time in each of the four CPT codes categorized as low-intensity (Appendix 2).

Trends in Visit Rates per Beneficiary

We found an increase from 535 to 565 ED visits per 1,000 beneficiaries that was not statistically significant (0.9% increase per 1,000 beneficiaries per year [95%CI, -1.1% to 2.9%]; p=0.37, Appendix 3). There was a significant increase in the high-intensity visit rate from 241 to 322 per 1,000 beneficiaries (4.9% increase in high-intensity visits per 1,000 beneficiaries per year, [95% CI, 2.0% to 7.8%]; p<.001), while the rate of low-intensity visits per beneficiary

decreased (294 to 243 visits per 1,000 beneficiaries; -3.2% decrease in low-intensity visits per 1,000 beneficiaries per year [95% CI, -5.9% to -0.4%]; p=0.03).

Trends in Patient Acuity and Treatment Intensity

When we looked at inpatient services for patients admitted from the ED, we found an increase in the mean number of total services (1.28 to 1.41 per admissions; +0.02 procedures per year, [95% CI, 0.018 to 0.021]; p<.001), which persisted even after reclassifying observation claims as admissions (1.23 to 1.29; +0.011 procedures per year [95% CI, 0.009 to 0.012]; p<.001). High-intensity admissions had a greater number of services in each year, and both groups saw an increase over time in the mean number of services (Table 2). The most frequent inpatient services by year are presented in Appendix 4. Several critical care procedures and services saw an increase over time including respiratory intubation and mechanical ventilation (9.9% of all admissions from the ED in 2006 compared to 12.6% in 2012 ;+0.45% per year [95% CI, 0.41% to 0.49%]; p<.001), blood transfusion (12.4% to 15.4%; +0.52% per year [95% CI, 0.48% to 0.56%]; p<.001), and other vascular catheterization, not heart (7.6% to 10.0%; +0.41% per year [95% CI, 0.38% to 0.44%]; p<.001).

Outpatient ED visits saw a significant increase in total average number of services per visit from a mean of 7.1 in 2006 to 8.6 in 2012 (+0.25 increase in mean services per year [95% CI, 0.245 to 0.255]; p<.001). High-intensity visits, relative to low-intensity visits, had a greater number of services in each year. High-intensity visits saw a significant increase in services (12.9 to 13.7; +0.14 services per year [95% CI, 0.13 to 0.15]; p<.001), whereas low-intensity visits saw a slight decrease (5.3 to 5.2; -0.008 services per year [95% CI, -0.121 to -0.003] p<.001; Table 2). After reclassifying observation claims as admissions, the mean number of outpatient

services still saw an increase from 6.7 to 8.1 services per visit (+0.23 increase per year, [95% CI, 0.22 to 0.23]; p<.001). The most frequent services provided during an outpatient ED visit are presented in Appendix 5. There were very few physician professional claims for services other than evaluation and management in all three years, but the mean number of procedures per visit increased slightly from 0.31 in 2006 to 0.34 in 2012 (p<.001), the most frequent of which were for electrocardiogram interpretation (Appendix 6).

When examining trends in hospital admission, we observed a reduction in admission rate from the ED over time, with 35.9% of visits leading to admission in 2012 compared to 40.1% in 2006 (-0.68% per year [95% CI, -0.71% to -0.65%]; p<.001; Table 2). The number of visits with an associated observation claim rose from 15,914 visits (3.9% of total) in 2006 to 22,226 visits (5.4% of total) in 2012. However, even after reclassifying observation claims as admissions, there was still a statistically significant decrease in admission rate from 42.1% in 2006 to 39.1% in 2012 (-0.48% per year [95% CI, -0.51% to -0.45%]; p<.001). In contrast, the proportion of all ED visits resulting in an ICU admission increased (11.7% to 12.3%; +0.11% per year, [95% CI, 0.09% to 0.12%]; p<.001).

Trends by Diagnosis

Upon examining the 39 condition categories individually (Appendix 1), diagnosis categories with the largest change in the proportion of high-intensity visits tended to have a mid-range baseline intensity (Appendix 7). Skin and subcutaneous infections had the lowest absolute change (5.9% of visits categorized as high-intensity in 2006 to 13.6% in 2012; +7.8% [95% CI, 6.4% to 9.3%]; p<.001) and intestinal infections had the greatest (25.2%; from 28.1% in 2006 to 53.3% in 2012; +25.2% [95% CI, 20.8% to 29.6%]; p<.001). We found that those diagnoses

with greater increases in intensity tended to have an increase in mean number of services (Figure 2), with moderate correlation (r=0.38 [95% CI, 0.07 to 0.63]; p=0.02) between the change in percentage of high-intensity visits and the change in mean number of services provided per visit for each diagnosis category.

Impact of Patient Characteristics and Services on High-Intensity Billing

We next used four separate logistic regressions to determine the extent to which the trends in high-intensity billing are explained by trends in patient demographics, chronic conditions, and services provided (Table 3). Time alone explained between 1.3% of the variation in high-intensity billing for all visits, 3.4% for inpatient visits, and 2.7% for outpatient visits. Incorporating patient age, sex, race, and Medicaid eligibility again increased the pseudo R^2 by less than 1%, regardless of disposition. Incorporating patient comorbidities (HCCs) increased the pseudo R^2 to 9.0% for all visits, 3.5% for inpatient visits, and 4.3% for outpatient visits. Incorporating services in the model led to the greatest increase in pseudo R^2 and explained 46.5% of the variation in high-intensity billing for outpatient visits. While incorporating services had the greatest impact on model R^2 for inpatient visits and visits overall, it still explained only 5.1% of the variation for inpatient visits and 14.8% for visits overall. When we reclassified observation claims as admissions, our results were similar (pseudo R^2 of 0.14 for visits overall, 0.05 for inpatient visits, and 0.44 for outpatient visits for the final model incorporating time, patient demographics and chronic conditions, and services).

Additionally, we calculated the predicted number of high-intensity visits that would have occurred in 2006 using coefficients for the variables in our models from 2009 and 2012. We calculated the difference between the predicted and observed number of high-intensity visits in

2006. For inpatient ED visits, this difference revealed an additional 24,819 visits that would have been classified as high-intensity using 2009 coefficients (9.5% of all inpatient visits; Appendix 8) and 35,504 inpatient visits (13.6%) that would have been classified as high-intensity using 2012 coefficients. For outpatient visits, this difference revealed an additional 1,101 visits (0.3%) that would have been classified as high-intensity using 2009 coefficients, and 16,905 (4.1%) would have been classified as high-intensity using 2012 coefficients. These additional visits represent the degree to which billing for high-intensity emergency care has changed in ways that are not explained by the variables in our model and may represent upcoding.

DISCUSSION

In our study of elderly Medicare beneficiaries, we found that ED visits are increasingly billed at the highest levels of intensity, with nearly 60% of ED visits in our sample coded at a level 5 or as critical care in 2012, up from 46% in 2006. We found a concomitant increase in services provided in the ED and during an associated inpatient stay. While overall admission rate decreased over time, a greater fraction of ED visits resulted in admission to intensive care. We found that trends in high intensity billing varied by clinical condition; diagnoses with the greatest change in high-intensity billing also had the greatest increase in number of services. These findings persisted when we repeated our analyses reclassifying observation claims as admissions. Finally, using multivariable modeling, we found that trends in patient characteristics as well as in services provided during the visit moderately accounted for the increase in practice intensity for outpatient ED visits. If the process for determining high-intensity visits in 2012 were applied to visits in 2006, we would have seen an additional 4.1% of outpatient visits and 13.6% of inpatient

visits coded as high-intensity. In other words, those additional increases were unexplained in our model, and could potentially represent secular changes such as upcoding.

Our results are consistent with other work showing a growth in high-intensity emergency care. A study of all ED visits in California[20] also demonstrated a growth in physician billing for high-intensity visits, particularly among safety net hospitals. Other studies using national datasets have documented greater use of tests and treatments in the ED such as advanced imaging, blood tests, and IV fluids.[15 16] Exploring the idea that doing more in the ED can prevent hospitalizations, one study found that greater use of CT scans was associated with a reduction in admissions and transfers.[31] Our study adds to this literature by linking physician billing for high-intensity emergency care to services provided during the ED visit for a national sample of Medicare beneficiaries. Our findings suggest that the growth in high-intensity billing has been accompanied by an observable increase in diagnostic and treatment intensity while admission rates have fallen.

While prior studies have suggested that the fears of upcoding due to EHRs may not be fully warranted,[14] there has been concern that the trend in billing for high-intensity emergency care may represent trends in coding rather than actual changes in practice. Using multivariable modeling, we found that observable factors such as patient characteristics and numbers of services and procedures moderately explained, but did not fully account for, the trends in high-intensity billing for outpatient visits. It is possible that part of the residual trend could be attributed to upcoding; our study, however, is unable to identify conclusively whether this is the case.

ED visits in the U.S. have continued to rise[10 32-34] despite health insurance expansion and cost control efforts that were predicted to reduce ED utilization. The role of emergency medicine

in the acute care landscape has also expanded,[35] with EDs assuming greater responsibility for managing complex problems while reserving limited and costly hospital capacity for those truly requiring inpatient care. With the growth of alternative payment models, reducing admissions for ED patients with moderate severity problems has been proposed as a strategy to reduce costs.[36] Our findings are consistent with this new model of emergency care. We found an increase in services while admission rates fell, even after accounting for the growth in observation stays. We found the greatest increases in high-intensity billing and services among conditions with moderate baseline intensity such as pneumonia and intestinal infections, for which the decision to admit likely involves greater provider discretion relative to higher acuity conditions. While our study was not designed to assess the relationship between intensity of emergency care and admission rate, it is possible that doing more for patients in the ED may have allowed a greater number to be safely discharged. The rise in number of services, including critical care procedures, provided during hospital admission suggests that the average acuity of patients who ultimately are admitted may be increasing over time.

Our study has a number of limitations. Given the use of administrative data, clinical markers of acuity, such as vital signs and laboratory data, that may have been helpful in further detailing any trends in patient acuity over time, were not available. Also, time spent observing and treating patients is another key component of practice intensity that we could not measure with our dataset and could potentially account for some of the remaining time trend in practice intensity. Additionally, our modeling explained relatively little of the variation for inpatient visits and ED visits overall. This is likely due to the fact that, unlike for outpatient visits, there is substantially less detail in the dataset regarding services provided in the ED. Also, while

national in scope, our analysis is limited to elderly fee-for-service Medicare beneficiaries and may not be generalizable to other populations.

In summary, the rise in billing for high-intensity emergency care has been portrayed as an unintended consequence of the growth of health information technology rather than reflecting a change in practice. However, this trend has been accompanied by an increase in the provision of services in the hospital as well as in the ED. Multivariable modeling incorporating patient characteristics, comorbidities, and services provided moderately explained the trends in high-intensity billing. It is unclear the degree to which changes in coding practices explain the remaining variation. This rise in high-intensity emergency care has occurred while rates of admission from the ED have fallen, raising the possibility that a greater amount of work performed in the ED may have allowed more patients to avoid inpatient treatment during an acute episode. Further study may be useful in determining what impact the trend in high-intensity emergency care has had on total costs of care as well as patient outcomes.

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TABLES

Table 1. Beneficiary and Hospital Characteristics as a Percentage of Total Emergency Department Visits by Year

		2006	2009	2012	Change, % per year (95% CI)*
Beneficiary Characteristics					
Age	Mean, yrs	79.3	78.9	78.8	-0.08 (-0.08 to -0.07)
	65-69	13.8%	16.1%	17.1%	+0.55 (0.53 to 0.57)
	70-79	37.6%	36.7%	36.9%	-0.12 (-0.15 to -0.09)
	>=80	48.7%	47.2%	46.1%	-0.43 (-0.46 to -0.40)
Gender	Female	66.1%	60.9%	60.6%	-0.94 (-0.97 to -0.91)
Race	White	85.9%	84.8%	84.1%	-0.29 (-0.31 to -0.27)
	Black	10.4%	10.7%	11.0%	+0.11 (0.10 to 0.13)
	Asian	0.9%	1.2%	1.3%	+0.06 (0.06 to 0.07)
	Hispanic	1.7%	2.0%	1.9%	+0.04 (0.03 to 0.05)
	Other	1.2%	1.4%	1.7%	+0.05 (0.04 to 0.06)
Medicaid Coverage	Yes	22.4%	23.2%	23.1%	+0.12 (0.09 to 0.14)
Average Number of HCCs per Beneficiary	Overall	4.6	4.9	4.9	+0.05 (0.049 to 0.054)
	Low Intensity Visits	3.9	4.0	3.9	+0.012 (0.0098 to 0.015)
	High Intensity Visits	5.5	5.7	5.7	+0.023 (0.0199 to 0.026)
Hospital Characteristics					
Region	Northeast	19.9%	19.5%	18.7%	-0.20 (-0.22 to -0.17)
	Midwest	25.2%	23.4%	23.0%	-0.38 (-0.36 to -0.41)
	South	39.9%	41.2%	41.9%	+0.33 (0.30 to 0.36)
	West	14.0%	15.3%	15.8%	+0.30 (0.28 to 0.32)
RUCA	Urban	71.5%	72.9%	73.1%	+0.26 (0.24 to 0.29)
	Suburban	3.0%	3.1%	3.1%	-0.13 (-0.15 to -0.11)
	Large Rural Town	16.1%	15.4%	15.3%	-0.13 (-0.15 to -0.11)
	Small Town/Isolated Rural	8.3%	7.6%	7.4%	-0.16 (-0.17 to -0.14)
Teaching Status	Major	12.3%	12.7%	12.3%	+0.11 (-0.02 to +0.02)
	Minor	26.4%	27.2%	30.8%	+0.74 (0.72 to 0.77)
	Non-Teaching	60.4%	59.5%	56.2%	-0.69 (-0.72 to -0.66)
Size	Small (1-99 beds)	16.9%	15.7%	16.2%	-0.12 (-0.15 to -0.10)
	Medium (100-399 beds)	58.6%	58.1%	56.8%	-0.30 (-0.33 to -0.28)
	Large (400+ beds)	23.6%	25.6%	26.4%	+0.48 (0.46 to 0.50)
Profit Status	For Profit	12.9%	13.5%	14.9%	+0.33 (0.31 to 0.35)
	Not For Profit	73.9%	73.3%	72.5%	-0.24 (-0.26 to -0.21)
	Government, nonfederal	12.3%	12.6%	12.0%	-0.04 (-0.06 to -0.02)
Trauma Center	No	49.2%	47.2%	44.2%	-0.83 (-0.86 to -0.80)
	Yes	38.2%	40.6%	43.7%	+0.91 (0.88 to 0.93)
	Missing	12.5%	12.2%	12.1%	-0.07 (-0.09 to -0.05)

All differences were statistically significant at p<.001 with the exception of proportion of visits to major teaching hospitals (p=0.92).

