

BMJ Open

BMJ Open is committed to open peer review. As part of this commitment we make the peer review history of every article we publish publicly available.

When an article is published we post the peer reviewers' comments and the authors' responses online. We also post the versions of the paper that were used during peer review. These are the versions that the peer review comments apply to.

The versions of the paper that follow are the versions that were submitted during the peer review process. They are not the versions of record or the final published versions. They should not be cited or distributed as the published version of this manuscript.

BMJ Open is an open access journal and the full, final, typeset and author-corrected version of record of the manuscript is available on our site with no access controls, subscription charges or pay-per-view fees (<http://bmjopen.bmj.com>).

If you have any questions on BMJ Open's open peer review process please email editorial.bmjopen@bmj.com

BMJ Open

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

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2017-019357
Article Type:	Research
Date Submitted by the Author:	08-Sep-2017
Complete List of Authors:	Burke, Laura; Beth Israel Deaconess Medical Center, Emergency Medicine; Harvard T.H. Chan School of Public Health, Department of Health Policy and Management Wild, Robert Orav, E. John; Harvard University, Hsia, Renee Y.; Univ Calif San Francisco
Primary Subject Heading:	Emergency medicine
Secondary Subject Heading:	Health policy
Keywords:	Quality in health care < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, Health policy < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, ACCIDENT & EMERGENCY MEDICINE

SCHOLARONE™
Manuscripts

1
2
3 **Trends in High-Intensity Billing for Emergency Care Accompanied by an Increase in**
4
5
6 **Services Provided in the Emergency Department**
7
8

9 Laura G. Burke,^{1,2} MD, MPH

10 Robert C. Wild,³ MS, MPH

11 E. John Orav,⁴ PhD

12 Renee Y. Hsia,^{5,6} MD, MSc
13
14
15
16
17
18
19
20

- 21 1. Beth Israel Deaconess Medical Center, Department of Emergency Medicine. Boston,
22 MA.
23
24
25 2. Harvard T.H. Chan School of Public Health, Department of Health Policy and
26 Management. Boston, MA.
27
28
29 3. Harvard Medical School, Department of Health Care Policy. Boston, MA.
30
31
32 4. Harvard T.H. Chan School of Public Health, Department of Biostatistics. Boston, MA.
33
34
35 5. University of California San Francisco, Department of Emergency Medicine. San
36 Francisco, CA.
37
38
39 6. University of California San Francisco, Philip R. Lee Institute of Health Policy Studies.
40 San Francisco, CA.
41
42
43
44
45
46

47 Corresponding Author: Laura G. Burke, MD, MPH, 1 Deaconess Road, Boston MA 02215. Tel
48 774-218-9514, email lgburke@bidmc.harvard.edu
49
50
51
52
53
54
55
56
57
58
59
60

Word Count

3,772 words

Funding

This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors.

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.

1
2
3 **ABSTRACT** (293 words; max 300 words)
4
5
6
7

8 **Objective:** To characterize the trends in billing for high-intensity emergency care among
9
10 Medicare beneficiaries as well as trends in ED and inpatient services.
11

12
13
14 **Design, Setting, and Participants:** Observational study using traditional Medicare claims to
15
16 identify ED visits at nonfederal acute care hospitals for elderly beneficiaries in 2006, 2009, and
17
18 2012.
19
20
21

22
23
24 **Outcomes Measures:** Billing intensity was defined by emergency physician evaluation and
25
26 management (E&M) codes. We tested for overall trends in high-intensity billing (E&M Codes
27
28 99285, 99291 and 99292) and in services provided over time using linear regression models,
29
30 adjusting for patient characteristics. Next we classified outpatient visits into one of 39 diagnosis
31
32 categories and analyzed the change in proportion of high-intensity visits versus the change in
33
34 number of services. Finally, we quantified the extent to which trends in high-intensity billing are
35
36 explained by changes in patient demographics and services provided in the ED.
37
38
39
40
41
42

43 **Results:** High-intensity visits grew from 45.5% of 671,103 visits in 2006 to 57.7% of 629,010
44
45 visits in 2012 (2.0% absolute increase per year (95% CI 1.97% to 2.03%) as did the mean
46
47 number of services provided for admitted (1.28 to 1.41; +0.02 increase in procedures per year
48
49 (95% CI 0.018 to 0.021) and discharged ED patients (7.1 to 8.6; +0.23 increase in procedures per
50
51 year, (95% CI 0.245 to 0.251). When we stratified by diagnosis category, there was a moderate
52
53 correlation between change in visits billed as high intensity and the change in mean number of
54
55
56
57
58
59
60

1
2
3 services provided per visit ($\rho=0.38$, (95% CI 0.07 to 0.63). Trends in patient characteristics and
4
5 services provided moderately accounted for the trend in practice intensity for outpatient visits
6
7
8 (pseudo R^2 of 0.47).
9

10
11
12 **Conclusions:** Increase in services provided in the ED moderately accounts for the trends in
13
14 billing for high-intensity emergency care for outpatient visits.
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

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-R² 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 attention¹ 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 care¹⁷ 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.

1
2
3 Given the increasing importance of the ED in providing acute care¹⁹ and its prominence
4 in the healthcare cost debate, we sought to evaluate the trends in intensity of emergency care, as
5 captured by billing codes emergency care by addressing three questions. First, what are the
6 trends in billing for high-intensity care in the Medicare fee-for-service population and to what
7 extent are these trends accompanied by changes in patient characteristics and other clinical
8 markers of acuity and complexity? Second, do particular diagnoses or conditions have greater
9 changes in intensity over time, and, if so, are these variations associated with trends in services?
10 Finally, how much of the trend in high-intensity billing is explained by trends in services
11 provided and patient characteristics?
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26

27 **METHODS**

28 **Study Design and Setting**

29
30
31 We used a five percent sample of Medicare fee-for-service claims to identify ED visits in
32 2006, 2009, and 2012. We examined ED visits by beneficiaries who were continuously-enrolled,
33 age 65 and over, not enrolled in private insurance, and presenting to nonfederal acute care
34 hospitals. The billing intensity level was obtained by identifying all claims in the Carrier file
35 with emergency physician Current Procedural Terminology (CPT) Healthcare Common
36 Procedure Coding System (HCPCS) evaluation and management codes 99281-99285, 99291 and
37 99292. Patient characteristics were obtained from the Master Beneficiary Summary File.
38 Information such as visit diagnosis and services provided were obtained from the Inpatient file
39 for admitted patients and the outpatient file for discharged and observation patients. Since claims
40 for substance abuse related visits were no longer available in Medicare data in 2012,²⁰ we
41 dropped substance abuse claims from the prior years. We used the American Hospital
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3 Association survey from 2012 to obtain data on hospital characteristics and linked this to ED
4
5 claims using Medicare provider identification numbers.
6
7
8
9

10 **Outcomes**

11
12 Our primary outcome was ED visit practice intensity level, defined by CPT code as
13 selected by the treating emergency physician or designee. CPT codes 99281 and 99282 represent
14 low complexity, 99283 and 99284 represent moderate complexity, 99285 represents high
15 complexity, while codes 99291 and 99292 are used to denote that critical care services were
16 provided. We created a binary intensity outcome variable, categorizing visits with codes 99281-
17 99284 as low-intensity and those with codes 99285, 99291, and 99292 as high-intensity.
18
19
20
21
22
23
24
25
26

27 Secondary outcomes included overall hospital admission rate, intensive care unit (ICU)
28 rate, as well as mean number and type of procedures per visit. For ED visits resulting in an
29 inpatient admission, we determined the principal admission diagnosis as well as the mean
30 number and type of services, as represented by International Classification of Diseases, Ninth
31 Revision (ICD9) procedure codes. Inpatient services may have been provided at any time during
32 that hospitalization, including during treatment in the ED, as we were unable to distinguish the
33 location of services provided for admitted patients in this dataset. For outpatient ED visits, we
34 looked at principal diagnosis, the mean number and type of ED services per visit. Other markers
35 of complexity and acuity were investigated as secondary outcomes including hospital admission
36 rate and intensive care unit (ICU) admission rate.
37
38
39
40
41
42
43
44
45
46
47
48
49

50 We looked at the following beneficiary characteristics: age, race, sex, Medicaid-
51 eligibility, and number of chronic conditions as indicated by the Hierarchical Condition
52
53
54
55
56
57
58
59
60

1
2
3 Categories (HCCs).²¹ We also categorized the following hospital characteristics in each year:
4
5 region, rural vs. urban location (RUCA), size and teaching, and profit and trauma center status.
6
7
8
9

10 **Analysis**

11 *Trend in Practice Intensity*

12
13 Changes in practice intensity were estimated by regressing a binary outcome (high or low
14
15 intensity) as continuous on time and controlling for patient characteristics. Patient age, race, sex,
16
17 and Medicaid coverage were used for the patient characteristics. Analysis occurred at the visit
18
19 level with each visit coded as high or low intensity. Generalized estimating equations were used
20
21 to account for clustering. The adjusted estimates of the proportion of high-intensity visits were
22
23 graphed over time and rates of change over the study period were tested for statistical
24
25 significance. In addition to examining the binary high-intensity outcome variable we examined
26
27 the time trends for each of the seven intensity categories individually.
28
29
30
31
32
33
34
35
36

37 *Visit Rate*

38
39 We next examined how the rate of high-intensity visits and overall ED visits changed.
40
41 An increase in the relative proportion of high-intensity visits could potentially reflect a reduction
42
43 in low acuity visits over time,^{5 22} so we calculated a per-beneficiary rate of overall high-intensity
44
45 and low-intensity visits for each year and tested for a time trend using negative binomial
46
47 regression.
48
49
50
51
52

53 *Secondary Outcomes*

1
2
3 We then calculated the overall hospital admission rate (percentage of ED visits leading to
4 a hospital admission) and the ICU admission rate (percentage of ED visits leading to an ICU
5 admission). We tested for a time trend using linear regression, adjusting for age, race, sex and
6 Medicaid coverage. Time trends in mean number of inpatient services, and outpatient services
7 were tested using linear regression, adjusting for age, sex, race, and Medicaid eligibility. We
8 used the Clinical Classifications Software developed by the Agency for Healthcare Research and
9 Quality (HCUP-CCS) to classify ICD-9 procedures codes for inpatient services and CPT codes
10 for outpatient services into 39 clinically meaningful categories (see Appendix 1). Additionally,
11 we looked at the Carrier professional fees claims file in our sample with CPT codes other than
12 the practice intensity codes to determine the number and type of physician-performed services
13 billed.
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31