Table 2. Trends* in selected markers of acuity or complexity for emergency department visits

	2006	2009	2012	Time Trend per Year, % (95% CI)	P-Value
Hospital Admission Rate	40.1%	38.7%	35.9%	-0.68 (-0.71 to -0.65)	<.001
Intensive Care Unit Admission Rate	11.7%	12.6%	12.3%	+0.11 (0.09 to 0.12)	<.001
Mean Number of Services per Admission†				**Change in Services per Year, % (95% CI)**	
All Admissions	1.28	1.31	1.41	+0.02 (0.018 to 0.021)	<.001
Low-Intensity	1.22	1.33	1.34	+0.02 (0.017 to 0.025)	<.001
High-Intensity	1.30	1.31	1.41	+0.017 (0.015 to 0.019)	<.001
Mean Number Services per Outpatient‡ ED Visit				**Change in Services per Year, % (95% CI)**	
All Outpatient Visits	7.11	8.05	8.60	+0.25 (0.25 to 0.26)	<.001
Low-Intensity Outpatient Visits	5.28	5.39	5.22	-0.008 (-0.01 to -0.003)	0.001
High-Intensity Outpatient Visits	12.85	13.37	13.68	+0.14 (0.13 to 0.15)	<.001

*Longitudinal linear regression models were used to estimate the time trend, adjusting for patient age, race, sex, and Medicaid eligibility. Generalized estimating equations were used to adjust for clustering.

†Inpatient services are ICD-9 procedures.

‡Outpatient services are represented using Current Procedural Terminology (CPT)/ Healthcare Common Procedure Coding System (HCPCS) codes.

Table 3. Comparison of Pseudo R2* for Sequential Models† Incorporating Explanatory Variables for the Trend in Emergency Department (ED) Practice Intensity

Model	Explanatory Variables	All Visits	Inpatient Visits	Outpatient Visits
1	Time	0.013	0.034	0.027
2	Time, Patient Demographics‡	0.021	0.034	0.028
3	Time, Patient Characteristics, Comorbidities§	0.090	0.036	0.043
4	Time, Patient Characteristics, Comorbidities, Services¶	0.148	0.051	0.465

* Pseudo R^2 determined using method described by Cragg, J and Uhler, RS. The Demand for Automobiles. Canadian Journal of Economics. 1970;3(3): 386-406.
† Generalized logistic regression modeling was used to control for repeated hospital measures.
‡Patient demographics included age, race, gender, and Medicaid eligibility.
§Comorbidities were characterized by the mean number of Hierarchical Condition Categories (HCCs). ¶ Services refers to ICD9 procedures for inpatient visits, HCPCS procedures for outpatient visits, and physician-billed HCPCS procedures in the carrier file for all visits.

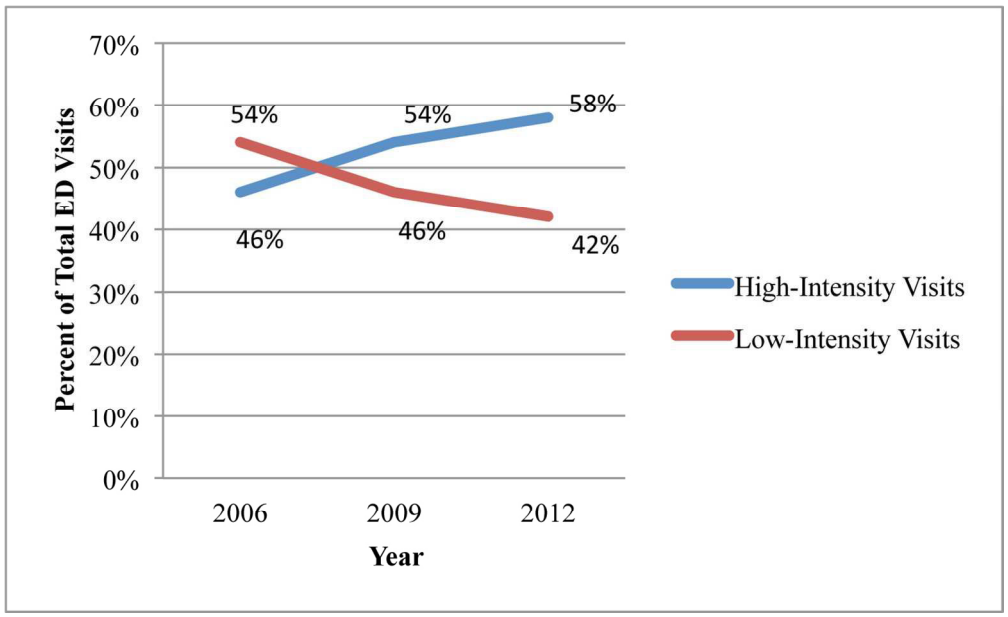
FIGURE LEGEND

Figure 1. Adjusted Time Trends* in Billing for High- and Low- Intensity‡ Emergency Care

Longitudinal linear regression was used to estimate the time trend, adjusting for patient age, race, sex, and Medicaid coverage. Generalized estimating equations were used to adjust for clustering at the level of the emergency department.
‡High-intensity visits are coded as 99285 or critical care (99291, 99292). Low-intensity visits are defined by emergency physician billed CPT/HCPCS codes 99281-99284.

Figure 2. Absolute Change in Visit Intensity Over Time versus Absolute Change in the Mean Number of Services by Diagnosis Category* for Outpatient Emergency Department Visits†

*Thirty-nine diagnosis categories previously defined in the emergency medicine literature (Gabayan, G.Z., et al *Annals of emergency medicine* 2011;58(6):551-58 e2).
†Changes in mean number of procedures and proportion of high intensity visits adjusted for patient age, sex, race and Medicaid eligibility.



Adjusted Time Trends* in Billing for High- and Low- Intensity‡ Emergency Care

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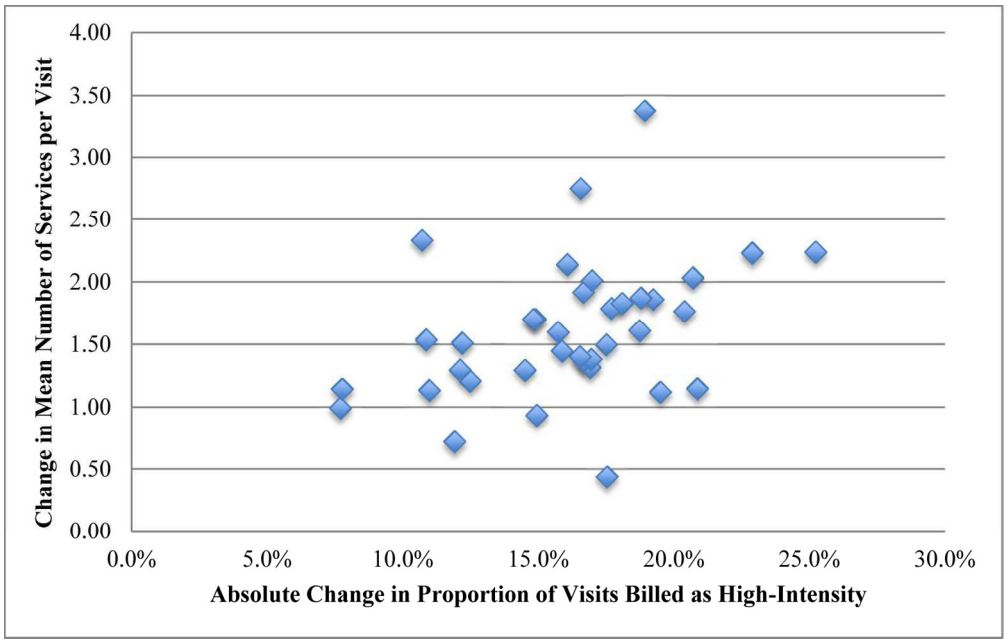

Absolute Change in Visit Intensity Over Time versus Absolute Change in the Mean Number of Services by Diagnosis Category* for Outpatient Emergency Department Visits†

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Appendices for "Trends in High-Intensity Billing for Emergency Care Accompanied by an Increase in Services Provided in the Emergency Department"

Appendix 1. Proportion of Emergency Department Visits Billed as High-Intensity Visits* by Diagnosis Category†

		2006	2009	2012	Absolute Change, % (95% CI)
1	*Minor injuries*	8.5%	14.4%	20.5%	12.0 (11.6 to 12.9)
2	*Major injuries*	34.0%	42.3%	51.7%	17.7 (14.8 to 20.6)
3	*Other injuries*	7.3%	12.3%	18.9%	12.0 (11.5 to 12.5)
4	*Symptoms: abdominal pain*	31.3%	44.0%	52.4%	21.0 (20.1 to 22.0)
5	*Symptoms: chest pain*	65.2%	77.5%	82.4%	17.2 (16.4 to 17.9)
6	*Symptoms: dizziness, vertigo, and syncope*	42.9%	57.3%	66.1%	23.0 (22.1 to 23.8)
7	*Symptoms: headache*	21.7%	30.5%	39.7%	17.9 (16.3 to 19.5)
8	*Other symptoms*	25.3%	35.7%	44.1%	18.8 (17.9 to 19.7)
9	*Upper respiratory infections*	12.8%	20.5%	27.6%	14.7 (13.5 to 15.9)
10	*Intestinal infections*	28.1%	40.1%	53.3%	25.2 (20.8 to 29.6)
11	*Urinary tract infection*	18.4%	27.3%	34.1%	15.9 (15.0 to 16.9)
12	*Other infectious and parasitic diseases*	12.6%	20.4%	23.6%	11.0 (9.1 to 12.9)
13	*Skin and subcutaneous infection*	5.9%	10.0%	13.6%	7.7 (6.4 to 9.3)
14	*Endocrine, nutritional; immunity and metabolic disorders*	29.0%	38.7%	45.8%	16.8 (15.6 to 18.0)
15	*Diabetes mellitus*	25.3%	33.5%	40.5%	15.0 (13.3 to 16.6)
16	*Hypertension*	24.4%	35.1%	41.4%	16.9 (15.6 to 18.3)
17	*Nonatherosclerotic heart disease*	61.2%	71.3%	78.3%	17.0 (14.6 6o 19.4)
18	*Dysrhythmias*	52.7%	65.4%	72.4%	19.6 (18.4 to 20.9)
19	*Ischemic heart disease*	75.8%	82.6%	86.7%	11.0 (9.0 to 12.9)
20	*Congestive heart failure*	57.2%	68.7%	75.8%	18.3 (16.5 to 20.1)
21	*Circulatory disorders*	25.0%	35.6%	40.8%	15.8 (14.2 to 17.4)
22	*Cerebrovascular disease*	63.4%	74.5%	80.5%	16.8 (15.0 to 18.5)
23	*Diseases of the blood*	32.3%	43.7%	50.1%	17.7 (15.2 to 20.3)
24	*Neoplasms*	32.9%	47.1%	49.0%	16.0 (12.7 to 19.4)
25	*Mental illness*	27.1%	36.5%	43.9%	16.8 (15.5 to 18.1)
26	*Nervous system disorders*	23.5%	31.4%	36.0%	12.4 (11.4 to 13.5)
27	*Pneumonia*	36.6%	52.0%	57.6%	20.9 (19.1 to 22.6)
28	*Other respiratory disease*	27.3%	35.6%	42.4%	15.1 (14.2 to 16.0)
29	*Chronic obstructive pulmonary disease*	31.6%	43.0%	52.4%	20.6 (19.5 to 21.8)
30	*Asthma*	28.5%	38.8%	48.3%	19.8 (16.9 to 22.1)
31	*Noninfectious lung disease*	44.0%	60.2%	62.9%	18.8 (15.0 to 22.7)
32	*GI system diseases*	21.7%	32.2%	38.4%	16.7 (16.0 to 17.4)
33	*Other renal and GU diseases*	11.5%	18.3%	24.1%	12.6 (11.6 to 13.6)
34	*End-stage renal disease*	7.1%	10.1%	25.4%	17.8 (-3.2 to 38.9)
35	*Chronic renal disease*	47.4%	61.9%	66.1%	18.6 (14.3 to 23.0)
37	*Diseases of the musculoskeletal system, skin, and connective tissue*	10.3%	16.0%	21.4%	11.1 (10.5 to 11.7)
38	*Complications and adverse events*	10.5%	15.0%	18.3%	7.8 (6.4 to 9.3)
39	*Other residual codes*	21.2%	33.7%	36.1%	14.9 (13.8 to 16.1)