32 *Trends in Practice Intensity by Diagnosis Category*

33
34 We categorized the principal diagnosis for each outpatient visit into one of 39 diagnosis
35 categories previously described in the emergency medicine literature²³ and used the analogous
36 adjusted longitudinal linear regression model for each diagnosis to estimate the percentage of
37 total visits in each year categorized as high-intensity as well as the absolute change in proportion
38 of high-intensity visits. We limited this analysis to outpatient visits because we could not
39 distinguish services provided in the ED from those provided in the inpatient setting for those
40 visits leading to a hospital admission. For each diagnostic category, we calculated the change in
41 high-intensity visit rate and the change in ED services between 2006 and 2012. The changes
42 were graphed against each other and a correlation coefficient was calculated to capture the
43 degree to which the two were associated with each other.
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

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 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 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

1
2
3 The most frequent intensity code in all three years was 99285, also known as a level 5
4 visit (Appendix 2). Level 5 visits represented 39.7% of all ED visits in 2006 and rose to 49.4%
5
6 in 2012 (+1.6% per year [95% CI, 1.57% to 1.63%]; $p < .001$). There was also an increase in visits
7
8 that were billed at a critical care level (CPT 99291) from 5.0% of all visits in 2006 to 7.6% in
9
10 2012 (+0.4% increase per year [95% CI, 0.39% to 0.41%]; $p < .001$). CPT 99292 comprised of
11
12 less than 1% of all visits in both years and showed a small increase that was not statistically
13
14 significant (+0.004% increase per year [95% CI, -0.0003% to +0.009%]; $p < .001$). Thus, the
15
16 combined proportion of high-intensity visits overall rose from 45.8% in 2006 to 57.9% in 2012
17
18 (+2.0% per year [95% CI, 1.97% to 2.03%]; $p < .001$; Figure 1). We observed a concomitant
19
20 decrease over time in each of the four CPT codes categorized as low-intensity (Appendix 2).
21
22
23
24
25
26
27
28

29 ***Trends in Visit Rates per Beneficiary***

30
31 We found an increase from 535 to 565 ED visits per 1,000 beneficiaries that was not
32
33 statistically significant (0.9% increase per 1,000 beneficiaries per year [95%CI, -1.1% to 2.9%];
34
35 $p = 0.37$, Figure 2). There was a significant increase in the high-intensity visit rate from 241 to
36
37 322 per 1,000 beneficiaries (4.9% increase in high-intensity visits per 1,000 beneficiaries per
38
39 year, [95% CI, 2.0% to 7.8%]; $p < .001$) while the rate of low-intensity visits per beneficiary
40
41 decreased (294 to 243 visits per 1,000 beneficiaries; -3.2% decrease in low-intensity visits per
42
43 1,000 beneficiaries per year [95% CI, -5.9% to -0.4%]; $p = 0.03$).
44
45
46
47
48
49
50

51 ***Trends in Patient Acuity and Treatment Intensity***

52
53 We found that there was a reduction in admission rate from the ED over time, with 35.9%
54
55 of visits leading to admission in 2012 compared to 40.1% in 2006 (-0.68% per year [95% CI, -
56
57
58
59
60

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

1
2
3 a slight decrease (5.3 to 5.2; -0.008 services per year [95% CI, -0.121 to -0.003] $p < .001$; Table
4
5 2). After reclassifying observation claims as admissions, the mean number of outpatient services
6
7 still saw an increase from 6.7 to 8.1 services per visit (+0.23 increase per year, [95% CI, 0.22 to
8
9 0.23]; $p < .001$). The most frequent services provided during an outpatient ED visit are presented
10
11 in Appendix 4.
12
13

14 15 16 17 **Trends by Diagnosis** 18

19
20 Upon examining the thirty-nine condition categories individually (Appendix 1), diagnosis
21
22 categories with the largest change in the proportion of high-intensity visits tended to have a mid-
23
24 range baseline intensity (Appendix 5). Skin and subcutaneous infections had the lowest absolute
25
26 change (5.9% of visits categorized as high-intensity in 2006 to 13.6% in 2012; +7.8% [95% CI,
27
28 6.4% to 9.3%]; $p < .001$) and intestinal infections had the greatest (25.2%; from 28.1% in 2006 to
29
30 53.3% in 2012; +25.2% [95% CI, 20.8% to 29.6%]; $p < .001$). We found that those diagnoses
31
32 with greater increases in intensity tended to have an increase in mean number of services (Figure
33
34 3), with moderate correlation ($r = 0.38$ [95% CI, 0.07 to 0.63]; $p = 0.02$) between the change in
35
36 percentage of high-intensity visits and the change in mean number of services provided per visit
37
38 for each diagnosis category.
39
40
41
42
43
44
45

46 **Impact of Patient Characteristics and Services on High-Intensity Billing** 47

48
49 We next used four separate logistic regressions to determine the extent to which the
50
51 trends in practice intensity are explained by observable markers of practice intensity and patient
52
53 characteristics (Appendix 5). Incorporating services into our model for ED practice intensity
54
55 increased the variability explained by our model from 8.0% (with time, demographics and co-
56
57
58
59
60

1
2
3 morbidity) to 14.8%. However, the model performance varied greatly by disposition, with the
4
5 pseudo R^2 increasing from 4.3% to 46.5% for outpatient visits, while only increasing from 5.0
6
7 to 5.1% for inpatient visits. Incorporation of services in the model led to the greatest increase for
8
9 both outpatient and inpatient visits. When we reclassified observation claims as admissions, our
10
11 results were similar (pseudo R^2 of 0.14 for visits overall, 0.04 for inpatient visits, and 0.44 for
12
13 outpatient visits).
14
15
16
17
18
19

20 DISCUSSION

21
22 In our study of elderly Medicare beneficiaries, we found that ED visits are increasingly
23
24 billed at the highest levels of intensity, with nearly 60% of ED visits in our sample coded at a
25
26 Level 5 or critical care in 2012. We found a concomitant increase in services provided in the ED
27
28 and during an associated inpatient stay. While overall admission rate decreased over time, a
29
30 greater fraction of ED visits resulted in admission to intensive care. We found that trends in high
31
32 intensity billing varied by clinical condition; diagnoses with the greatest change in high-intensity
33
34 billing also had the greatest increase in number of services. These findings persisted when we
35
36 repeated our analyses reclassifying observation claims as admissions. Finally, using
37
38 multivariable modeling, we found that trends in patient characteristics as well as in services
39
40 provided during the visit moderately accounted for the increase in practice intensity for
41
42 outpatient ED visits.
43
44
45
46
47

48 Our results are consistent with other work showing a growth in high-intensity emergency
49
50 care. A study of all ED visits in California²⁹ also demonstrated a growth in physician billing for
51
52 high-intensity visits, particularly among safety net hospitals. Other studies using national
53
54 datasets have documented greater use of tests and treatments in the ED such as advanced
55
56
57
58
59
60

1
2
3 imaging, blood tests and IV fluids.^{15 16} Exploring the idea that doing more in the ED can prevent
4 hospitalizations, one study found that greater use of CT scans was associated with a reduction in
5 admissions and transfers.³⁰ Our study adds to this literature by linking billed practice intensity to
6 the procedures and services provided at the visit level for a national sample of Medicare
7 beneficiaries and includes both outpatient and inpatient visits. We found the greatest increase in
8 high-intensity billing among conditions with moderate baseline intensity for which the decision
9 to admit may involve provider discretion; patients with conditions such as pneumonia and
10 intestinal infections may safely avoid admission with a thorough ED work-up and adequate time
11 for monitoring to ensure stability.
12
13
14
15
16
17
18
19
20
21
22
23

24
25 Our study of ED visits is consistent with other studies suggesting that the fears of
26 upcoding due to EHRs may not be fully warranted.¹⁴ Using multivariable modeling, we found
27 that observable factors such as patient characteristics and numbers of services and procedures
28 moderately explained the trends in billed practice intensity for outpatient visits. It is possible that
29 part of the residual effect could be attributed to upcoding; our study, however, is unable to
30 identify conclusively whether this is the case.
31
32
33
34
35
36
37

38 ED visits in the U.S. have continued to rise^{10 31-33} despite health insurance expansion and
39 cost control efforts that were predicted to reduce ED utilization. The role of emergency medicine
40 in the acute care landscape has also expanded,¹⁹ with the ED serving as the source of most
41 unscheduled admissions.^{17 34} EDs have assumed greater responsibility for managing complex
42 problems while reserving limited and costly hospital capacity for those truly requiring inpatient
43 care. With the growth of alternative payment models, reducing admissions for ED patients with
44 moderate severity problems has been proposed as a strategy to reduce costs.³⁵ Initiatives aimed at
45 reducing admissions, such as clinical pathways and ED observation units, depend on the
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3 expertise of emergency providers in performing complex but efficient work-ups. Our findings
4 are consistent with this new model of emergency care. We found an increase in services while
5 admission rates fell, even after accounting for the growth in observation stays. While our study
6 was not designed to assess the relationship between intensity of emergency care and admission
7 rate, it is possible that doing more for patients in the ED may have allowed a greater number to
8 be safely discharged. The rise in number of services, including critical care procedures, provided
9 during hospital admission, including critical care procedures, suggests that the average acuity of
10 patients who ultimately are admitted may be increasing over time.
11
12
13
14
15
16
17
18
19
20
21

22 Our study has a number of limitations. Given the use of administrative data, clinical
23 markers of acuity such as vital signs and laboratory data were not available. Also, time spent
24 observing and treating patients is another key component of practice intensity that we could not
25 measure with our dataset. Additionally, it is not possible to distinguish ED observation status
26 from ward observation status in Medicare data, although the former represents actual work done
27 in the ED whereas the latter is functionally similar to an inpatient admission. If ED length of stay
28 or observation status were observable in our data set, they might potentially account for some of
29 the remaining time trend in practice intensity. Additionally, our modeling explained relatively
30 little of the variation for inpatient visits and ED visits overall. This is likely due to the fact that,
31 unlike for outpatient visits, services provided during an ED visit that ultimately results in an
32 admission are not distinguishable from those provided during subsequent hospitalizations. Also,
33 there is substantially less detail regarding laboratory and radiology services provided for
34 inpatient ED visits. Thus, it is impossible to adequately characterize work done in the ED for
35 admitted patients to the same degree as was done for those who were discharged. Also, while
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3 national in scope, our analysis is limited to elderly fee-for-service Medicare beneficiaries and
4
5
6 may not be generalizable to other populations.
7

8 In summary, the rise in billing for high-intensity emergency care has been portrayed as an
9
10 unintended consequence of the growth of health information technology rather than reflecting a
11
12 change in practice. However, this trend has been accompanied by an increase in the provision of
13
14 services in the hospital as well as in the ED. Multivariable modeling incorporating patient
15
16 characteristics, comorbidities and services provided moderately explained the trends in high-
17
18 intensity billing. This rise in high-intensity emergency care has occurred while rates of admission
19
20 from the ED have fallen, raising the possibility that a greater amount of work performed in the
21
22 ED may have allowed more patients to avoid inpatient treatment during an acute episode.
23
24
25
26
27 Further study may be useful in determining what impact the trend in high-intensity emergency
28
29 care has had total costs of care as well as patient outcomes.
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

REFERENCES

1. Brill S. Bitter Pill: Why Medical Bills Are Killing Us. *Time*, 2013.
2. Boyd D. The Potential Impact of Alternative Health Care Spending Scenarios on Future and Local Government Budgets: Brookings Institute, 2014.
3. Orszag PR, Ellis P. The challenge of rising health care costs--a view from the Congressional Budget Office. *The New England journal of medicine* 2007;357(18):1793-5. doi: 10.1056/NEJMp078190
4. Auerbach DI, Kellermann AL. A decade of health care cost growth has wiped out real income gains for an average US family. *Health affairs* 2011;30(9):1630-6. doi: 10.1377/hlthaff.2011.0585
5. Weinick RM, Burns RM, Mehrotra A. Many emergency department visits could be managed at urgent care centers and retail clinics. *Health affairs* 2010;29(9):1630-6. doi: 10.1377/hlthaff.2009.0748
6. Baker LC, Baker LS. Excess cost of emergency department visits for nonurgent care. *Health affairs* 1994;13(5):162-71.
7. Bamezai A, Melnick G, Nawathe A. The cost of an emergency department visit and its relationship to emergency department volume. *Annals of emergency medicine* 2005;45(5):483-90. doi: 10.1016/j.annemergmed.2004.08.029
8. Ostrom CM. State Medicaid program to stop paying for unneeded ER visits. *The Seattle Times* 2012 February 9, 2012.
9. Whitman E. Reducing Emergency Room Visits In Houston: Texas Firefighters Use Tablets To Connect Patients With Doctors, Not ERs. *International Business Times* 2015 April 9, 2015.
10. Skinner HG, Blanchard J, Elixhauser A. Trends in Emergency Department Visits, 2006-2011: Statistical Brief #179. Healthcare Cost and Utilization Project (HCUP) Statistical Briefs. Rockville (MD)2006.
11. Rui PK, K; Albert, M. National Hospital Ambulatory Medical Care Survey: 2013 Emergency Department Summary Tables. Available at https://www.cdc.gov/nchs/data/ahcd/nhamcs_emergency/2013_ed_web_tables.pdf. Accessed August 22, 2017.
12. Levinson DR. Coding Trends of Medicare Evaluation and Management: Department of Health and Human Services, USA, 2012.
13. Abelson RC, J. ; Palmer, G. Medicare Bills Rise as Records Turn Electronic. *The New York Times* 2012 September 21, 2012.

14. Adler-Milstein J, Jha AK. No evidence found that hospitals are using new electronic health records to increase Medicare reimbursements. *Health affairs* 2014;33(7):1271-7. doi: 10.1377/hlthaff.2014.0023
15. Pitts SR, Pines JM, Handrigan MT, et al. National trends in emergency department occupancy, 2001 to 2008: effect of inpatient admissions versus emergency department practice intensity. *Annals of emergency medicine* 2012;60(6):679-86 e3. doi: 10.1016/j.annemergmed.2012.05.014
16. Pitts SR. Higher-complexity ED billing codes--sicker patients, more intensive practice, or improper payments? *The New England journal of medicine* 2012;367(26):2465-7. doi: 10.1056/NEJMp1211315
17. Schuur JD, Venkatesh AK. The growing role of emergency departments in hospital admissions. *The New England journal of medicine* 2012;367(5):391-3. doi: 10.1056/NEJMp1204431
18. Bodenheimer T, Chen E, Bennett HD. Confronting the growing burden of chronic disease: can the U.S. health care workforce do the job? *Health affairs* 2009;28(1):64-74. doi: 10.1377/hlthaff.28.1.64
19. Gonzalez Morganti K, Sebastian, B., Blanchard, J.C., Abir, M., Smith, A., Vesely, J.V., Okeke, E. N., Kellermann, A.L., Iyer, N. *The Evolving Roles of Emergency Departments*. Santa Monica, CA: RAND Corporation, 2013.
20. Frakt AB, Bagley N. Protection or harm? Suppressing substance-use data. *The New England journal of medicine* 2015;372(20):1879-81. doi: 10.1056/NEJMp1501362
21. Li P, Kim MM, Doshi JA. Comparison of the performance of the CMS Hierarchical Condition Category (CMS-HCC) risk adjuster with the Charlson and Elixhauser comorbidity measures in predicting mortality. *BMC Health Serv Res* 2010;10:245. doi: 10.1186/1472-6963-10-245
22. Uscher-Pines L, Pines J, Kellermann A, et al. Emergency department visits for nonurgent conditions: systematic literature review. *Am J Manag Care* 2013;19(1):47-59.
23. Gabayan GZ, Derosé SF, Asch SM, et al. Patterns and predictors of short-term death after emergency department discharge. *Annals of emergency medicine* 2011;58(6):551-58 e2. doi: 10.1016/j.annemergmed.2011.07.001
24. Cragg J and Uhler RS. The Demand for Automobiles. *Canadian Journal of Economics* 1970;3:20.
25. Veall MR ZK. Pseudo-R2 Measures for Some Common Limited Dependent Variable Models. *Journal of Economic Surveys* 1996;10(3):18.

- 1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
26. Feng Z, Wright B, Mor V. Sharp rise in Medicare enrollees being held in hospitals for observation raises concerns about causes and consequences. *Health affairs* 2012;31(6):1251-9. doi: 10.1377/hlthaff.2012.0129
 27. Zuckerman RB, Sheingold SH, Orav EJ, et al. Readmissions, Observation, and the Hospital Readmissions Reduction Program. *The New England journal of medicine* 2016 doi: 10.1056/NEJMsa1513024
 28. Venkatesh AK, Geisler BP, Gibson Chambers JJ, et al. Use of observation care in US emergency departments, 2001 to 2008. *PLoS One* 2011;6(9):e24326. doi: 10.1371/journal.pone.0024326
 29. Herring AA, Johnson B, Ginde AA, et al. High-intensity emergency department visits increased in California, 2002-09. *Health affairs* 2013;32(10):1811-9. doi: 10.1377/hlthaff.2013.0397
 30. Kocher KE, Meurer WJ, Fazel R, et al. National trends in use of computed tomography in the emergency department. *Annals of emergency medicine* 2011;58(5):452-62 e3. doi: 10.1016/j.annemergmed.2011.05.020
 31. Chen C, Scheffler G, Chandra A. Massachusetts' health care reform and emergency department utilization. *The New England journal of medicine* 2011;365(12):e25. doi: 10.1056/NEJMp1109273
 32. Pines JM, Mullins PM, Cooper JK, et al. National trends in emergency department use, care patterns, and quality of care of older adults in the United States. *Journal of the American Geriatrics Society* 2013;61(1):12-7. doi: 10.1111/jgs.12072
 33. Trendwatch Chartbook: Trends Affecting Hospitals and Health Systems: American Hospital Association, 2015.
 34. Kocher KE, Dimick JB, Nallamotheu BK. Changes in the source of unscheduled hospitalizations in the United States. *Medical care* 2013;51(8):689-98. doi: 10.1097/MLR.0b013e3182992c7b
 35. Smulowitz PB, Honigman L, Landon BE. A novel approach to identifying targets for cost reduction in the emergency department. *Annals of emergency medicine* 2013;61(3):293-300. doi: 10.1016/j.annemergmed.2012.05.042

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

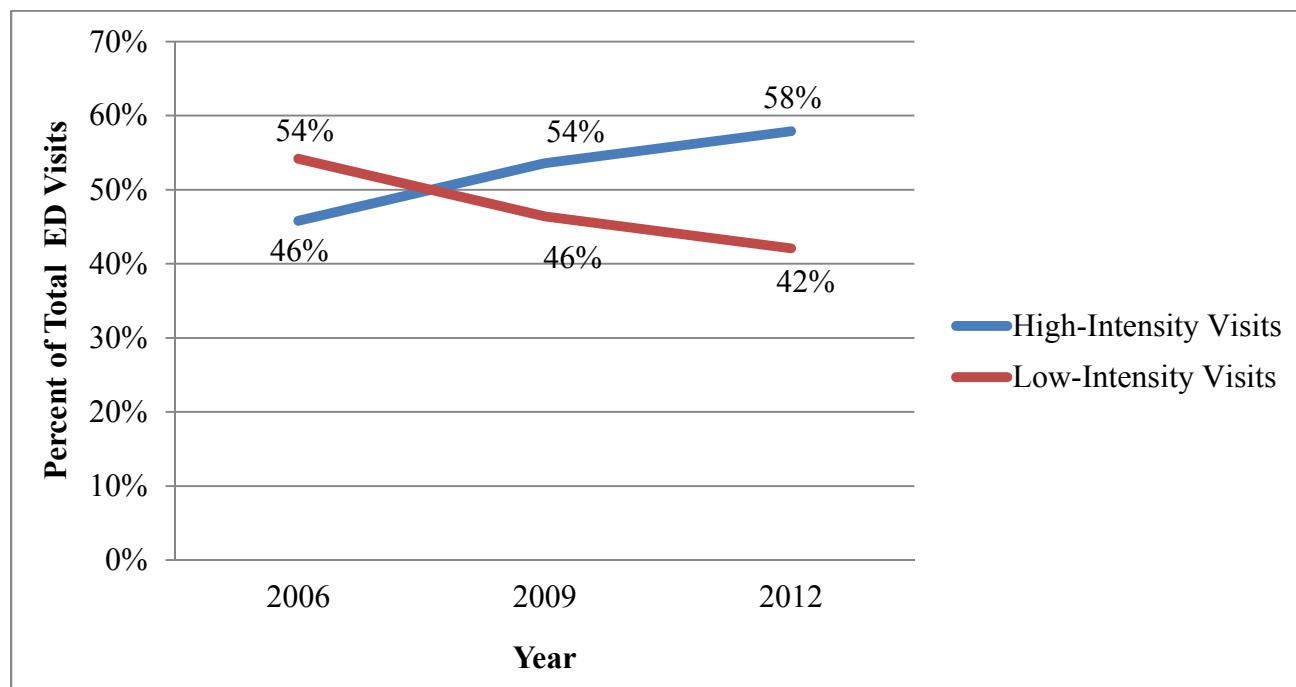
	2006	2009	2012	Time Trend per Year, % (95% CI)	P-Value
Hospital Admission Rate	40.1%	38.7%	35.9%	-0.68 (-0.71 to -0.65)	<.001
Intensive Care Unit Admission Rate	11.7%	12.6%	12.3%	+0.11 (0.09 to 0.12)	<.001
Mean Number of Services per Admission[†]				Change in Services per Year, % (95% CI)	
<i>All Admissions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