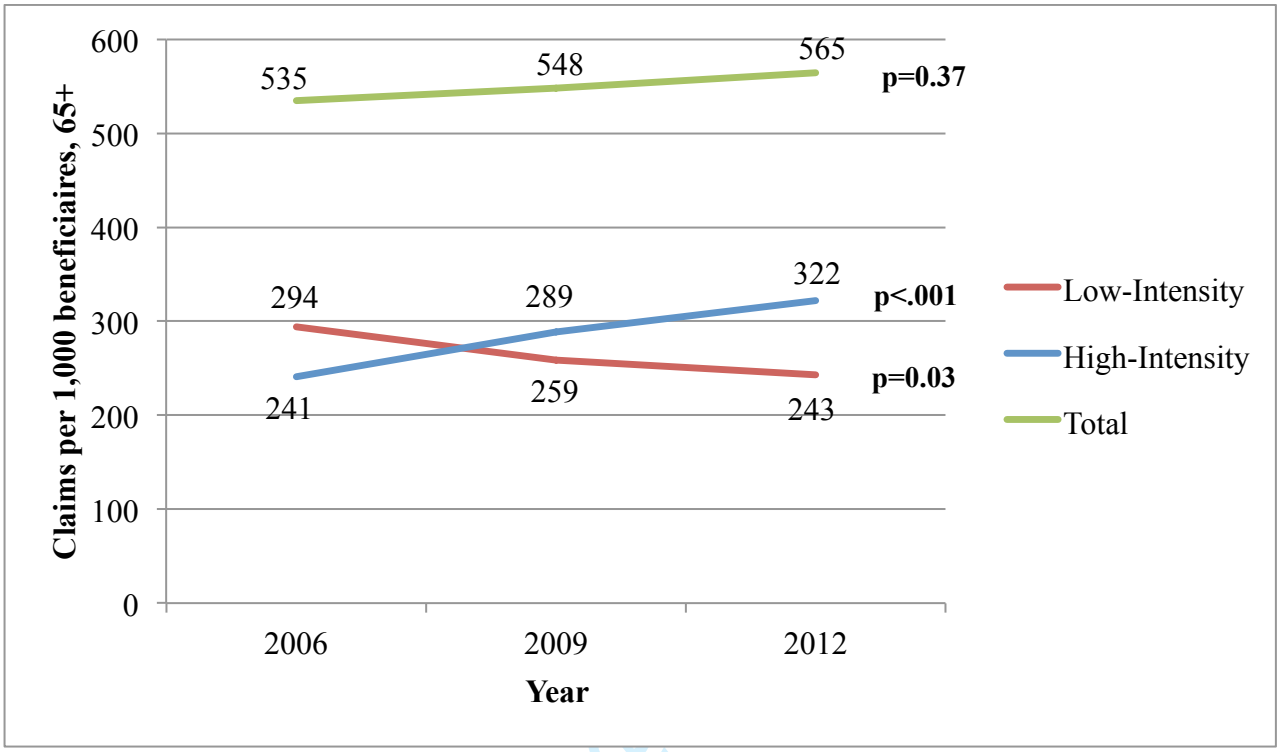
* Proportion of high-intensity visits is adjusted for patient age, sex, Medicaid eligibility and race.
† Categories defined by Gabayan, G.Z., et al *Annals of emergency medicine* 2011;58(6):551-58 e2). Category 36, pregnancy and childbirth related disorders, is omitted as it is not applicable to the elderly, Medicare population.

Appendix 2. Trends* in Billing for High-Intensity Emergency Care

		2006	2009	2012	Trend, % change per year (95% CI)	P-Value
Proportion of ED Visits by Intensity Level CPT Code‡	*99281*	0.60%	0.40%	0.40%	-0.03 (-0.04 to -0.03)	<.001
	99282	3.70%	2.60%	2.00%	-0.30 (-0.31 to -0.29)	<.001
	99283	22.20%	17.50%	14.80%	-1.25 (-1.27 to -1.22)	<.001
	99284	27.10%	25.60%	24.70%	-0.42 (-0.45 to -0.40)	<.001
	99285	39.70%	45.90%	49.40%	+1.60 (1.57 to 1.63)	<.001
	99291	5.00%	6.60%	7.60%	+0.40 (0.39 to 0.41)	<.001
	99292	0.70%	0.80%	0.70%	+0.004 (-0.0003 to 0.009)	.07

* Longitudinal linear regression models were used to estimate the time trend, adjusting for patient age, race, sex, and Medicaid coverage. Generalized estimating equations were used to adjust for clustering at the level of the emergency department.
‡Current Procedural Terminology Healthcare Common Procedure Coding System codes 99281-99285 denote increasing levels of intensity of emergency physician evaluation and management. Codes 99291 and 99292 indicate critical care services were provided.

Appendix 3. Unadjusted Rate of Emergency Department Visits per 1,000 Medicare* Beneficiaries Overall and Stratified by Intensity



*Traditional Medicare beneficiaries age 65 and over with continuous coverage during the year.

Appendix 4. Trends* in the Most Common Services† among Admitted Patients

Service	2006 (%)‡	2009 (%)	2012 (%)	Absolute Change/Year, % (95% CI)§
Blood transfusion	12.4	14.3	15.4	+0.52 (0.48 to 0.56)
Diagnostic cardiac catheterization	10.4	9.3	9.7	-0.11 (-0.16 to -0.06)
Respiratory intubation and mechanical ventilation	9.9	11.1	12.6	+0.45 (0.41 to 0.49)
Other vascular catheterization; not heart	7.6	8.9	10.0	+0.41 (0.38 to 0.44)
Upper gastrointestinal endoscopy; biopsy	6.5	6.1	5.9	-0.11 (-0.13 to -0.08)
Other therapeutic procedures	5.8	5.7	7.1	+0.21 (0.18 to 0.24)
Other OR procedures on vessels other than head and neck	4.8	4.7	6.2	+0.24 (0.21 to 0.27)
Hemodialysis	5.9	6.3	6.5	+0.10 (0.08 to 0.12)
Colonoscopy and biopsy	3.2	2.8	2.6	-0.11(-0.13 to -0.10)
Diagnostic ultrasound of heart (echocardiogram)	2.9	3.4	4.0	+0.17 (0.16 to 0.19)

* Longitudinal linear regression models were used to estimate the time trend, adjusting for patient age, race, sex, and Medicaid coverage and stratified by outpatient and inpatient visits and clustering at the level of the emergency department.
†Most common services among patients admitted from the ED occurring in the ED or during an inpatient stay. Services were defined by ICD9 procedure codes and categorized using the Clinical Classifications Software for Services and Procedures software.
‡ Percentage of all admissions including the service.
§ All changes were statistically significant at p<.001

Appendix 5. Trends* in the Most Common Services† among Patients Discharged from the ED

Service	2006	2009	2012	Trend, %† (95% CI)	P-Value
Laboratory-chemistry and hematology	3.35	3.68	3.85	0.083 (0.080 to 0.086)	<.001
Medications	0.60	0.42	0.56	-0.007 (-0.008 to -0.007)	<.001
Other therapeutic procedures	0.48	0.97	1.06	0.096 (0.095 to 0.097)	<.001
Microscopic examination (bacterial smear, culture, toxicology)	0.49	0.58	0.63	0.023 (0.023 to 0.024)	<.001
Electrocardiogram (ECG)	0.38	0.38	0.39	0.001 (0.000 to 0.0001)	.003
Other diagnostic radiology and related techniques	0.34	0.32	0.30	-0.007 (-0.0007 to -0.0006)	<.001
Routine chest X-ray	0.37	0.37	0.38	0.002 (0.002 to 0.003)	<.001
Other laboratory	0.17	0.19	0.22	0.008 (0.007 to 0.008)	<.001
Computerized axial tomography (CT) scan of the head	0.14	0.17	0.18	0.03 (0.026 to 0.027)	<.001
Durable Medical Equipment and supplies	0.10	0.18	0.26	0.026 (0.026 to 0.027)	<.001

* Services were defined by the Current Procedural Terminology (CPT) Healthcare Common Procedure Coding System codes (HCPCS) and categorized using the Clinical Classifications Software for Services and Procedures software.
†Longitudinal linear regression models were used to estimate the time trend, adjusting for patient age, race, sex, and Medicaid coverage. Generalized estimating equations were used to adjust for clustering at the level of the emergency department.

Appendix 6. Ten Most Frequent Physician Services* by Year for Emergency Department Visits

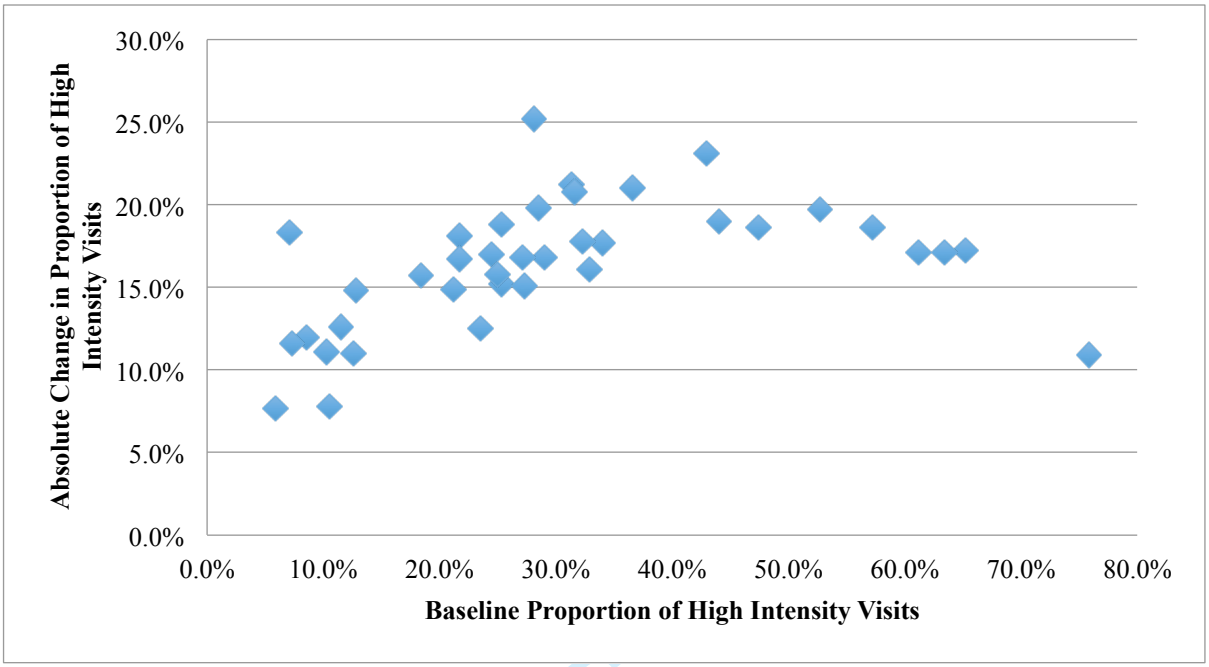
	2006		2009		2012	
	Service	**%†**	**Service**	**%**	**Service**	**%**
1	Electrocardiogram	63.5%	Electrocardiogram	64.4%	Electrocardiogram	67.4%
2	Suture of skin and subcutaneous tissue	8.3%	Suture of skin and subcutaneous tissue	8.2%	Suture of skin and subcutaneous tissue	7.4%
3	Other therapeutic procedures	6.1%	Routine chest X-ray	4.1%	Routine chest X-ray	3.2%
4	Routine chest X-ray	3.7%	Laboratory - Chemistry and Hematology	3.3%	Laboratory - Chemistry and Hematology	3.1%
5	Other diagnostic radiology and related techniques	2.2%	Other diagnostic radiology and related techniques	2.2%	Other diagnostic radiology and related techniques	1.7%
6	Laboratory - Chemistry and Hematology	1.7%	Other therapeutic procedures	1.8%	Traction, splints, and other wound care	1.6%
7	Control of epistaxis	1.7%	Control of epistaxis	1.6%	Other OR therapeutic procedures on nose, mouth and pharynx	1.6%
8	Traction, splints, and other wound care	1.6%	Traction, splints, and other wound care	1.6%	Control of epistaxis	1.4%
9	Respiratory intubation and mechanical ventilation	1.5%	Respiratory intubation and mechanical ventilation	1.5%	Other therapeutic procedures	1.4%
10	Other vascular catheterization, not heart	1.1%	Other fracture and dislocation procedure	1.3%	Other fracture and dislocation procedure	1.4%

* Services were defined by the Current Procedural Terminology (CPT) Healthcare Common Procedure Coding System codes (HCPCS) and categorized using the Clinical Classifications Software for Services and Procedures software. Codes for emergency physician evaluation and management codes (99281-99285, 99291, 99292) were excluded.

†Longitudinal linear regression models were used to estimate the time trend, adjusting for patient age, race, sex, and Medicaid coverage. Generalized estimating equations were used to adjust for clustering at the level of the emergency department.

‡Percentage of all physician services in the sample.