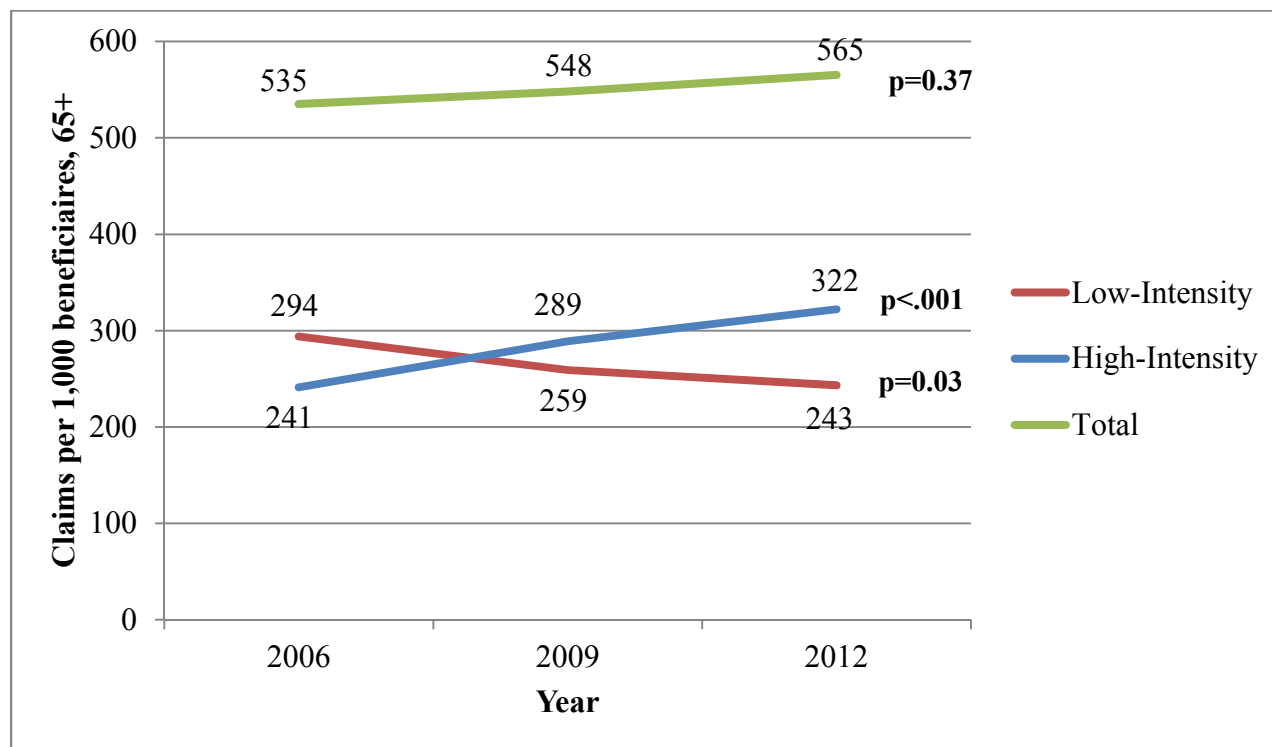
Figure 1. Adjusted Time Trends* in Billing for High- and Low- Intensity‡ Emergency Care



*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.

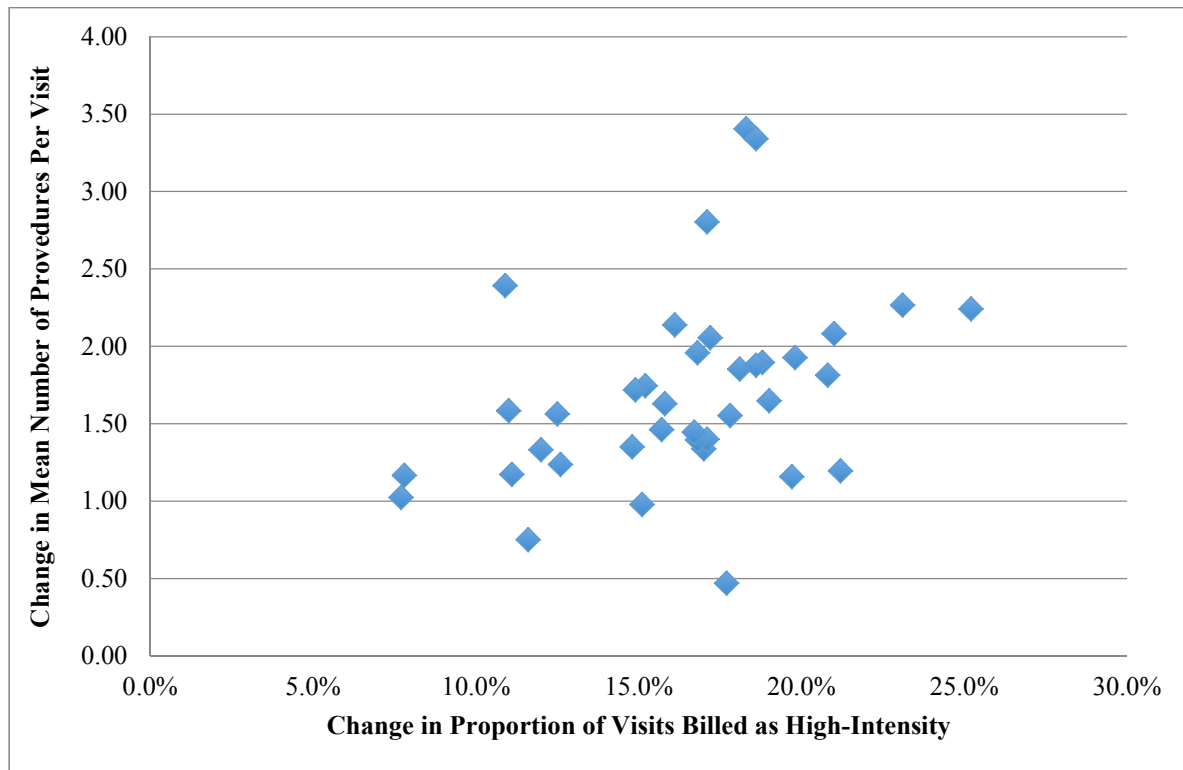
‡High-intensity visits are coded as 99285 or critical care (99291, 99292). Low-intensity visits are defined by emergency physician billed CPT/HCPCS codes 99281-99284.

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.

1
2
3
4
5
6 **Appendices for “Trends in High-Intensity Billing for Emergency Care Accompanied by an**
7
8 **Increase in Services Provided in the Emergency Department”**
9
10

11
12
13
14 **Appendix 1.** Proportion of Emergency Department Visits Billed as High-Intensity Visits by
15 Diagnosis Category
16

17 **Appendix 2.** Trends in Billing* for High-Intensity Emergency Care
18

19
20 **Appendix 3.** Most Frequent Services among Emergency Admissions by Year
21

22 **Appendix 4.** Most Frequent Services among Outpatient Emergency Department Visits
23

24 **Appendix 5.** Absolute Change in Proportion of High-Intensity Visits versus Baseline Proportion
25 of High-Intensity Visits by Diagnosis Category for Outpatient Emergency Department Visits
26

27
28 **Appendix 6.** Comparison of Pseudo R² for Sequential Models Incorporating Explanatory
29 Variables for the Trend in Emergency Department (ED) Practice Intensity
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

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

		2006	2009	2012	Absolute Change, % (95% CI)
1	<i>Minor injuries</i>	8.5%	14.4%	20.5%	12.0 (11.6 to 12.9)
2	<i>Major injuries</i>	34.0%	42.3%	51.7%	17.7 (14.8 to 20.6)
3	<i>Other injuries</i>	7.3%	12.3%	18.9%	12.0 (11.5 to 12.5)
4	<i>Symptoms: abdominal pain</i>	31.3%	44.0%	52.4%	21.0 (20.1 to 22.0)
5	<i>Symptoms: chest pain</i>	65.2%	77.5%	82.4%	17.2 (16.4 to 17.9)
6	<i>Symptoms: dizziness, vertigo, and syncope</i>	42.9%	57.3%	66.1%	23.0 (22.1 to 23.8)
7	<i>Symptoms: headache</i>	21.7%	30.5%	39.7%	17.9 (16.3 to 19.5)
8	<i>Other symptoms</i>	25.3%	35.7%	44.1%	18.8 (17.9 to 19.7)
9	<i>Upper respiratory infections</i>	12.8%	20.5%	27.6%	14.7 (13.5 to 15.9)
10	<i>Intestinal infections</i>	28.1%	40.1%	53.3%	25.2 (20.8 to 29.6)
11	<i>Urinary tract infection</i>	18.4%	27.3%	34.1%	15.9 (15.0 to 16.9)
12	<i>Other infectious and parasitic diseases</i>	12.6%	20.4%	23.6%	11.0 (9.1 to 12.9)
13	<i>Skin and subcutaneous infection</i>	5.9%	10.0%	13.6%	7.7 (6.4 to 9.3)
14	<i>Endocrine, nutritional; immunity and metabolic disorders</i>	29.0%	38.7%	45.8%	16.8 (15.6 to 18.0)
15	<i>Diabetes mellitus</i>	25.3%	33.5%	40.5%	15.0 (13.3 to 16.6)
16	<i>Hypertension</i>	24.4%	35.1%	41.4%	16.9 (15.6 to 18.3)
17	<i>Nonatherosclerotic heart disease</i>	61.2%	71.3%	78.3%	17.0 (14.6 to 19.4)
18	<i>Dysrhythmias</i>	52.7%	65.4%	72.4%	19.6 (18.4 to 20.9)
19	<i>Ischemic heart disease</i>	75.8%	82.6%	86.7%	11.0 (9.0 to 12.9)
20	<i>Congestive heart failure</i>	57.2%	68.7%	75.8%	18.3 (16.5 to 20.1)
21	<i>Circulatory disorders</i>	25.0%	35.6%	40.8%	15.8 (14.2 to 17.4)
22	<i>Cerebrovascular disease</i>	63.4%	74.5%	80.5%	16.8 (15.0 to 18.5)
23	<i>Diseases of the blood</i>	32.3%	43.7%	50.1%	17.7 (15.2 to 20.3)
24	<i>Neoplasms</i>	32.9%	47.1%	49.0%	16.0 (12.7 to 19.4)
25	<i>Mental illness</i>	27.1%	36.5%	43.9%	16.8 (15.5 to 18.1)
26	<i>Nervous system disorders</i>	23.5%	31.4%	36.0%	12.4 (11.4 to 13.5)
27	<i>Pneumonia</i>	36.6%	52.0%	57.6%	20.9 (19.1 to 22.6)
28	<i>Other respiratory disease</i>	27.3%	35.6%	42.4%	15.1 (14.2 to 16.0)
29	<i>Chronic obstructive pulmonary disease</i>	31.6%	43.0%	52.4%	20.6 (19.5 to 21.8)
30	<i>Asthma</i>	28.5%	38.8%	48.3%	19.8 (16.9 to 22.1)
31	<i>Noninfectious lung disease</i>	44.0%	60.2%	62.9%	18.8 (15.0 to 22.7)
32	<i>GI system diseases</i>	21.7%	32.2%	38.4%	16.7 (16.0 to 17.4)
33	<i>Other renal and GU diseases</i>	11.5%	18.3%	24.1%	12.6 (11.6 to 13.6)
34	<i>End-stage renal disease</i>	7.1%	10.1%	25.4%	17.8 (-3.2 to 38.9)
35	<i>Chronic renal disease</i>	47.4%	61.9%	66.1%	18.6 (14.3 to 23.0)
37	<i>Diseases of the musculoskeletal system, skin, and connective tissue</i>	10.3%	16.0%	21.4%	11.1 (10.5 to 11.7)
38	<i>Complications and adverse events</i>	10.5%	15.0%	18.3%	7.8 (6.4 to 9.3)
39	<i>Other residual codes</i>	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 $p < .001$