Appendix 7. Absolute Change* in Proportion of High-Intensity Visits versus Baseline Proportion of High-Intensity Visits by Diagnosis Category* for Outpatient Emergency Department Visits†



*Longitudinal linear regression models were used to estimate the time trend, adjusting for patient age, race, sex, and Medicaid coverage. Generalized estimating equations were used to adjust for clustering. †Thirty-nine diagnosis categories previously defined in the emergency medicine literature (Gabayan, G.Z., et al *Annals of emergency medicine* 2011;58(6):551-58 e2)‡Proportion of high-intensity visits is adjusted for patient age, sex and Medicaid eligibility.

Appendix 8. Comparison of Observed versus Expected Number of High-Intensity Visits* in 2006 Using Multivariable Modeling

	Observed High-Intensity Visits 2006	**Using 2009 Regression Coefficients†**		**Using 2012 Regression Coefficients**	
		Predicted High-Intensity‡	*Observed - Expected (%)*	*Predicted High-Intensity*	*Observed - Expected (%)*
Inpatient (N=261,230)	203,344	228,163	-24,819	238,848	-35,504
Outpatient (N=409,864)	98,801	99,902	-1,101	115,706	-16,905

* High-intensity visits were defined as visits with an emergency physician professional claim for evaluation and management codes 99285, 99291, and 99292.

†Logistic regression models were run separately for emergency department (ED) visits in 2009 and 2012 incorporating patient age, sex, Medicaid eligibility, race, chronic conditions (Hierarchical Condition Categories). The model also incorporated the number of services billed for the associated facility and physician professional claims (excluding evaluation and management services). Models were run separately for inpatient and outpatient ED visits.

‡The coefficients for each variable in the regression model were applied to the 2006 data to obtain an expected number of high-intensity visits.

§The difference between the observed and predicted number of high-intensity visits represents the degree to which high-intensity billing has changed in ways that cannot be explained by the variables in our model.

Trends in High-Intensity Billing for Emergency Care Accompanied by an Increase in Services Provided in the Emergency Department

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STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract **This has been done in the title and on the abstract (page 4)**
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found **This is in the abstract section on page 4 & 5.**
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported **This has been done. Rationale for investigation is explained on pages 8 and 9.**
Objectives	3	State specific objectives, including any prespecified hypotheses **Specific objectives are listed out as three separate questions on pages 9.**
Methods		
Study design	4	Present key elements of study design early in the paper. **This has been done both in the abstract and in the Methods section on page 9-15.**
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection **This has been done in the Methods section (pages 9-11).**
Participants	6	*Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants **The description of data can be found in the "Study Design and Setting" subsection of the Methods section (page (9&10).**
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable **All these data have been included in the Methods section (pages 9-14).**
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group. **This has been done in the Methods section (pages 9-15).**
Bias	9	Describe any efforts to address potential sources of bias **The limitations section on discussion on page 22 address the potential sources of bias.**
Study size	10	Explain how the study size was arrived at **The study population and inclusion/exclusion can be found in the "Study Design and Setting" subsection of the Methods section on page 9.**
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why.

		This is addressed in the subsection "Analysis" in the Methods section (pages 12-15).
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding **This has been done in the subsection "Analysis" in the Methods section (pages 12-15).**
		(*b*) Describe any methods used to examine subgroups and interactions **This has been done in the Methods section (pages 12-15).**
		(*c*) Explain how missing data were addressed **This has been done in the "Study Design and Setting" subsection of the Methods section (page 7 & 8).**
		(*d*) *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy **N/A**
		(*e*) Describe any sensitivity analyses **This has been done in the subsection "Analysis" in the Methods section (pages 14-15).**
Results		
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed **This is done in the first paragraph of the Results section (page 15).**
		(b) Give reasons for non-participation at each stage
		(c) Consider use of a flow diagram
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders **This is done in the first paragraph of the Results section (page 15) and Table 1.**
		(b) Indicate number of participants with missing data for each variable of interest
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time
		Case-control study—Report numbers in each exposure category, or summary measures of exposure
		Cross-sectional study—Report numbers of outcome events or summary measures **All these data have been included in the Results section (pages 15-20) and relevant tables.**
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included **All these data have been included in the Results section (pages 15-20) and relevant tables.**
		(*b*) Report category boundaries when continuous variables were categorized
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses **All these data have been included in the Results section (pages 15-20) and relevant tables, as well in the Appendix.**
Discussion		
Key results	18	Summarise key results with reference to study objectives **Key results are summarized in the first paragraph of the Discussion (page 20).**

Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias **Limitations are outlined in the discussion (page 22).**
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence **An interpretation and implications are discussed (pages 20-23).**
Generalisability	21	Discuss the generalisability (external validity) of the study results **The external validity of this study is discussed in the "Limitations" subsection (page 22).**
Other information		
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based **This study had no funding source.**

Continued on next page

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Are trends in billing for high-intensity emergency care explained by changes in services provided in the emergency department? An observational study among US Medicare beneficiaries

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Are trends in billing for high-intensity emergency care explained by changes in services provided in the emergency department? An observational study among US Medicare beneficiaries

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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 support from any organisation for the submitted work; no financial relationships with any organisations 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.

Data Sharing

No additional data available.

Details of Contributors

LB had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. LB and RH developed the study concept and LB, RW, EO and RH all substantially contributed to the study design. LB, RW, and EO performed the statistical analyses and all authors interpreted the data. LB and RH drafted the manuscript. LB,

RW, EO, and RH revised the manuscript for important intellectual content. All authors approved the final version of the manuscript.

ABSTRACT (409 words)

Objective: There has been concern that an increase in billing for high-intensity emergency care is due to changes in coding practices facilitated by electronic health records. We sought to characterize the trends in billing for high-intensity emergency care among Medicare beneficiaries and to examine the degree to which trends in high-intensity billing are explained by changes in patient characteristics and services provided in the emergency department (ED).

Design, Setting, and Participants: Observational study using traditional Medicare claims to identify ED visits at nonfederal acute care hospitals for elderly beneficiaries in 2006, 2009, and 2012.

Outcomes Measures: Billing intensity was defined by emergency physician evaluation and management (E&M) codes. We tested for overall trends in high-intensity billing (E&M codes 99285, 99291 and 99292) and in services provided over time using linear regression models, adjusting for patient characteristics. Additionally, we tested for time trends in rates of admission to the hospital and to the intensive care unit. Next we classified outpatient visits into 39 diagnosis categories and analyzed the change in proportion of high-intensity visits versus the change in number of services. Finally, we quantified the extent to which trends in high-intensity billing are explained by changes in patient demographics and services provided in the ED using multivariable modeling.

Results: High-intensity visits grew from 45.8% of 671,103 visits in 2006 to 57.8% of 629,010

visits in 2012 (2.0% absolute increase per year; 95% CI, 1.97% to 2.03%) as did the mean number of services provided for admitted (1.28 to 1.41; +0.02 increase in procedures per year; 95% CI, 0.018 to 0.021) and discharged ED patients (7.1 to 8.6; +0.25 increase in procedures per year; 95% CI, 0.245 to 0.255). There was a reduction in hospital admission rate from 40.1% to 35.9% (-0.68% per year; 95% CI, -0.71% to -0.65%; p<.001), while the ICU rate of admission rose from 11.7% to 12.3% (+0.11% per year; 95% CI, 0.09% to 0.12%; p<.001). When we stratified by diagnosis category, there was a moderate correlation between change in visits billed as high intensity and the change in mean number of services provided per visit (ρ=0.38; 95% CI, 0.07 to 0.63). Trends in patient characteristics and services provided accounted moderately for the trend in practice intensity for outpatient visits (pseudo R^2 of 0.47) but very little for inpatient visits (0.051 and visits overall (0.148).

Conclusions: Increases in services provided in the ED moderately account for the trends in billing for high-intensity emergency care for outpatient visits.

STRENGTHS AND LIMITATIONS OF THIS STUDY

Strengths

- Examined 1.9 million emergency department (ED) visits by Medicare beneficiaries in the United States in 2006, 2009 and 2012.
- Employed multivariable modeling to examine the extent to which trends in practice intensity are explained by changes in patient characteristics and services provided.

Limitations

- Lacks some clinical information such as vital signs, laboratory results, and total time spent in the ED undergoing treatment and observation, as is inherent to the use of claims data.
- There is less detail regarding work performed in the ED for admitted patients compared to those who are discharged.
- The analysis is limited to elderly fee-for-service Medicare beneficiaries and may not be generalizable to other populations.

INTRODUCTION

The rising cost of healthcare in the United States has received increasing attention[1] as it has strained state and federal budgets[2 3] and directly impacted individuals via lost income and higher out-of-pocket costs.[4] Emergency care has often been portrayed as an expensive and inefficient contributor to the healthcare crisis.[5-7] Concerns about the cost of emergency care have led to a variety of initiatives seeking to steer patients away from the emergency department (ED) to lower cost settings during an acute illness.[8 9] Despite these concerns, the number of ED visits in the U.S. has continued to rise,[10 11] as have the numbers of visits billed at the highest level of intensity.[12] As billing for high-intensity emergency care has risen, some have questioned whether the growth of electronic health records (EHRs) has exacerbated the problem by allowing providers to more easily "upcode" or bill for services without changing the work performed.[13] While prior work has suggested that EHRs have not led to upcoding for inpatient care,[14] relatively little is known about this phenomenon for emergency care.

Research has demonstrated that the average number of diagnostic and treatment services provided during an ED visit has also risen over time,[15 16] suggesting that upcoding alone is unlikely to explain the growth in billing for high-intensity emergency care. Such an increase in the intensity of care provided may reflect efforts to improve quality and reduce costs of care by avoiding a more expensive hospital admission, or to reserve limited availability of inpatient space for the highest acuity patients.[15] To our knowledge, no studies have used multivariable modeling at the visit level to examine the relative contribution of patient characteristics and clinical practice patterns to trends in billing for high-intensity emergency care or whether the trend in high-intensity billing has been uniform across various conditions treated in the ED.

Thus, we sought to evaluate the trends in billing for high-intensity emergency care and the underlying mechanism for these trends by addressing three questions. First, what are the trends in billing for high-intensity care in the Medicare fee-for-service population, and to what extent are these trends accompanied by changes in patient characteristics and practice patterns? Second, do particular diagnoses or conditions have greater changes in intensity over time, and, if so, are these variations associated with trends in services? Finally, how much of the trend in high-intensity billing is explained by trends in services provided and patient characteristics when using multivariable modeling?

METHODS

Study Design and Setting

We used a five percent sample of national Medicare fee-for-service claims to identify ED visits in 2006, 2009, and 2012. We examined ED visits by beneficiaries age 65 and older who were continuously-enrolled in traditional Medicare and presented to nonfederal acute care hospitals. The billing intensity level was obtained by identifying all emergency physician professional claims in the Carrier file for Current Procedural Terminology (CPT) Healthcare Common Procedure Coding System (HCPCS) evaluation and management codes 99281-99285, 99291 and 99292. Patient characteristics (age, sex, race, Medicaid eligibility) were obtained from the Master Beneficiary Summary File. Patient chronic conditions were assigned using software from the Centers for Medicare and Medicaid Services that allows for the creation of Hierarchical Condition Categories (HCCs)[17] based on conditions coded in claims for that year. Information such as visit diagnosis and services provided were obtained from the inpatient file for admitted patients and the outpatient file for visits resulting in discharge or observation status.

Procedures were denoted by International Classification of Diseases, Ninth Revision (ICD9) procedure codes for inpatient visits and CPT/HCPCS codes for outpatient visits and physician professional claims. Since claims for substance abuse related visits were no longer available in Medicare data in 2012,[18] we dropped substance abuse claims from the prior years. We used the American Hospital Association survey from 2012 to obtain data on hospital characteristics (region, rural vs. urban location [RUCA], size, as well as trauma center, profit, and teaching status) and linked this to ED claims using Medicare provider identification numbers.

Outcomes

High-Intensity Billing

Our primary outcome was the ED visit level of billing intensity, defined by CPT codes as selected by the treating emergency physician or designee. CPT codes 99281 and 99282 represent low complexity, 99283 and 99284 represent moderate complexity, 99285 represents high complexity, while codes 99291 and 99292 are used to denote that critical care services were provided. While prior studies have used 99285 alone to define high-intensity ED visits,[19 20] we chose to also define ED visits with critical care billing as high intensity as these were available in our dataset and have been evaluated in prior research on ED visit acuity.[21] Thus, we created a binary intensity outcome variable, categorizing visits with codes 99281-99284 as low-intensity and those with codes 99285, 99291, and 99292 as high-intensity.

Clinical Services Provided

If a rise in high-intensity billing was due to upcoding alone rather than trends in actual practice, we might expect relatively little change in the frequency and type of services provided

in the ED. As such, we determined the mean number of services provided per visit according to the ED facility claims. For discharged patients, we identified all services on outpatient ED facility claims (outpatient services) such as laboratory and radiology tests and clinical procedures that occurred in the ED. For admitted patients, services from inpatient facility claims (inpatient services) may have been provided at any time during that hospitalization, including during treatment in the ED, as we could not readily distinguish the location of services provided for admitted patients in this dataset. We also determined the mean number of physician professional claims for services other than evaluation and management for all visits (physician services).

Hospital and Intensive Care Unit Admission Rate

We also evaluated trends in rates of admission to the hospital and to the intensive care unit (ICU) as additional indicators or clinical practice and patient acuity. Hospital utilization rates in the United States have fallen[22] as the number of inpatient beds per capita has declined. Thus, temporal trends in hospital admission may reflect changing practice patterns in response to a variety of incentives to admit fewer patients rather than patient acuity alone. More intensive ED evaluation and treatment may allow emergency physicians to safely discharge a greater number of patients of moderate acuity or complexity. ICU admission, however, is generally reserved for the most seriously-ill patients and is less likely to be avoided by an intensive ED work-up. Thus, we hypothesized that any increase in high-intensity billing would be accompanied by a reduction in hospital admission and stable or increasing rates of ICU admission.[23]

Analysis

Trend in High-Intensity Billing

Changes in billing for high-intensity emergency care were estimated by regressing a binary outcome (high or low intensity) against time while controlling for patient characteristics. Patient age, race, sex, and Medicaid coverage were used for the patient characteristics. Analysis occurred at the visit level with each visit coded as high or low intensity. The models accounted for patient clustering at the level of the ED. The adjusted estimates of the proportion of high-intensity visits were graphed over time and rates of change over the study period were tested for statistical significance. A logistic regression model using generalized estimating equations and time as a categorical predictor was used for the adjusted estimates, while, for interpretability, linear regression with time as a continuous predictor was used for rates of change. In addition to examining the binary high-intensity outcome variable, we examined the time trends for each of the seven intensity categories individually.

Visit Rate

We next examined how the rate of high-intensity visits and overall ED visits changed. An increase in the relative proportion of high-intensity visits could potentially reflect a reduction in low-acuity visits over time rather than an increase in population rates of high-acuity visits.[5 24] Thus, we calculated a per beneficiary rate of overall high-intensity and low-intensity visits for each year and tested for a time trend using negative binomial regression.

Secondary Outcomes

We used the Clinical Classifications Software developed by the Agency for Healthcare Research and Quality (HCUP-CCS) to classify procedures codes for inpatient, outpatient, and

physician services into clinically meaningful categories and determined the frequency of each procedure type. We tested for time trends in mean number and type of services per visit for admitted and discharged patients using linear regression adjusting for age, sex, race, and Medicaid eligibility. The yearly estimates for rates of procedures were obtained using negative binomial regression using generalized estimating equations to account for patient clustering at the level of the ED and with time as a categorical predictor. We tested for time trends in the overall hospital admission rate (percentage of ED visits leading to a hospital admission) and the ICU admission rate (percentage of ED visits leading to an ICU admission), again using linear regression, adjusting for age, race, sex, and Medicaid coverage. The yearly estimates for these outcomes were obtained from binomial regression using generalized estimating equations to account for patient clustering at the level of the ED.

Trends in Practice Intensity by Diagnosis Category

Next, we evaluated if trends in billing for high-intensity emergency care varied by condition treated and if those conditions with the greatest changes in high-intensity emergency care also saw the greatest changes in services over time. We categorized the principal diagnosis for each outpatient visit into one of 39 diagnosis categories, previously described in the emergency medicine literature (Appendix 1),[25] and used the analogous adjusted longitudinal linear regression model for each diagnosis to estimate the percentage of total visits in each year categorized as high-intensity as well as the absolute change in proportion of high-intensity visits. We limited this analysis to outpatient visits because of the limited detail regarding ED services for admitted patients. For each diagnostic category, we calculated the change in high-intensity visit rate and the change in ED services between 2006 and 2012. The changes were graphed

against each other and a correlation coefficient was calculated to capture the degree to which the two were associated with each other. Additionally, for each diagnosis category, we graphed the change in proportion of high-intensity visits against the baseline proportion of high-intensity visits in 2006. We did this in order to determine if high- or low-complexity conditions saw greater changes over time.

Multivariable Modeling

We used generalized logistic regression modeling, controlling for repeated hospital measures, to investigate the extent to which trends in practice intensity are explained by concomitant changes in patient characteristics, chronic conditions, and services provided in the ED. We specified four models with the initial model having the binary variable intensity as the outcome and time as the predictor. The second model incorporated beneficiary characteristics. The third model incorporated number of chronic conditions. The fourth model further incorporated inpatient, outpatient, and physician-billed services (CPT codes) for all visits. We calculated a pseudo R^2 for each model[26 27] as a measure of the proportion of total variation explained by the model. We ran these models for all visits and for inpatient and outpatient visits separately.

As a complementary analysis examining the degree to which trends in coding are explained by the variables in our model, we ran two logistic regression models separately for 2009 and 2012 and obtained the coefficients for each variable in the model for those years. We then applied those coefficients to ED visits in 2006 to obtain an expected number of visits in 2006. The difference between the observed and predicted number of visits billed as high-intensity in 2006 using coefficients from the later years represents the degree to which high-

intensity billing has changed in ways that cannot be explained by the variables in our model. We performed this analysis for outpatient and inpatient visits separately.

Sensitivity Analysis

There has been a growth in use of observation services for Medicare beneficiaries[28 29] both in the ED and the inpatient setting.[30] There has been some concern that the concomitant growth in observation status and decline in hospital admissions may represent substitution in response to Medicare payment policies.[28] To evaluate if our results were sensitive to inclusion of observations visits in our sample, we recalculated the admission rate and mean number of inpatient and outpatient services and repeated our mediation analysis after reclassifying all observation claims as admissions.

Analyses were conducted using SAS version 9.3 (SAS institute). The Office of Human Research Administration approved this study.

RESULTS

Characteristics of Study Sample

We examined 1,883,650 ED total visits. Patient and hospital characteristics are summarized for all ED visits in Table 1. There was a decrease in the proportion of ED visits by women (66.1% to 60.6%; -0.94% absolute decrease per year [95%CI, -0.97% to -0.91%]; p<.001) and whites (85.9% to 84.1%; -0.29% absolute decrease per year [95%CI, -0.31% to -0.27%]; p<.001) while all other racial groups saw a slight increase. The proportion of visits by Medicaid beneficiaries rose from 22.4% in 2006 to 23.1% in 2012 (+0.12% absolute increase per year [95% CI, 0.09% to 0.14%]; p<.001). The average number of chronic conditions per

beneficiary increased slightly from 4.61 in 2006 to 4.91 in 2012 (+0.05 conditions/per year [95% CI, 0.049 to 0.054]; p<.001). When we stratified by high- and low-intensity ED visits, the number of chronic conditions (HCCs) was higher for beneficiaries with a high-intensity visit than for those with a low-intensity visit (5.66 HCCs vs. 3.93 HCCs, respectively in 2012; Table 1). Over the study period there was an increase in proportion of visits to urban (71.5% in 2006 to 73.1% in 2012; +0.26% absolute increase per year [95% CI, 0.24% to 0.29%]; p<.001), large (23.6 to 26.4%; +0.48% per year [95% CI, 0.46% to 0.50%]; p<.001), minor teaching (26.4% to 30.8%; +0.74% per year [95% CI, 0.72% to 0.77%]; p<.001), and for-profit hospitals (12.9% to 14.9%; +0.33% per year [95% CI, 0.31% to 0.35%]; p<.001), as well as trauma centers (38.2% to 43.7%; +0.91% per year [95% CI, 0.88% to 0.93%]; p<.001).

Trends in Practice Intensity

High-intensity visits overall rose from 45.8% in 2006 to 57.8% in 2012 (+2.0% per year [95% CI, 1.97% to 2.03%]; p<.001; Figure 1).The most frequent intensity code in all three years was 99285, also known as a level 5 visit (Appendix 2). Level 5 visits represented 39.7% of all ED visits in 2006 and 49.4% in 2012 (+1.6% per year [95% CI, 1.57% to 1.63%]; p<.001). There was also an increase in visits that were billed at a critical care level (CPT 99291) from 5.0% of all visits in 2006 to 7.6% in 2012 (+0.4% increase per year [95% CI, 0.39% to 0.41%]; p<.001). CPT 99292 comprised of less than 1% of all visits in both years and showed a small increase that was not statistically significant (+0.004% increase per year [95% CI, -0.0003% to +0.009%]; p=.07). We observed a concomitant decrease over time in each of the four CPT codes categorized as low-intensity (Appendix 2).

Trends in Visit Rates per Beneficiary

We found an increase from 535 to 565 ED visits per 1,000 beneficiaries that was not statistically significant (0.9% increase per 1,000 beneficiaries per year [95%CI, -1.1% to 2.9%]; p=0.37, Appendix 3). There was a significant increase in the high-intensity visit rate from 241 to 322 per 1,000 beneficiaries (4.8% increase in high-intensity visits per 1,000 beneficiaries per year, [95% CI, 2.0% to 7.5%]; p<.001), while the rate of low-intensity visits per beneficiary decreased (294 to 243 visits per 1,000 beneficiaries; -3.2% decrease in low-intensity visits per 1,000 beneficiaries per year [95% CI, -6.1% to -0.4%]; p=0.03).

Trends in Patient Acuity and Treatment Intensity

When we looked at inpatient services for patients admitted from the ED, we found an increase in the mean number of total services (1.28 to 1.41 per admissions; +0.02 procedures per year, [95% CI, 0.018 to 0.021]; p<.001), which persisted even after reclassifying observation claims as admissions (1.23 to 1.29; +0.011 procedures per year [95% CI, 0.009 to 0.012]; p<.001). High-intensity admissions had a greater number of services in each year, and both groups saw an increase over time in the mean number of services (Table 2). The most frequent inpatient services by year are presented in Appendix 4. Several critical care procedures and services saw an increase over time including respiratory intubation and mechanical ventilation (9.9% of all admissions from the ED in 2006 compared to 12.6% in 2012 ;+0.45% per year [95% CI, 0.41% to 0.49%]; p<.001), blood transfusion (12.4% to 15.4%; +0.52% per year [95% CI, 0.48% to 0.56%]; p<.001), and other vascular catheterization, not heart (7.6% to 10.0%; +0.41% per year [95% CI, 0.38% to 0.44%]; p<.001).

Outpatient ED visits saw a significant increase in total average number of services per visit from a mean of 7.1 in 2006 to 8.6 in 2012 (+0.25 increase in mean services per year [95% CI, 0.25 to 0.26]; p<.001). High-intensity visits, relative to low-intensity visits, had a greater number of services in each year. High-intensity visits saw a significant increase in services (12.9 to 13.7; +0.14 services per year [95% CI, 0.13 to 0.15]; p<.001), whereas low-intensity visits saw a slight decrease (5.3 to 5.2; -0.008 services per year [95% CI, -0.121 to -0.003] p<.001; Table 2). After reclassifying observation claims as admissions, the mean number of outpatient services still saw an increase from 6.7 to 8.1 services per visit (+0.23 increase per year, [95% CI, 0.22 to 0.23]; p<.001). The most frequent services provided during an outpatient ED visit are presented in Appendix 5. There were very few physician professional claims for services other than evaluation and management in all three years, but the mean number of procedures per visit increased slightly from 0.31 in 2006 to 0.34 in 2012 (p<.001), the most frequent of which were for electrocardiogram interpretation (Appendix 6).

When examining trends in hospital admission, we observed a reduction in admission rate from the ED over time, with 35.9% of visits leading to admission in 2012 compared to 40.1% in 2006 (-0.68% per year [95% CI, -0.71% to -0.65%]; p<.001; Table 2). The number of visits with an associated observation claim rose from 15,914 visits (3.9% of total) in 2006 to 22,226 visits (5.4% of total) in 2012. However, even after reclassifying observation claims as admissions, there was still a statistically significant decrease in admission rate from 42.1% in 2006 to 39.1% in 2012 (-0.48% per year [95% CI, -0.51% to -0.45%]; p<.001). In contrast, the proportion of all ED visits resulting in an ICU admission increased (11.7% to 12.3%; +0.11% per year, [95% CI, 0.09% to 0.12%]; p<.001).

Trends by Diagnosis

Upon examining the 39 condition categories individually (Appendix 1), diagnosis categories with the largest change in the proportion of high-intensity visits tended to have a mid-range baseline intensity (Appendix 7). Skin and subcutaneous infections had the lowest absolute change (5.9% of visits categorized as high-intensity in 2006 to 13.6% in 2012; +7.8% [95% CI, 6.4% to 9.3%]; p<.001) and intestinal infections had the greatest (25.2%; from 28.1% in 2006 to 53.3% in 2012; +25.2% [95% CI, 20.8% to 29.6%]; p<.001). We found that those diagnoses with greater increases in intensity tended to have an increase in mean number of services (Figure 2), with moderate correlation (r=0.38 [95% CI, 0.07 to 0.63]; p=0.02) between the change in percentage of high-intensity visits and the change in mean number of services provided per visit for each diagnosis category.

Impact of Patient Characteristics and Services on High-Intensity Billing

We next used four separate logistic regressions to determine the extent to which the trends in high-intensity billing are explained by trends in patient demographics, chronic conditions, and services provided (Table 3). Time alone explained between 1.3% of the variation in high-intensity billing for all visits, 3.4% for inpatient visits, and 2.7% for outpatient visits. Incorporating patient age, sex, race, and Medicaid eligibility again increased the pseudo R^2 by less than 1%, regardless of disposition. Incorporating patient comorbidities (HCCs) increased the pseudo R^2 to 9.0% for all visits, 3.6% for inpatient visits, and 4.3% for outpatient visits. Incorporating services in the model led to the greatest increase in pseudo R^2 and explained 46.5% of the variation in high-intensity billing for outpatient visits. While incorporating services had the greatest impact on model R^2 for inpatient visits and visits overall,

it still explained only 5.1% of the variation for inpatient visits and 14.8% for visits overall. When we reclassified observation claims as admissions, our results were similar (pseudo R^2 of 0.14 for visits overall, 0.05 for inpatient visits, and 0.44 for outpatient visits for the final model incorporating time, patient demographics and chronic conditions, and services).