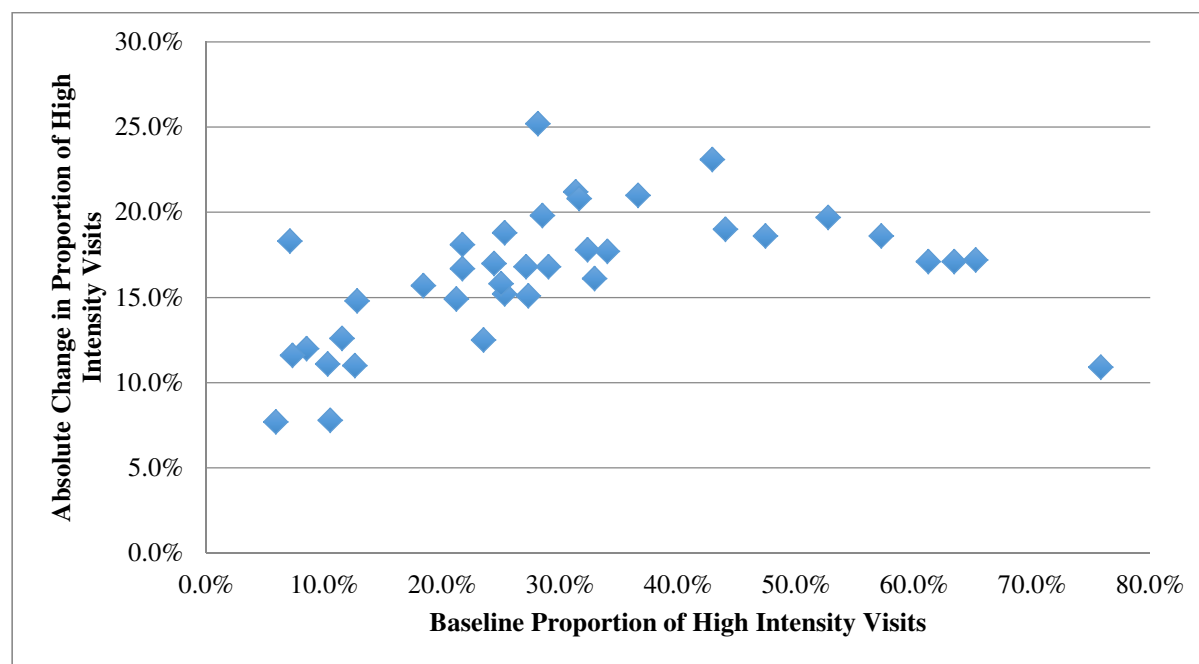
Appendix 4. Mean Number of Services per Visit for the Ten Most Frequent Services* among Outpatient Emergency Department Visits

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 R² 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

Laura G. Burke, MD, MPH

Robert C. Wild, MS, MPH

E. John Orav, PhD

Renee Y. Hsia, MD, MSc

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	<i>Cross-sectional study</i> —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) <i>Cross-sectional study</i> —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) <i>Cohort study</i> —Summarise follow-up time (eg, average and total amount)
Outcome data	15*	<i>Cohort study</i> —Report numbers of outcome events or summary measures over time <i>Case-control study</i> —Report numbers in each exposure category, or summary measures of exposure <i>Cross-sectional study</i> —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).

1			
2	Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision.
3			Discuss both direction and magnitude of any potential bias
4			Limitations are clearly outlined in the “Limitations” subsection (page 18).
5	<hr/>		
6	Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity
7			of analyses, results from similar studies, and other relevant evidence
8			An interpretation and implications are discussed (pages 16-19).
9	<hr/>		
10	Generalisability	21	Discuss the generalisability (external validity) of the study results
11			The external validity of this study is discussed in the “Limitations” subsection (page 19).
12	<hr/>		
13	Other information		
14	<hr/>		
15	Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable,
16			for the original study on which the present article is based
17			This study had no funding source.

Continued on next page

BMJ Open

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

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2017-019357.R1
Article Type:	Research
Date Submitted by the Author:	10-Nov-2017
Complete List of Authors:	Burke, Laura; Beth Israel Deaconess Medical Center, Emergency Medicine; Harvard T.H. Chan School of Public Health, Department of Health Policy and Management Wild, Robert; Harvard Medical School Department of Health Care Policy Orav, E. John; Harvard University, Hsia, Renee Y.; Univ Calif San Francisco
Primary Subject Heading:	Emergency medicine
Secondary Subject Heading:	Health policy
Keywords:	Quality in health care < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, Health policy < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, ACCIDENT & EMERGENCY MEDICINE

SCHOLARONE™
Manuscripts

Only

1
2
3 **Are trends in billing for high-intensity emergency care explained by changes in services**
4 **provided in the emergency department? An observational study among US Medicare**
5 **beneficiaries**
6
7
8
9

10
11 Laura G. Burke,^{1,2} MD, MPH

12
13 Robert C. Wild,³ MS, MPH

14
15 E. John Orav,⁴ PhD

16
17
18 Renee Y. Hsia,^{5,6} MD, MSc
19
20
21
22

- 23 1. Beth Israel Deaconess Medical Center, Department of Emergency Medicine. Boston,
24 MA.
25
26
27 2. Harvard T.H. Chan School of Public Health, Department of Health Policy and
28 Management. Boston, MA.
29
30
31
32 3. Harvard Medical School, Department of Health Care Policy. Boston, MA.
33
34
35 4. Harvard T.H. Chan School of Public Health, Department of Biostatistics. Boston, MA.
36
37
38 5. University of California San Francisco, Department of Emergency Medicine. San
39 Francisco, CA.
40
41
42 6. University of California San Francisco, Philip R. Lee Institute of Health Policy Studies.
43 San Francisco, CA.
44
45
46
47

48 Corresponding Author: Laura G. Burke, MD, MPH, 1 Deaconess Road, Boston MA 02215. Tel
49 774-218-9514, email lgburke@bidmc.harvard.edu
50
51
52
53
54
55
56
57

Word Count

4,454 words

Funding

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

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,

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

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

For peer review only

1
2
3 **ABSTRACT** (409 words)
4
5
6
7

8 **Objective:** There has been concern that an increase in billing for high-intensity emergency care
9
10 is due to changes in coding practices facilitated by electronic health records. We sought to
11
12 characterize the trends in billing for high-intensity emergency care among Medicare
13
14 beneficiaries and to examine the degree to which trends in high-intensity billing are explained by
15
16 changes in patient characteristics and services provided in the emergency department (ED).
17
18
19

20
21 **Design, Setting, and Participants:** Observational study using traditional Medicare claims to
22
23 identify ED visits at nonfederal acute care hospitals for elderly beneficiaries in 2006, 2009, and
24
25 2012.
26
27
28
29

30
31 **Outcomes Measures:** Billing intensity was defined by emergency physician evaluation and
32
33 management (E&M) codes. We tested for overall trends in high-intensity billing (E&M codes
34
35 99285, 99291 and 99292) and in services provided over time using linear regression models,
36
37 adjusting for patient characteristics. Additionally, we tested for time trends in rates of admission
38
39 to the hospital and to the intensive care unit. Next we classified outpatient visits into 39
40
41 diagnosis categories and analyzed the change in proportion of high-intensity visits versus the
42
43 change in number of services. Finally, we quantified the extent to which trends in high-intensity
44
45 billing are explained by changes in patient demographics and services provided in the ED using
46
47 multivariable modeling.
48
49
50

51
52
53 **Results:** High-intensity visits grew from 45.8% of 671,103 visits in 2006 to 57.8% of 629,010
54
55
56
57

1
2
3 visits in 2012 (2.0% absolute increase per year; 95% CI, 1.97% to 2.03%) as did the mean
4
5 number of services provided for admitted (1.28 to 1.41; +0.02 increase in procedures per year;
6
7 95% CI, 0.018 to 0.021) and discharged ED patients (7.1 to 8.6; +0.23 increase in procedures per
8
9 year; 95% CI, 0.245 to 0.251). There was a reduction in hospital admission rate from 40.1% to
10
11 35.9% (-0.68% per year; 95% CI, -0.71% to -0.65%; $p < .001$), while the ICU rate of admission
12
13 rose from 11.7% to 12.3% (+0.11% per year; 95% CI, 0.09% to 0.12%; $p < .001$). When we
14
15 stratified by diagnosis category, there was a moderate correlation between change in visits billed
16
17 as high intensity and the change in mean number of services provided per visit ($\rho = 0.38$; 95% CI,
18
19 0.07 to 0.63). Trends in patient characteristics and services provided accounted moderately for
20
21 the trend in practice intensity for outpatient visits (pseudo R^2 of 0.47) but very little for inpatient
22
23 visits (5.1%) and visits overall (14.8%).
24
25
26
27
28
29
30

31 **Conclusions:** Increases in services provided in the ED moderately account for the trends in
32
33 billing for high-intensity emergency care for outpatient visits.
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

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-R² 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.

For peer review only

INTRODUCTION

The rising cost of healthcare in the United States has received increasing attention¹ 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.