Additionally, we calculated the predicted number of high-intensity visits that would have occurred in 2006 using coefficients for the variables in our models from 2009 and 2012. We calculated the difference between the predicted and observed number of high-intensity visits in 2006. For inpatient ED visits, this difference revealed an additional 24,819 visits that would have been classified as high-intensity using 2009 coefficients (9.5% of all inpatient visits; Appendix 8) and 35,504 inpatient visits (13.6%) that would have been classified as high-intensity using 2012 coefficients. For outpatient visits, this difference revealed an additional 1,101 visits (0.3%) that would have been classified as high-intensity using 2009 coefficients, and 16,905 (4.1%) would have been classified as high-intensity using 2012 coefficients. These additional visits represent the degree to which billing for high-intensity emergency care has changed in ways that are not explained by the variables in our model and may represent upcoding.

DISCUSSION

In our study of elderly Medicare beneficiaries, we found that ED visits are increasingly billed at the highest levels of intensity, with nearly 60% of ED visits in our sample coded at a level 5 or as critical care in 2012, up from 46% in 2006. We found a concomitant increase in services provided in the ED and during an associated inpatient stay. While overall admission rate decreased over time, a greater fraction of ED visits resulted in admission to intensive care. We

found that trends in high intensity billing varied by clinical condition; diagnoses with the greatest change in high-intensity billing also had the greatest increase in number of services. These findings persisted when we repeated our analyses reclassifying observation claims as admissions. Finally, using multivariable modeling, we found that trends in patient characteristics as well as in services provided during the visit moderately accounted for the increase in practice intensity for outpatient ED visits. If the process for determining high-intensity visits in 2012 were applied to visits in 2006, we would have seen an additional 4.1% of outpatient visits and 13.6% of inpatient visits coded as high-intensity. In other words, those additional increases were unexplained in our model, and could potentially represent secular changes such as upcoding.

Our results are consistent with other work showing a growth in high-intensity emergency care. A study of all ED visits in California[20] also demonstrated a growth in physician billing for high-intensity visits, particularly among safety net hospitals. Other studies using national datasets have documented greater use of tests and treatments in the ED such as advanced imaging, blood tests, and IV fluids.[15 16] Exploring the idea that doing more in the ED can prevent hospitalizations, one study found that greater use of CT scans was associated with a reduction in admissions and transfers.[31] Our study adds to this literature by linking physician billing for high-intensity emergency care to services provided during the ED visit for a national sample of Medicare beneficiaries. Our findings suggest that the growth in high-intensity billing has been accompanied by an observable increase in diagnostic and treatment intensity while admission rates have fallen.

While prior studies have suggested that the fears of upcoding due to EHRs may not be fully warranted,[14] there has been concern that the trend in billing for high-intensity emergency care may represent trends in coding rather than actual changes in practice. Using multivariable

modeling, we found that observable factors such as patient characteristics and numbers of services and procedures moderately explained, but did not fully account for, the trends in high-intensity billing for outpatient visits. It is possible that part of the residual trend could be attributed to upcoding; our study, however, is unable to identify conclusively whether this is the case.

ED visits in the U.S. have continued to rise[10 32-34] despite health insurance expansion and cost control efforts that were predicted to reduce ED utilization. The role of emergency medicine in the acute care landscape has also expanded,[35] with EDs assuming greater responsibility for managing complex problems while reserving limited and costly hospital capacity for those truly requiring inpatient care. With the growth of alternative payment models, reducing admissions for ED patients with moderate severity problems has been proposed as a strategy to reduce costs.[36] Our findings are consistent with this new model of emergency care. We found an increase in services while admission rates fell, even after accounting for the growth in observation stays. We found the greatest increases in high-intensity billing and services among conditions with moderate baseline intensity such as pneumonia and intestinal infections, for which the decision to admit likely involves greater provider discretion relative to higher acuity conditions. While our study was not designed to assess the relationship between intensity of emergency care and admission rate, it is possible that doing more for patients in the ED may have allowed a greater number to be safely discharged. The rise in number of services, including critical care procedures, provided during hospital admission suggests that the average acuity of patients who ultimately are admitted may be increasing over time.

Our study has a number of limitations. Given the use of administrative data, clinical markers of acuity, such as vital signs and laboratory data, that may have been helpful in further

detailing any trends in patient acuity over time, were not available. Also, time spent observing and treating patients is another key component of practice intensity that we could not measure with our dataset and could potentially account for some of the remaining time trend in practice intensity. Additionally, our modeling explained relatively little of the variation for inpatient visits and ED visits overall. This is likely due to the fact that, unlike for outpatient visits, there is substantially less detail in the dataset regarding services provided in the ED. Also, while national in scope, our analysis is limited to elderly fee-for-service Medicare beneficiaries and may not be generalizable to other populations.

In summary, the rise in billing for high-intensity emergency care has been portrayed as an unintended consequence of the growth of health information technology rather than reflecting a change in practice. However, this trend has been accompanied by an increase in the provision of services in the hospital as well as in the ED. Multivariable modeling incorporating patient characteristics, comorbidities, and services provided moderately explained the trends in high-intensity billing. It is unclear the degree to which changes in coding practices explain the remaining variation. This rise in high-intensity emergency care has occurred while rates of admission from the ED have fallen, raising the possibility that a greater amount of work performed in the ED may have allowed more patients to avoid inpatient treatment during an acute episode. Further study may be useful in determining what impact the trend in high-intensity emergency care has had on total costs of care as well as patient outcomes.

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TABLES

Table 1. Beneficiary and Hospital Characteristics as a Percentage of Total Emergency Department Visits by Year

		2006	2009	2012	Change, % per year (95% CI)*
Beneficiary Characteristics					
Age	Mean, yrs	79.3	78.9	78.8	-0.08 (-0.08 to -0.07)
	65-69	13.8%	16.1%	17.1%	+0.55 (0.53 to 0.57)
	70-79	37.6%	36.7%	36.9%	-0.12 (-0.15 to -0.09)
	>=80	48.7%	47.2%	46.1%	-0.43 (-0.46 to -0.40)
Gender	Female	66.1%	60.9%	60.6%	-0.94 (-0.97 to -0.91)
Race	White	85.9%	84.8%	84.1%	-0.29 (-0.31 to -0.27)
	Black	10.4%	10.7%	11.0%	+0.11 (0.10 to 0.13)
	Asian	0.9%	1.2%	1.3%	+0.06 (0.06 to 0.07)
	Hispanic	1.7%	2.0%	1.9%	+0.04 (0.03 to 0.05)
	Other	1.2%	1.4%	1.7%	+0.05 (0.04 to 0.06)
Medicaid Coverage	Yes	22.4%	23.2%	23.1%	+0.12 (0.09 to 0.14)
Average Number of HCCs per Beneficiary	Overall	4.6	4.9	4.9	+0.05 (0.049 to 0.054)
	Low Intensity Visits	3.9	4.0	3.9	+0.013 (0.0098 to 0.015)
	High Intensity Visits	5.5	5.7	5.7	+0.023 (0.020 to 0.026)
Hospital Characteristics					
Region	Northeast	19.9%	19.5%	18.7%	-0.20 (-0.22 to -0.17)
	Midwest	25.2%	23.4%	23.0%	-0.38 (-0.41 to -0.36)
	South	39.9%	41.2%	41.9%	+0.33 (0.30 to 0.36)
	West	14.0%	15.3%	15.8%	+0.30 (0.28 to 0.32)
RUCA	Urban	71.5%	72.9%	73.1%	+0.26 (0.24 to 0.29)
	Suburban	3.0%	3.1%	3.1%	+0.02 (0.01 to 0.03)
	Large Rural Town	16.1%	15.4%	15.3%	-0.13 (-0.15 to -0.11)
	Small Town/Isolated Rural	8.3%	7.6%	7.4%	-0.16 (-0.17 to -0.14)
Teaching Status	Major	12.3%	12.7%	12.3%	+0,001 (-0.02 to +0.02)
	Minor	26.4%	27.2%	30.8%	+0.74 (0.72 to 0.77)
	Non-Teaching	60.4%	59.5%	56.2%	-0.69 (-0.72 to -0.66)
Size	Small (1-99 beds)	16.9%	15.7%	16.2%	-0.12 (-0.15 to -0.10)
	Medium (100-399 beds)	58.6%	58.1%	56.8%	-0.30 (-0.33 to -0.28)
	Large (400+ beds)	23.6%	25.6%	26.4%	+0.48 (0.46 to 0.50)
Profit Status	For Profit	12.9%	13.5%	14.9%	+0.33 (0.31 to 0.35)
	Not For Profit	73.9%	73.3%	72.5%	-0.24 (-0.26 to -0.21)
	Government, nonfederal	12.3%	12.6%	12.0%	-0.04 (-0.06 to -0.02)
Trauma Center	No	49.2%	47.2%	44.2%	-0.83 (-0.86 to -0.80)
	Yes	38.2%	40.6%	43.7%	+0.91 (0.88 to 0.93)
	Missing	12.5%	12.2%	12.1%	-0.07 (-0.09 to -0.05)

All differences were statistically significant at p<.001 with the exception of proportion of visits to major teaching hospitals (p=0.92).

Table 2. Trends* in selected markers of acuity or complexity for emergency department visits

	2006	2009	2012	Time Trend per Year, % (95% CI)	P-Value
Hospital Admission Rate	40.1%	38.7%	35.9%	-0.68 (-0.71 to -0.65)	<.001
Intensive Care Unit (ICU) Admission Rate	11.7%	12.6%	12.3%	+0.11 (0.09 to 0.12)	<.001
Mean Number of Services per Admission†				**Change in Services per Year, % (95% CI)**	
All Admissions	1.28	1.31	1.41	+0.02 (0.018 to 0.021)	<.001
Low-Intensity	1.22	1.25	1.37	+0.02 (0.017 to 0.025)	<.001
High-Intensity	1.30	1.31	1.41	+0.017 (0.015 to 0.019)	<.001
Mean Number Services per Outpatient‡ ED Visit				**Change in Services per Year, % (95% CI)**	
All Outpatient Visits	7.11	8.05	8.60	+0.25 (0.25 to 0.26)	<.001
Low-Intensity Outpatient Visits	5.28	5.39	5.22	-0.008 (-0.01 to -0.003)	0.001
High-Intensity Outpatient Visits	12.85	13.37	13.68	+0.14 (0.13 to 0.15)	<.001

*Longitudinal linear regression models were used to estimate the time trend, adjusting for patient age, race, sex, and Medicaid eligibility. The yearly estimates were based on binomial regression for hospital and ICU admission rate and negative binomial regression for mean number of services per admission/outpatient visit and used generalized estimating equations to account for clustering at the level of the emergency department.

†Inpatient services are ICD-9 procedures.

‡Outpatient services are represented using Current Procedural Terminology (CPT)/ Healthcare Common Procedure Coding System (HCPCS) codes.

Table 3. Comparison of Pseudo R2* for Sequential Models† Incorporating Explanatory Variables for the Trend in Emergency Department (ED) Practice Intensity

Model	Explanatory Variables	All Visits	Inpatient Visits	Outpatient Visits
1	Time	0.013	0.034	0.027
2	Time, Patient Demographics‡	0.021	0.034	0.028
3	Time, Patient Characteristics, Comorbidities§	0.090	0.036	0.043
4	Time, Patient Characteristics, Comorbidities, Services¶	0.148	0.051	0.465

* Pseudo R^2 determined using method described by Cragg, J and Uhler, RS. The Demand for Automobiles. Canadian Journal of Economics. 1970;3(3): 386-406.
† Generalized logistic regression modeling was used to account for clustering at the level of the emergency department.
‡Patient demographics included age, race, gender, and Medicaid eligibility.
§Comorbidities were characterized by the mean number of Hierarchical Condition Categories (HCCs). ¶ Services refers to ICD9 procedures for inpatient visits, HCPCS procedures for outpatient visits, and physician-billed HCPCS procedures in the carrier file for all visits.

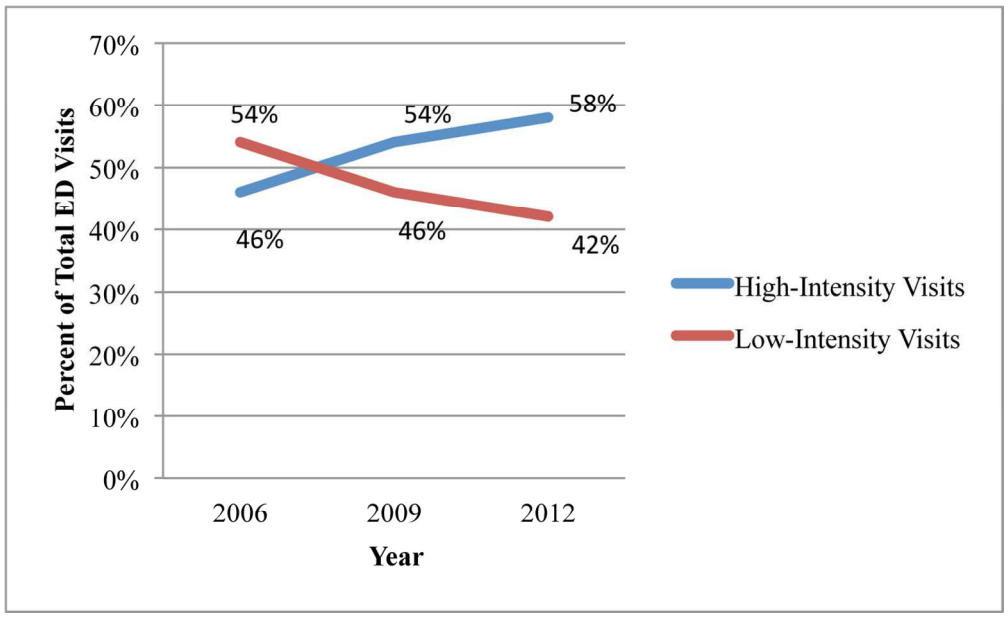
FIGURE LEGEND

Figure 1. Adjusted Time Trends* in Billing for High- and Low- Intensity‡ Emergency Care

Longitudinal linear regression was used to estimate the time trend, adjusting for patient age, race, sex, and Medicaid coverage. The yearly estimates were based on binomial regression using generalized estimating equations to adjust for clustering at the level of the emergency department.
‡High-intensity visits are coded as 99285 or critical care (99291, 99292). Low-intensity visits are defined by emergency physician billed CPT/HCPCS codes 99281-99284.

Figure 2. Absolute Change in Visit Intensity Over Time versus Absolute Change in the Mean Number of Services by Diagnosis Category* for Outpatient Emergency Department Visits†

*Thirty-nine diagnosis categories previously defined in the emergency medicine literature (Gabayan, G.Z., et al *Annals of emergency medicine* 2011;58(6):551-58 e2).
†Changes in mean number of procedures and proportion of high intensity visits adjusted for patient age, sex, race and Medicaid eligibility.



Adjusted Time Trends* in Billing for High- and Low- Intensity‡ Emergency Care

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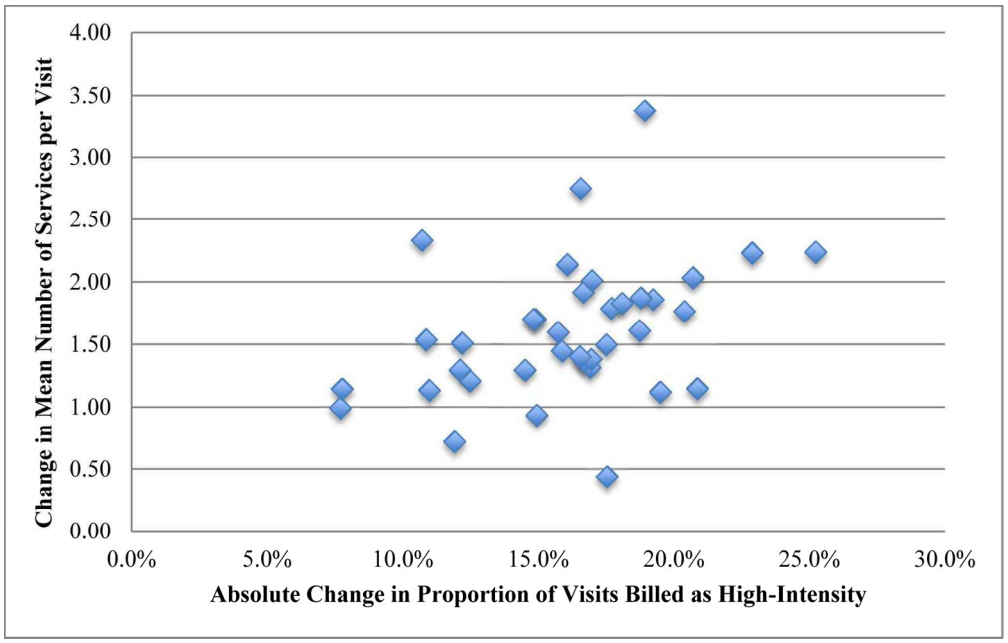


Absolute Change in Visit Intensity Over Time versus Absolute Change in the Mean Number of Services by Diagnosis Category* for Outpatient Emergency Department Visits†

147x93mm (300 x 300 DPI)

Appendices for "Trends in High-Intensity Billing for Emergency Care Accompanied by an Increase in Services Provided in the Emergency Department"

Appendix 1. Proportion of Outpatient Emergency Department Visits Billed as High-Intensity Visits by Diagnosis Category

Appendix 2. Trends in Billing* for High-Intensity Emergency Care

Appendix 3. Unadjusted Rate of Emergency Department Visits per 1,000 Medicare* Beneficiaries Overall and Stratified by Intensity

Appendix 4. Trends* in the Most Common Services† among Admitted Patients

Appendix 5. Trends* in the Most Common Services† among Patients Discharged from the ED

Appendix 6. Ten Most Frequent Physician Services by Year

Appendix 7. Absolute Change in Proportion of High-Intensity Visits versus Baseline Proportion of High-Intensity Visits by Diagnosis Category for Outpatient Emergency Department Visits

Appendix 8. Comparison of Observed versus Expected Number of High-Intensity Visits in 2006 Using Multivariable Modeling

Appendix 1. Proportion of Outpatient Emergency Department Visits Billed as High-Intensity Visits* by Diagnosis Category†

		2006	2009	2012	Absolute Change, % (95% CI)
1	*Minor injuries*	8.5%	14.4%	20.5%	12.2 (11.6 to 12.9)
2	*Major injuries*	34.0%	42.3%	51.7%	17.7 (14.8 to 20.6)
3	*Other injuries*	7.3%	12.3%	18.9%	12.0 (11.5 to 12.5)
4	*Symptoms: abdominal pain*	31.3%	44.0%	52.4%	21.0 (20.1 to 22.0)
5	*Symptoms: chest pain*	65.2%	77.5%	82.4%	17.2 (16.4 to 17.9)
6	*Symptoms: dizziness, vertigo, and syncope*	42.9%	57.3%	66.1%	23.0 (22.1 to 23.8)
7	*Symptoms: headache*	21.7%	30.5%	39.7%	17.9 (16.3 to 19.5)
8	*Other symptoms*	25.3%	35.7%	44.1%	18.8 (17.9 to 19.7)
9	*Upper respiratory infections*	12.8%	20.5%	27.6%	14.7 (13.5 to 15.9)
10	*Intestinal infections*	28.1%	40.1%	53.3%	25.2 (20.8 to 29.6)
11	*Urinary tract infection*	18.4%	27.3%	34.1%	15.9 (15.0 to 16.9)
12	*Other infectious and parasitic diseases*	12.6%	20.4%	23.6%	11.0 (9.1 to 12.9)
13	*Skin and subcutaneous infection*	5.9%	10.0%	13.6%	7.8 (6.4 to 9.3)
14	*Endocrine, nutritional; immunity and metabolic disorders*	29.0%	38.7%	45.8%	16.8 (15.6 to 18.0)
15	*Diabetes mellitus*	25.3%	33.5%	40.5%	15.0 (13.3 to 16.6)
16	*Hypertension*	24.4%	35.1%	41.4%	16.9 (15.6 to 18.3)
17	*Nonatherosclerotic heart disease*	61.2%	71.3%	78.3%	17.0 (14.6 6 to 19.4)
18	*Dysrhythmias*	52.7%	65.4%	72.4%	19.6 (18.4 to 20.9)
19	*Ischemic heart disease*	75.8%	82.6%	86.7%	11.0 (9.0 to 12.9)
20	*Congestive heart failure*	57.2%	68.7%	75.8%	18.3 (16.5 to 20.1)
21	*Circulatory disorders*	25.0%	35.6%	40.8%	15.8 (14.2 to 17.4)
22	*Cerebrovascular disease*	63.4%	74.5%	80.5%	16.8 (15.0 to 18.5)
23	*Diseases of the blood*	32.3%	43.7%	50.1%	17.7 (15.2 to 20.3)
24	*Neoplasms*	32.9%	47.1%	49.0%	16.0 (12.7 to 19.4)
25	*Mental illness*	27.1%	36.5%	43.9%	16.8 (15.5 to 18.1)
26	*Nervous system disorders*	23.5%	31.4%	36.0%	12.4 (11.4 to 13.5)
27	*Pneumonia*	36.6%	52.0%	57.6%	20.9 (19.1 to 22.6)
28	*Other respiratory disease*	27.3%	35.6%	42.4%	15.1 (14.2 to 16.0)
29	*Chronic obstructive pulmonary disease*	31.6%	43.0%	52.4%	20.6 (19.5 to 21.8)
30	*Asthma*	28.5%	38.8%	48.3%	19.5 (16.9 to 22.1)
31	*Noninfectious lung disease*	44.0%	60.2%	62.9%	18.8 (15.0 to 22.7)
32	*GI system diseases*	21.7%	32.2%	38.4%	16.7 (16.0 to 17.4)
33	*Other renal and GU diseases*	11.5%	18.3%	24.1%	12.6 (11.6 to 13.6)
34	*End-stage renal disease*	7.1%	10.1%	25.4%	17.8 (-3.2 to 38.9)
35	*Chronic renal disease*	47.4%	61.9%	66.1%	18.6 (14.3 to 23.0)
37	*Diseases of the musculoskeletal system, skin, and connective tissue*	10.3%	16.0%	21.4%	11.1 (10.5 to 11.7)
38	*Complications and adverse events*	10.5%	15.0%	18.3%	7.8 (6.4 to 9.3)
39	*Other residual codes*	21.2%	33.7%	36.1%	14.9 (13.8 to 16.1)

* Proportions of high-intensity visits are estimated using logistic regression adjusted for patient age, sex, Medicaid eligibility and race. The absolute change is estimated using linear regression.

† Categories defined by Gabayan, G.Z., et al *Annals of emergency medicine* 2011;58(6):551-58 e2). Category 36, pregnancy and childbirth related disorders, is omitted as it is not applicable to the elderly, Medicare population.

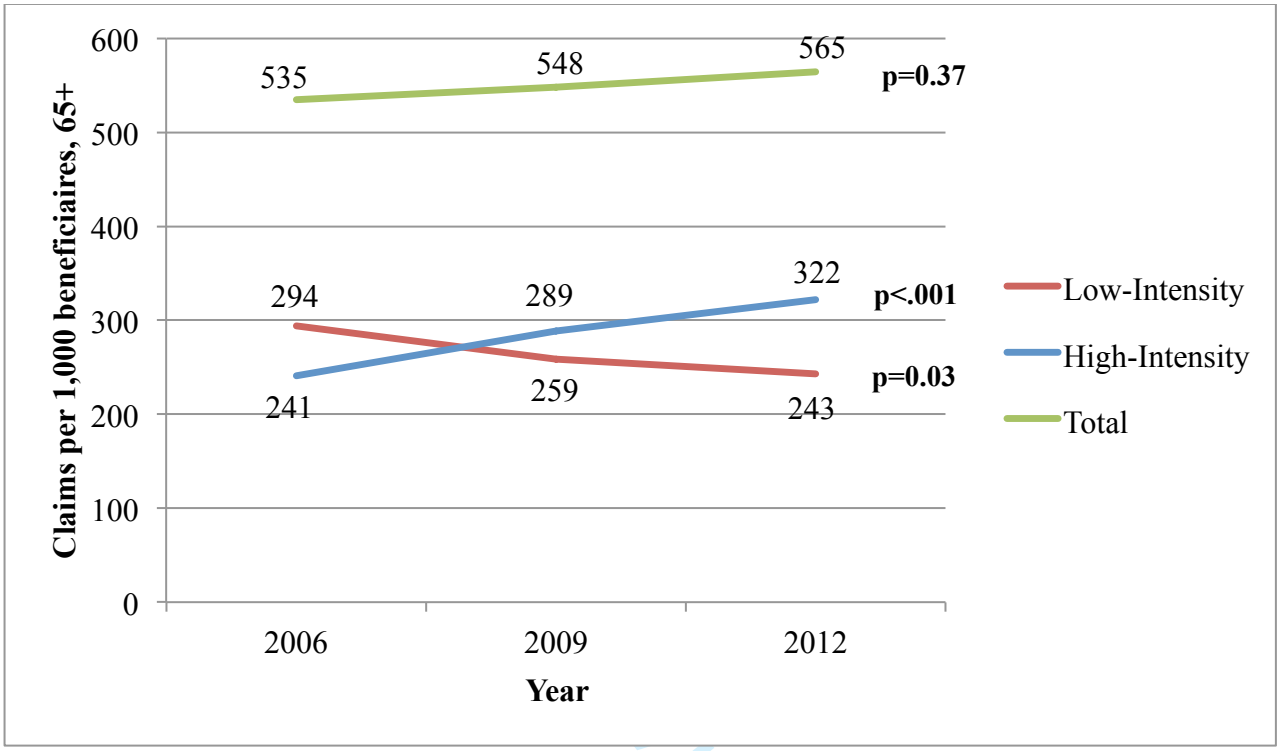
Appendix 2. Trends* in Billing for High-Intensity Emergency Care

		2006	2009	2012	Trend, % change per year (95% CI)	P-Value
Proportion of ED Visits by Intensity Level CPT Code‡	*99281*	0.60%	0.40%	0.40%	-0.03 (-0.04 to -0.03)	<.001
	99282	3.70%	2.60%	2.00%	-0.30 (-0.31 to -0.29)	<.001
	99283	22.20%	17.50%	14.80%	-1.25 (-1.27 to -1.22)	<.001
	99284	27.10%	25.60%	24.70%	-0.42 (-0.45 to -0.40)	<.001
	99285	39.70%	45.90%	49.40%	+1.60 (1.57 to 1.63)	<.001
	99291	5.00%	6.60%	7.60%	+0.40 (0.39 to 0.41)	<.001
	99292	0.70%	0.80%	0.70%	+0.004 (-0.0003 to 0.009)	.07

* Longitudinal linear regression models were used to estimate the time trends, adjusting for patient age, race, sex, and Medicaid coverage. The yearly estimates were based on binomial regression using generalized estimating equations to adjust for clustering at the level of the emergency department.