1
2
3 Thus, we sought to evaluate the trends in billing for high-intensity emergency care and
4 the underlying mechanism for these trends by addressing three questions. First, what are the
5 trends in billing for high-intensity care in the Medicare fee-for-service population, and to what
6 extent are these trends accompanied by changes in patient characteristics and practice patterns?
7
8 Second, do particular diagnoses or conditions have greater changes in intensity over time, and, if
9 so, are these variations associated with trends in services? Finally, how much of the trend in
10 high-intensity billing is explained by trends in services provided and patient characteristics when
11 using multivariable modeling?
12
13
14
15
16
17
18
19
20
21
22
23

24 **METHODS**

25 **Study Design and Setting**

26
27 We used a five percent sample of national Medicare fee-for-service claims to identify ED
28 visits in 2006, 2009, and 2012. We examined ED visits by beneficiaries age 65 and older who
29 were continuously-enrolled in traditional Medicare and presented to nonfederal acute care
30 hospitals. The billing intensity level was obtained by identifying all emergency physician
31 professional claims in the Carrier file for Current Procedural Terminology (CPT) Healthcare
32 Common Procedure Coding System (HCPCS) evaluation and management codes 99281-99285,
33 99291 and 99292. Patient characteristics (age, sex, race, Medicaid eligibility) were obtained
34 from the Master Beneficiary Summary File. Patient chronic conditions were assigned using
35 software from the Centers for Medicare and Medicaid Services that allows for the creation of
36 Hierarchical Condition Categories (HCCs)¹⁷ based on conditions coded in claims for that year.
37
38 Information such as visit diagnosis and services provided were obtained from the inpatient file
39 for admitted patients and the outpatient file for visits resulting in discharge or observation status.
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3 Procedures were denoted by International Classification of Diseases, Ninth Revision (ICD9)
4 procedure codes for inpatient visits and CPT/HCPCS codes for outpatient visits and physician
5 professional claims. Since claims for substance abuse related visits were no longer available in
6 Medicare data in 2012,¹⁸ we dropped substance abuse claims from the prior years. We used the
7 American Hospital Association survey from 2012 to obtain data on hospital characteristics
8 (region, rural vs. urban location [RUCA], size, as well as trauma center, profit, and teaching
9 status) and linked this to ED claims using Medicare provider identification numbers.
10
11
12
13
14
15
16
17
18
19
20

21 **Conceptual Model and Outcomes**

22 ***High-Intensity Billing***

23
24
25
26 Our primary outcome was the ED visit level of billing intensity, defined by CPT codes as
27 selected by the treating emergency physician or designee. CPT codes 99281 and 99282 represent
28 low complexity, 99283 and 99284 represent moderate complexity, 99285 represents high
29 complexity, while codes 99291 and 99292 are used to denote that critical care services were
30 provided. While prior studies have used 99285 alone to define high-intensity ED visits,^{19 20} we
31 chose to also define ED visits with critical care billing as high intensity as these were available in
32 our dataset and have been evaluated in prior research on ED visit acuity.²¹ Thus, we created a
33 binary intensity outcome variable, categorizing visits with codes 99281-99284 as low-intensity
34 and those with codes 99285, 99291, and 99292 as high-intensity.
35
36
37
38
39
40
41
42
43
44
45
46
47
48

49 ***Clinical Services Provided***

50
51 If a rise in high-intensity billing was due to upcoding alone rather than trends in actual
52 practice, we might expect relatively little change in the frequency and type of services provided
53
54
55
56
57
58
59
60

1
2
3 in the ED. As such, we determined the mean number of services provided per visit according to
4 the ED facility claims. For discharged patients, we identified all services on outpatient ED
5 facility claims (outpatient services) such as laboratory and radiology tests and clinical procedures
6 that occurred in the ED. For admitted patients, services from inpatient facility claims (inpatient
7 services) may have been provided at any time during that hospitalization, including during
8 treatment in the ED, as we could not readily distinguish the location of services provided for
9 admitted patients in this dataset. We also determined the mean number of physician professional
10 claims for services other than evaluation and management for all visits (physician services).
11
12
13
14
15
16
17
18
19
20
21
22
23

24 ***Hospital and Intensive Care Unit Admission Rate***

25
26 We also evaluated trends in rates of admission to the hospital and to the intensive care
27 unit (ICU) as additional indicators of clinical practice and patient acuity. Hospital utilization
28 rates in the United States have fallen²² as the number of inpatient beds per capita has declined.
29 Thus, temporal trends in hospital admission may reflect changing practice patterns in response to
30 a variety of incentives to admit fewer patients rather than patient acuity alone. More intensive
31 ED evaluation and treatment may allow emergency physicians to safely discharge a greater
32 number of patients of moderate acuity or complexity. ICU admission, however, is generally
33 reserved for the most seriously ill patients and less likely to be avoided by completing an
34 intensive ED work-up. Thus, we hypothesized that any increase in high-intensity billing would
35 be accompanied by a reduction in hospital admission and stable or increasing rates of ICU
36 admission.²³
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53

54 **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 procedure 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

1
2
3 admitted and discharged patients using linear regression adjusting for age, sex, race, and
4
5 Medicaid eligibility. We then calculated the overall hospital admission rate (percentage of ED
6
7 visits leading to a hospital admission) and the ICU admission rate (percentage of ED visits
8
9 leading to an ICU admission), again using linear regression, adjusting for age, race, sex, and
10
11 Medicaid coverage.
12
13

14 15 16 17 ***Trends in Practice Intensity by Diagnosis Category*** 18

19
20 Next, we evaluated if trends in billing for high-intensity emergency care varied by
21
22 condition treated and if those conditions with the greatest changes in high-intensity emergency
23
24 care also saw the greatest changes in services over time. We categorized the principal diagnosis
25
26 for each outpatient visit into one of 39 diagnosis categories, previously described in the
27
28 emergency medicine literature (Appendix 1),²⁵ and used the analogous adjusted longitudinal
29
30 linear regression model for each diagnosis to estimate the percentage of total visits in each year
31
32 categorized as high-intensity as well as the absolute change in proportion of high-intensity visits.
33
34 We limited this analysis to outpatient visits because of the limited detail regarding ED services
35
36 for admitted patients. For each diagnostic category, we calculated the change in high-intensity
37
38 visit rate and the change in ED services between 2006 and 2012. The changes were graphed
39
40 against each other and a correlation coefficient was calculated to capture the degree to which the
41
42 two were associated with each other. Additionally, for each diagnosis category, we graphed the
43
44 change in proportion of high-intensity visits against the baseline proportion of high-intensity
45
46 visits in 2006. We did this in order to determine if high- or low-complexity conditions saw
47
48 greater changes over time.
49
50
51
52
53
54
55
56
57
58
59
60

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

1
2
3 growth in observation status and decline in hospital admissions may represent substitution in
4 response to Medicare payment policies.²⁸ To evaluate if our results were sensitive to inclusion of
5 observations visits in our sample, we recalculated the admission rate and mean number of
6 inpatient and outpatient services and repeated our mediation analysis after reclassifying all
7 observation claims as admissions.
8
9
10
11
12
13

14 Analyses were conducted using SAS version 9.3 (SAS institute). The Office of Human
15 Research Administration approved this study.
16
17
18
19
20

21 RESULTS

22 Characteristics of Study Sample

23
24 We examined 1,883,650 ED total visits. Patient and hospital characteristics are
25 summarized for all ED visits in Table 1. There was a decrease in the proportion of ED visits by
26 women (66.1% to 60.6%; -0.94% absolute decrease per year [95%CI, -0.97% to -0.91%];
27 p<.001) and whites (85.9% to 84.1%; -0.29% absolute decrease per year [95%CI, -0.31% to -
28 0.27%]; p<.001) while all other racial groups saw a slight increase. The proportion of visits by
29 Medicaid beneficiaries rose from 22.4% in 2006 to 23.1% in 2012 (+0.12% absolute increase per
30 year [95% CI, 0.09% to 0.14%]; p<.001). The average number of chronic conditions per
31 beneficiary increased slightly from 4.61 in 2006 to 4.91 in 2012 (+0.05 conditions/per year [95%
32 CI, 0.050 to 0.054]; p<.001). When we stratified by high- and low-intensity ED visits, the
33 number of chronic conditions (HCCs) was higher for beneficiaries with a high-intensity visit
34 than for those with a low-intensity visit (5.96 HCCs vs. 3.93 HCCs, respectively in 2012; Table
35 1). Over the study period there was an increase in proportion of visits to urban (71.5% in 2006 to
36 73.1% in 2012; +0.26% absolute increase per year [95% CI, 0.24% to 0.29%]; p<.001), large
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3 (23.6 to 26.4%; +0.48% per year [95% CI, 0.46% to 0.50%]; $p < .001$), minor teaching (26.4% to
4
5 30.8%; +0.74% per year [95% CI, 0.72% to 0.77%]; $p < .001$), and for-profit hospitals (12.9% to
6
7 14.9%; +0.33% per year [95% CI, 0.31% to 0.35%]; $p < .001$), as well as trauma centers (38.2%
8
9 to 43.7%; +0.91% per year [95% CI, 0.88% to 0.93%]; $p < .001$).

14 15 ***Trends in Practice Intensity***

16
17 High-intensity visits overall rose from 45.8% in 2006 to 57.8% in 2012 (+2.0% per year
18
19 [95% CI, 1.97% to 2.03%]; $p < .001$; Figure 1). The most frequent intensity code in all three years
20
21 was 99285, also known as a level 5 visit (Appendix 2). Level 5 visits represented 39.7% of all
22
23 ED visits in 2006 and 49.4% in 2012 (+1.6% per year [95% CI, 1.57% to 1.63%]; $p < .001$). There
24
25 was also an increase in visits that were billed at a critical care level (CPT 99291) from 5.0% of
26
27 all visits in 2006 to 7.6% in 2012 (+0.4% increase per year [95% CI, 0.39% to 0.41%]; $p < .001$).
28
29 CPT 99292 comprised of less than 1% of all visits in both years and showed a small increase that
30
31 was not statistically significant (+0.004% increase per year [95% CI, -0.0003% to +0.009];
32
33 $p = .07$). We observed a concomitant decrease over time in each of the four CPT codes
34
35 categorized as low-intensity (Appendix 2).
36
37
38
39
40
41

42 43 ***Trends in Visit Rates per Beneficiary***

44
45 We found an increase from 535 to 565 ED visits per 1,000 beneficiaries that was not
46
47 statistically significant (0.9% increase per 1,000 beneficiaries per year [95% CI, -1.1% to 2.9%];
48
49 $p = 0.37$, Appendix 3). There was a significant increase in the high-intensity visit rate from 241 to
50
51 322 per 1,000 beneficiaries (4.9% increase in high-intensity visits per 1,000 beneficiaries per
52
53 year, [95% CI, 2.0% to 7.8%]; $p < .001$), while the rate of low-intensity visits per beneficiary
54
55
56
57
58
59
60

1
2
3 decreased (294 to 243 visits per 1,000 beneficiaries; -3.2% decrease in low-intensity visits per
4
5 1,000 beneficiaries per year [95% CI, -5.9% to -0.4%]; p=0.03).
6
7
8
9

10 ***Trends in Patient Acuity and Treatment Intensity***

11
12 When we looked at inpatient services for patients admitted from the ED, we found an
13
14 increase in the mean number of total services (1.28 to 1.41 per admissions; +0.02 procedures per
15
16 year, [95% CI, 0.018 to 0.021]; p<.001), which persisted even after reclassifying observation
17
18 claims as admissions (1.23 to 1.29; +0.011 procedures per year [95% CI, 0.009 to 0.012];
19
20 p<.001). High-intensity admissions had a greater number of services in each year, and both
21
22 groups saw an increase over time in the mean number of services (Table 2). The most frequent
23
24 inpatient services by year are presented in Appendix 4. Several critical care procedures and
25
26 services saw an increase over time including respiratory intubation and mechanical ventilation
27
28 (9.9% of all admissions from the ED in 2006 compared to 12.6% in 2012 ;+0.45% per year [95%
29
30 CI, 0.41% to 0.49%]; p<.001), blood transfusion (12.4% to 15.4%; +0.52% per year [95% CI,
31
32 0.48% to 0.56%]; p<.001), and other vascular catheterization, not heart (7.6% to 10.0%; +0.41%
33
34 per year [95% CI, 0.38% to 0.44%]; p<.001).
35
36
37
38
39

40 Outpatient ED visits saw a significant increase in total average number of services per
41
42 visit from a mean of 7.1 in 2006 to 8.6 in 2012 (+0.25 increase in mean services per year [95%
43
44 CI, 0.245 to 0.255]; p<.001). High-intensity visits, relative to low-intensity visits, had a greater
45
46 number of services in each year. High-intensity visits saw a significant increase in services (12.9
47
48 to 13.7; +0.14 services per year [95% CI, 0.13 to 0.15]; p<.001), whereas low-intensity visits
49
50 saw a slight decrease (5.3 to 5.2; -0.008 services per year [95% CI, -0.121 to -0.003] p<.001;
51
52 Table 2). After reclassifying observation claims as admissions, the mean number of outpatient
53
54
55
56
57
58
59
60

1
2
3 services still saw an increase from 6.7 to 8.1 services per visit (+0.23 increase per year, [95% CI,
4 0.22 to 0.23]; $p < .001$). The most frequent services provided during an outpatient ED visit are
5 presented in Appendix 5. There were very few physician professional claims for services other
6 than evaluation and management in all three years, but the mean number of procedures per visit
7 increased slightly from 0.31 in 2006 to 0.34 in 2012 ($p < .001$), the most frequent of which were
8 for electrocardiogram interpretation (Appendix 6).

9
10
11
12
13
14
15
16
17 When examining trends in hospital admission, we observed a reduction in admission rate
18 from the ED over time, with 35.9% of visits leading to admission in 2012 compared to 40.1% in
19 2006 (-0.68% per year [95% CI, -0.71% to -0.65%]; $p < .001$; Table 2). The number of visits with
20 an associated observation claim rose from 15,914 visits (3.9% of total) in 2006 to 22,226 visits
21 (5.4% of total) in 2012. However, even after reclassifying observation claims as admissions,
22 there was still a statistically significant decrease in admission rate from 42.1% in 2006 to 39.1%
23 in 2012 (-0.48% per year [95% CI, -0.51% to -0.45%]; $p < .001$). In contrast, the proportion of all
24 ED visits resulting in an ICU admission increased (11.7% to 12.3%; +0.11% per year, [95% CI,
25 0.09% to 0.12%]; $p < .001$).

40 Trends by Diagnosis

41
42 Upon examining the 39 condition categories individually (Appendix 1), diagnosis
43 categories with the largest change in the proportion of high-intensity visits tended to have a mid-
44 range baseline intensity (Appendix 7). Skin and subcutaneous infections had the lowest absolute
45 change (5.9% of visits categorized as high-intensity in 2006 to 13.6% in 2012; +7.8% [95% CI,
46 6.4% to 9.3%]; $p < .001$) and intestinal infections had the greatest (25.2%; from 28.1% in 2006 to
47 53.3% in 2012; +25.2% [95% CI, 20.8% to 29.6%]; $p < .001$). We found that those diagnoses

1
2
3 with greater increases in intensity tended to have an increase in mean number of services (Figure
4 2), with moderate correlation ($r=0.38$ [95% CI, 0.07 to 0.63]; $p=0.02$) between the change in
5 percentage of high-intensity visits and the change in mean number of services provided per visit
6 for each diagnosis category.
7
8
9
10
11
12
13

14 **Impact of Patient Characteristics and Services on High-Intensity Billing**

15
16 We next used four separate logistic regressions to determine the extent to which the
17 trends in high-intensity billing are explained by trends in patient demographics, chronic
18 conditions, and services provided (Table 3). Time alone explained between 1.3% of the
19 variation in high-intensity billing for all visits, 3.4% for inpatient visits, and 2.7% for outpatient
20 visits. Incorporating patient age, sex, race, and Medicaid eligibility again increased the pseudo
21 R^2 by less than 1%, regardless of disposition. Incorporating patient comorbidities (HCCs)
22 increased the pseudo R^2 to 9.0% for all visits, 3.5% for inpatient visits, and 4.3% for outpatient
23 visits. Incorporating services in the model led to the greatest increase in pseudo R^2 and
24 explained 46.5% of the variation in high-intensity billing for outpatient visits. While
25 incorporating services had the greatest impact on model R^2 for inpatient visits and visits overall,
26 it still explained only 5.1% of the variation for inpatient visits and 14.8% for visits overall. When
27 we reclassified observation claims as admissions, our results were similar (pseudo R^2 of 0.14 for
28 visits overall, 0.05 for inpatient visits, and 0.44 for outpatient visits for the final model
29 incorporating time, patient demographics and chronic conditions, and services).
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48

49 Additionally, we calculated the predicted number of high-intensity visits that would have
50 occurred in 2006 using coefficients for the variables in our models from 2009 and 2012. We
51 calculated the difference between the predicted and observed number of high-intensity visits in
52
53
54
55
56
57
58
59
60

1
2
3 2006. For inpatient ED visits, this difference revealed an additional 24,819 visits that would
4 have been classified as high-intensity using 2009 coefficients (9.5% of all inpatient visits;
5 Appendix 8) and 35,504 inpatient visits (13.6%) that would have been classified as high-
6 intensity using 2012 coefficients. For outpatient visits, this difference revealed an additional
7 1,101 visits (0.3%) that would have been classified as high-intensity using 2009 coefficients, and
8 16,905 (4.1%) would have been classified as high-intensity using 2012 coefficients. These
9 additional visits represent the degree to which billing for high-intensity emergency care has
10 changed in ways that are not explained by the variables in our model and may represent
11 upcoding.
12
13
14
15
16
17
18
19
20
21
22
23
24
25

26 **DISCUSSION**

27
28 In our study of elderly Medicare beneficiaries, we found that ED visits are increasingly
29 billed at the highest levels of intensity, with nearly 60% of ED visits in our sample coded at a
30 level 5 or as critical care in 2012, up from 46% in 2006. We found a concomitant increase in
31 services provided in the ED and during an associated inpatient stay. While overall admission rate
32 decreased over time, a greater fraction of ED visits resulted in admission to intensive care. We
33 found that trends in high intensity billing varied by clinical condition; diagnoses with the greatest
34 change in high-intensity billing also had the greatest increase in number of services. These
35 findings persisted when we repeated our analyses reclassifying observation claims as admissions.
36 Finally, using multivariable modeling, we found that trends in patient characteristics as well as in
37 services provided during the visit moderately accounted for the increase in practice intensity for
38 outpatient ED visits. If the process for determining high-intensity visits in 2012 were applied to
39 visits in 2006, we would have seen an additional 4.1% of outpatient visits and 13.6% of inpatient
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3 visits coded as high-intensity. In other words, those additional increases were unexplained in our
4
5 model, and could potentially represent secular changes such as upcoding.
6

7
8 Our results are consistent with other work showing a growth in high-intensity emergency
9
10 care. A study of all ED visits in California²⁰ also demonstrated a growth in physician billing for
11
12 high-intensity visits, particularly among safety net hospitals. Other studies using national
13
14 datasets have documented greater use of tests and treatments in the ED such as advanced
15
16 imaging, blood tests, and IV fluids.^{15 16} Exploring the idea that doing more in the ED can prevent
17
18 hospitalizations, one study found that greater use of CT scans was associated with a reduction in
19
20 admissions and transfers.³¹ Our study adds to this literature by linking physician billing for high-
21
22 intensity emergency care to services provided during the ED visit for a national sample of
23
24 Medicare beneficiaries. Our findings suggest that the growth in high-intensity billing has been
25
26 accompanied by an observable increase in diagnostic and treatment intensity while admission
27
28 rates have fallen.
29
30
31

32
33 While prior studies have suggested that the fears of upcoding due to EHRs may not be
34
35 fully warranted,¹⁴ there has been concern that the trend in billing for high-intensity emergency
36
37 care may represent trends in coding rather than actual changes in practice. Using multivariable
38
39 modeling, we found that observable factors such as patient characteristics and numbers of
40
41 services and procedures moderately explained, but did not fully account for, the trends in high-
42
43 intensity billing for outpatient visits. It is possible that part of the residual trend could be
44
45 attributed to upcoding; our study, however, is unable to identify conclusively whether this is the
46
47 case.
48
49
50

51 ED visits in the U.S. have continued to rise^{10 32-34} despite health insurance expansion and
52
53 cost control efforts that were predicted to reduce ED utilization. The role of emergency medicine
54
55
56
57

1
2
3 in the acute care landscape has also expanded,³⁵ with EDs assuming greater responsibility for
4 managing complex problems while reserving limited and costly hospital capacity for those truly
5 requiring inpatient care. With the growth of alternative payment models, reducing admissions
6 for ED patients with moderate severity problems has been proposed as a strategy to reduce
7 costs.³⁶ Our findings are consistent with this new model of emergency care. We found an
8 increase in services while admission rates fell, even after accounting for the growth in
9 observation stays. We found the greatest increases in high-intensity billing and services among
10 conditions with moderate baseline intensity such as pneumonia and intestinal infections, for
11 which the decision to admit likely involves greater provider discretion relative to higher acuity
12 conditions. While our study was not designed to assess the relationship between intensity of
13 emergency care and admission rate, it is possible that doing more for patients in the ED may
14 have allowed a greater number to be safely discharged. The rise in number of services, including
15 critical care procedures, provided during hospital admission suggests that the average acuity of
16 patients who ultimately are admitted may be increasing over time.