‡Current Procedural Terminology Healthcare Common Procedure Coding System codes 99281-99285 denote increasing levels of intensity of emergency physician evaluation and management. Codes 99291 and 99292 indicate critical care services were provided.

Appendix 3. Unadjusted Rate of Emergency Department Visits per 1,000 Medicare* Beneficiaries Overall and Stratified by Intensity



*Traditional Medicare beneficiaries age 65 and over with continuous coverage during the year.

Appendix 4. Trends* in the Most Common Services† among Admitted Patients

Service	2006 (%)‡	2009 (%)	2012 (%)	Absolute Change/Year, % (95% CI)§
Blood transfusion	12.4	14.3	15.4	+0.52 (0.48 to 0.56)
Diagnostic cardiac catheterization	10.4	9.3	9.7	-0.11 (-0.16 to -0.06)
Respiratory intubation and mechanical ventilation	9.9	11.1	12.6	+0.45 (0.41 to 0.49)
Other vascular catheterization; not heart	7.6	8.9	10.0	+0.41 (0.38 to 0.44)
Upper gastrointestinal endoscopy; biopsy	6.5	6.1	5.9	-0.11 (-0.13 to -0.08)
Other therapeutic procedures	5.8	5.7	7.1	+0.21 (0.18 to 0.24)
Other OR procedures on vessels other than head and neck	4.7	4.7	6.2	+0.24 (0.21 to 0.27)
Hemodialysis	5.9	6.3	6.5	+0.10 (0.08 to 0.12)
Colonoscopy and biopsy	3.2	2.8	2.6	-0.11(-0.13 to -0.10)
Diagnostic ultrasound of heart (echocardiogram)	2.9	3.4	4.0	+0.17 (0.16 to 0.19)

* Longitudinal linear regression models were used to estimate the time trends, adjusting for patient age, race, sex, and Medicaid coverage. The adjusted yearly estimates were based on binomial regression, using generalized estimating equations.

†Most common services among patients admitted from the ED occurring in the ED or during an inpatient stay. Services were defined by ICD9 procedure codes and categorized using the Clinical Classifications Software for Services and Procedures software.

‡ Percentage of all admissions including the service.

§ All changes were statistically significant at p<.001

Appendix 5. Trends* in the Most Common Services† among Patients Discharged from the ED

Service	2006	2009	2012	Trend, %† (95% CI)	P-Value
Laboratory-chemistry and hematology	3.35	3.68	3.85	0.083 (0.080 to 0.086)	<.001
Medications	0.60	0.42	0.56	-0.007 (-0.008 to -0.007)	<.001
Other therapeutic procedures	0.48	0.97	1.06	0.096 (0.095 to 0.097)	<.001
Microscopic examination (bacterial smear, culture, toxicology)	0.49	0.58	0.63	0.023 (0.023 to 0.024)	<.001
Electrocardiogram (ECG)	0.38	0.38	0.39	0.001 (0.000 to 0.0001)	.003
Other diagnostic radiology and related techniques	0.34	0.32	0.30	-0.007 (-0.007 to -0.006)	<.001
Routine chest X-ray	0.37	0.37	0.38	0.002 (0.002 to 0.003)	<.001
Other laboratory	0.17	0.19	0.22	0.008 (0.007 to 0.008)	<.001
Computerized axial tomography (CT) scan of the head	0.14	0.17	0.18	0.006 (0.006 to 0.007)	<.001
Durable Medical Equipment and supplies	0.10	0.18	0.26	0.026 (0.026 to 0.027)	<.001

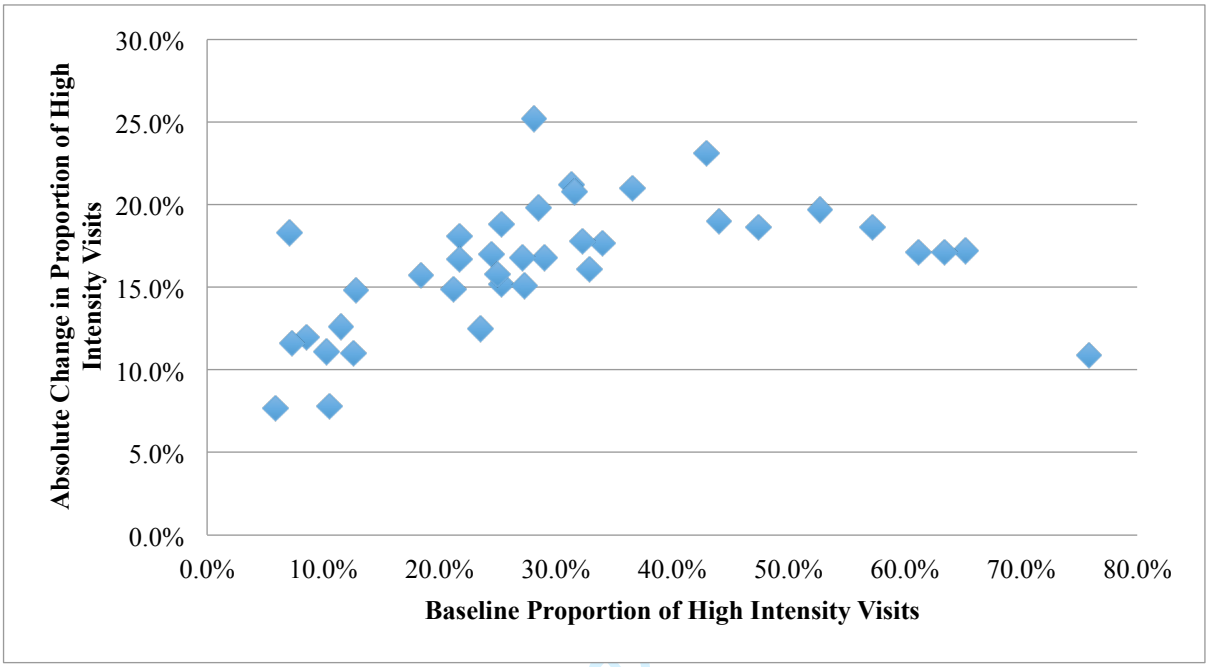
* Services were defined by the Current Procedural Terminology (CPT) Healthcare Common Procedure Coding System codes (HCPCS) and categorized using the Clinical Classifications Software for Services and Procedures software.
†Longitudinal linear regression models were used to estimate the time trends, adjusting for patient age, race, sex, and Medicaid coverage. The adjusted yearly estimates were based on negative binomial regression using generalized estimating equations.

Appendix 6. Ten Most Frequent Physician Services* by Year for Emergency Department Visits

	2006		2009		2012	
	Service	**%†**	**Service**	**%**	**Service**	**%**
1	Electrocardiogram	63.5%	Electrocardiogram	64.4%	Electrocardiogram	67.4%
2	Suture of skin and subcutaneous tissue	8.3%	Suture of skin and subcutaneous tissue	8.2%	Suture of skin and subcutaneous tissue	7.4%
3	Other therapeutic procedures	6.1%	Routine chest X-ray	4.1%	Routine chest X-ray	3.2%
4	Routine chest X-ray	3.7%	Laboratory - Chemistry and Hematology	3.3%	Laboratory - Chemistry and Hematology	3.1%
5	Other diagnostic radiology and related techniques	2.2%	Other diagnostic radiology and related techniques	2.2%	Other diagnostic radiology and related techniques	1.7%
6	Laboratory - Chemistry and Hematology	1.7%	Other therapeutic procedures	1.8%	Traction, splints, and other wound care	1.6%
7	Control of epistaxis	1.7%	Control of epistaxis	1.6%	Other OR therapeutic procedures on nose, mouth and pharynx	1.6%
8	Traction, splints, and other wound care	1.6%	Traction, splints, and other wound care	1.6%	Control of epistaxis	1.4%
9	Respiratory intubation and mechanical ventilation	1.5%	Respiratory intubation and mechanical ventilation	1.5%	Other therapeutic procedures	1.4%
10	Other vascular catheterization, not heart	1.1%	Other fracture and dislocation procedure	1.3%	Other fracture and dislocation procedure	1.4%

* Services were defined by the Current Procedural Terminology (CPT) Healthcare Common Procedure Coding System codes (HCPCS) and categorized using the Clinical Classifications Software for Services and Procedures software. Codes for emergency physician evaluation and management codes (99281-99285, 99291, 99292) were excluded.
‡Percentage of all physician services in the sample.

Appendix 7. Absolute Change* in Proportion of High-Intensity Visits versus Baseline Proportion of High-Intensity Visits by Diagnosis Category* for Outpatient Emergency Department Visits†



*Longitudinal linear regression models were used to estimate the time trends, adjusting for patient age, race, sex, and Medicaid coverage. †Thirty-nine diagnosis categories previously defined in the emergency medicine literature (Gabayan, G.Z., et al *Annals of emergency medicine* 2011;58(6):551-58 e2)‡Proportion of high-intensity visits is adjusted for patient age, sex and Medicaid eligibility.

Appendix 8. Comparison of Observed versus Expected Number of High-Intensity Visits* in 2006 Using Multivariable Modeling

	Observed High-Intensity Visits 2006	**Using 2009 Regression Coefficients†**		**Using 2012 Regression Coefficients**	
		Predicted High-Intensity‡	*Observed - Expected (%)*	*Predicted High-Intensity*	*Observed - Expected (%)*
Inpatient (N=261,239)	203,344	228,163	-24,819	238,848	-35,504
Outpatient (N=409,864)	98,801	99,902	-1,101	115,706	-16,905

* High-intensity visits were defined as visits with an emergency physician professional claim for evaluation and management codes 99285, 99291, and 99292.

†Generalized logistic regression models that accounted for clustering at the level of the ED were run separately for emergency department (ED) visits in 2009 and 2012 incorporating patient age, sex, Medicaid eligibility, race, chronic conditions (Hierarchical Condition Categories). The model also incorporated the number of services billed for the associated facility and physician professional claims (excluding evaluation and management services). Models were run separately for inpatient and outpatient ED visits.

‡The coefficients for each variable in the regression model were applied to the 2006 data to obtain an expected number of high-intensity visits.

§The difference between the observed and predicted number of high-intensity visits represents the degree to which high-intensity billing has changed in ways that cannot be explained by the variables in our model.

Trends in High-Intensity Billing for Emergency Care Accompanied by an Increase in Services Provided in the Emergency Department

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STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract **This has been done in the title and on the abstract (page 4)**
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found **This is in the abstract section on page 4 & 5.**
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported **This has been done. Rationale for investigation is explained on pages 8 and 9.**
Objectives	3	State specific objectives, including any prespecified hypotheses **Specific objectives are listed out as three separate questions on pages 9.**
Methods		
Study design	4	Present key elements of study design early in the paper. **This has been done both in the abstract and in the Methods section on page 9-15.**
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection **This has been done in the Methods section (pages 9-11).**
Participants	6	*Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants **The description of data can be found in the "Study Design and Setting" subsection of the Methods section (page (9&10).**
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable **All these data have been included in the Methods section (pages 9-14).**
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group. **This has been done in the Methods section (pages 9-15).**
Bias	9	Describe any efforts to address potential sources of bias **The limitations section on discussion on page 22 address the potential sources of bias.**
Study size	10	Explain how the study size was arrived at **The study population and inclusion/exclusion can be found in the "Study Design and Setting" subsection of the Methods section on page 9.**
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why.

		This is addressed in the subsection "Analysis" in the Methods section (pages 12-15).
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding **This has been done in the subsection "Analysis" in the Methods section (pages 12-15).**
		(*b*) Describe any methods used to examine subgroups and interactions **This has been done in the Methods section (pages 12-15).**
		(*c*) Explain how missing data were addressed **This has been done in the "Study Design and Setting" subsection of the Methods section (page 7 & 8).**
		(*d*) *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy **N/A**
		(*e*) Describe any sensitivity analyses **This has been done in the subsection "Analysis" in the Methods section (pages 14-15).**
Results		
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed **This is done in the first paragraph of the Results section (page 15).**
		(b) Give reasons for non-participation at each stage
		(c) Consider use of a flow diagram
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders **This is done in the first paragraph of the Results section (page 15) and Table 1.**
		(b) Indicate number of participants with missing data for each variable of interest
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time
		Case-control study—Report numbers in each exposure category, or summary measures of exposure
		Cross-sectional study—Report numbers of outcome events or summary measures **All these data have been included in the Results section (pages 15-20) and relevant tables.**
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included **All these data have been included in the Results section (pages 15-20) and relevant tables.**
		(*b*) Report category boundaries when continuous variables were categorized
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses **All these data have been included in the Results section (pages 15-20) and relevant tables, as well in the Appendix.**
Discussion		
Key results	18	Summarise key results with reference to study objectives **Key results are summarized in the first paragraph of the Discussion (page 20).**

Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias **Limitations are outlined in the discussion (page 22).**
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence **An interpretation and implications are discussed (pages 20-23).**
Generalisability	21	Discuss the generalisability (external validity) of the study results **The external validity of this study is discussed in the "Limitations" subsection (page 22).**
Other information		
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based **This study had no funding source.**

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