17
18
19 Our study has a number of limitations. Given the use of administrative data, clinical
20 markers of acuity, such as vital signs and laboratory data, that may have been helpful in further
21 detailing any trends in patient acuity over time, were not available. Also, time spent observing
22 and treating patients is another key component of practice intensity that we could not measure
23 with our dataset and could potentially account for some of the remaining time trend in practice
24 intensity. Additionally, our modeling explained relatively little of the variation for inpatient visits
25 and ED visits overall. This is likely due to the fact that, unlike for outpatient visits, there is
26 substantially less detail in the dataset regarding services provided in the ED. Also, while
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3 national in scope, our analysis is limited to elderly fee-for-service Medicare beneficiaries and
4
5 may not be generalizable to other populations.
6

7
8 In summary, the rise in billing for high-intensity emergency care has been portrayed as an
9
10 unintended consequence of the growth of health information technology rather than reflecting a
11
12 change in practice. However, this trend has been accompanied by an increase in the provision of
13
14 services in the hospital as well as in the ED. Multivariable modeling incorporating patient
15
16 characteristics, comorbidities, and services provided moderately explained the trends in high-
17
18 intensity billing. It is unclear the degree to which changes in coding practices explain the
19
20 remaining variation. This rise in high-intensity emergency care has occurred while rates of
21
22 admission from the ED have fallen, raising the possibility that a greater amount of work
23
24 performed in the ED may have allowed more patients to avoid inpatient treatment during an
25
26 acute episode. Further study may be useful in determining what impact the trend in high-
27
28 intensity emergency care has had on total costs of care as well as patient outcomes.
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

REFERENCES

1. Brill S. Bitter Pill: Why Medical Bills Are Killing Us. *Time*, 2013.
2. Boyd D. The Potential Impact of Alternative Health Care Spending Scenarios on Future and Local Government Budgets: Brookings Institute, 2014.
3. Orszag PR, Ellis P. The challenge of rising health care costs--a view from the Congressional Budget Office. *The New England Journal of Medicine* 2007;357(18):1793-5. doi: 10.1056/NEJMp078190
4. Auerbach DI, Kellermann AL. A decade of health care cost growth has wiped out real income gains for an average US family. *Health Affairs* 2011;30(9):1630-6. doi: 10.1377/hlthaff.2011.0585
5. Weinick RM, Burns RM, Mehrotra A. Many emergency department visits could be managed at urgent care centers and retail clinics. *Health Affairs* 2010;29(9):1630-6. doi: 10.1377/hlthaff.2009.0748
6. Baker LC, Baker LS. Excess cost of emergency department visits for nonurgent care. *Health Affairs* 1994;13(5):162-71.
7. Bamezai A, Melnick G, Nawathe A. The cost of an emergency department visit and its relationship to emergency department volume. *Annals of Emergency Medicine* 2005;45(5):483-90. doi: 10.1016/j.annemergmed.2004.08.029
8. Ostrom CM. State Medicaid program to stop paying for unneeded ER visits. *The Seattle Times* 2012 February 9, 2012.
9. Whitman E. Reducing Emergency Room Visits In Houston: Texas Firefighters Use Tablets To Connect Patients With Doctors, Not ERs. *International Business Times* 2015 April 9, 2015.
10. Skinner HG, Blanchard J, Elixhauser A. Trends in Emergency Department Visits, 2006-2011: Statistical Brief #179. Healthcare Cost and Utilization Project (HCUP) Statistical Briefs. Rockville (MD)2006.
11. Rui PK, K; Albert, M. . National Hospital Ambulatory Medical Care Survey: 2013 Emergency Department Summary Tables.
12. Levinson DR. Coding Trends of Medicare Evaluation and Management: Department of Health and Human Services, USA, 2012.
13. Abelson RC, J. ; Palmer, G. Medicare Bills Rise as Records Turn Electronic. *The New York Times* 2012 September 21, 2012.

14. Adler-Milstein J, Jha AK. No evidence found that hospitals are using new electronic health records to increase Medicare reimbursements. *Health Affairs* 2014;33(7):1271-7. doi: 10.1377/hlthaff.2014.0023
15. Pitts SR, Pines JM, Handrigan MT, et al. National trends in emergency department occupancy, 2001 to 2008: effect of inpatient admissions versus emergency department practice intensity. *Annals of Emergency Medicine* 2012;60(6):679-86 e3. doi: 10.1016/j.annemergmed.2012.05.014
16. Pitts SR. Higher-complexity ED billing codes--sicker patients, more intensive practice, or improper payments? *The New England Journal of Medicine* 2012;367(26):2465-7. doi: 10.1056/NEJMp1211315
17. Li P, Kim MM, Doshi JA. Comparison of the performance of the CMS Hierarchical Condition Category (CMS-HCC) risk adjuster with the Charlson and Elixhauser comorbidity measures in predicting mortality. *BMC Health Serv Res* 2010;10:245. doi: 10.1186/1472-6963-10-245
18. Frakt AB, Bagley N. Protection or harm? Suppressing substance-use data. *The New England Journal of Medicine* 2015;372(20):1879-81. doi: 10.1056/NEJMp1501362
19. Kaskie B, Obrizan M, Cook EA, et al. Defining emergency department episodes by severity and intensity: A 15-year study of Medicare beneficiaries. *BMC Health Serv Res* 2010;10:173. doi: 10.1186/1472-6963-10-173
20. Herring AA, Johnson B, Ginde AA, et al. High-intensity emergency department visits increased in California, 2002-09. *Health Affairs* 2013;32(10):1811-9. doi: 10.1377/hlthaff.2013.0397
21. Wiler JL, Poirier RF, Farley H, et al. Emergency severity index triage system correlation with emergency department evaluation and management billing codes and total professional charges. *Acad Emerg Med* 2011;18(11):1161-6. doi: 10.1111/j.1553-2712.2011.01203.x
22. McDermott K.W. EE, Sun R. Trends in Hospital Inpatient Stays in the United States, 2005-2014: Healthcare Cost and Utilization Project, 2017.
23. Mullins PM, Goyal M, Pines JM. National growth in intensive care unit admissions from emergency departments in the United States from 2002 to 2009. *Acad Emerg Med* 2013;20(5):479-86. doi: 10.1111/acem.12134
24. Uscher-Pines L, Pines J, Kellermann A, et al. Emergency department visits for nonurgent conditions: systematic literature review. *Am J Manag Care* 2013;19(1):47-59.
25. Gabayan GZ, Derose SF, Asch SM, et al. Patterns and predictors of short-term death after emergency department discharge. *Annals of Emergency Medicine* 2011;58(6):551-58 e2. doi: 10.1016/j.annemergmed.2011.07.001

- 1
- 2
- 3 26. Cragg J. The Demand for Automobiles. *Canadian Journal of Economics* 1970;3:20.
- 4
- 5 27. Veall MR ZK. Pseudo-R2 Measures for Some Common Limited Dependent Variable
- 6 Pseudo-R2 Measures for Some Common Limited Dependent Variable
- 7 Models. *Journal of Economic Surveys* 1996;10(3):18.
- 8
- 9 28. Feng Z, Wright B, Mor V. Sharp rise in Medicare enrollees being held in hospitals for
- 10 observation raises concerns about causes and consequences. *Health Affairs*
- 11 2012;31(6):1251-9. doi: 10.1377/hlthaff.2012.0129
- 12
- 13 29. Zuckerman RB, Sheingold SH, Orav EJ, et al. Readmissions, Observation, and the Hospital
- 14 Readmissions Reduction Program. *The New England Journal of Medicine* 2016 doi:
- 15 10.1056/NEJMsa1513024
- 16
- 17 30. Venkatesh AK, Geisler BP, Gibson Chambers JJ, et al. Use of observation care in US
- 18 emergency departments, 2001 to 2008. *PLoS One* 2011;6(9):e24326. doi:
- 19 10.1371/journal.pone.0024326
- 20
- 21 31. Kocher KE, Meurer WJ, Fazel R, et al. National trends in use of computed tomography in the
- 22 emergency department. *Annals of Emergency Medicine* 2011;58(5):452-62 e3. doi:
- 23 10.1016/j.annemergmed.2011.05.020
- 24
- 25 32. Chen C, Scheffler G, Chandra A. Massachusetts' health care reform and emergency
- 26 department utilization. *The New England Journal of Medicine* 2011;365(12):e25. doi:
- 27 10.1056/NEJMp1109273
- 28
- 29 33. Pines JM, Mullins PM, Cooper JK, et al. National trends in emergency department use, care
- 30 patterns, and quality of care of older adults in the United States. *Journal of the American*
- 31 *Geriatrics Society* 2013;61(1):12-7. doi: 10.1111/jgs.12072
- 32
- 33 34. Trendwatch Chartbook: Trends Affecting Hospitals and Health Systems: American Hospital
- 34 Association, 2015.
- 35
- 36 35. Gonzalez Morganti K, Sebastian, B., Blanchard, J.C., Abir, M., Smith, A., Vesely, J.V.,
- 37 Okeke, E. N., Kellermann, A.L., Iyer, N. The Evolving Roles of Emergency
- 38 Departments. Santa Monica, CA: RAND Corporation, 2013.
- 39
- 40 36. Smulowitz PB, Honigman L, Landon BE. A novel approach to identifying targets for cost
- 41 reduction in the emergency department. *Annals of Emergency Medicine* 2013;61(3):293-
- 42 300. doi: 10.1016/j.annemergmed.2012.05.042
- 43
- 44
- 45
- 46
- 47
- 48
- 49
- 50
- 51
- 52
- 53
- 54
- 55
- 56
- 57
- 58
- 59
- 60

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)	
<i>All Admissions</i>	1.28	1.31	1.41	+0.02 (0.018 to 0.021)	<.001
<i>Low-Intensity</i>	1.22	1.33	1.34	+0.02 (0.017 to 0.025)	<.001
<i>High-Intensity</i>	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)	
<i>All Outpatient Visits</i>	7.11	8.05	8.60	+0.25 (0.25 to 0.26)	<.001
<i>Low-Intensity Outpatient Visits</i>	5.28	5.39	5.22	-0.008 (-0.01 to -0.003)	0.001
<i>High-Intensity Outpatient Visits</i>	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 R² 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.

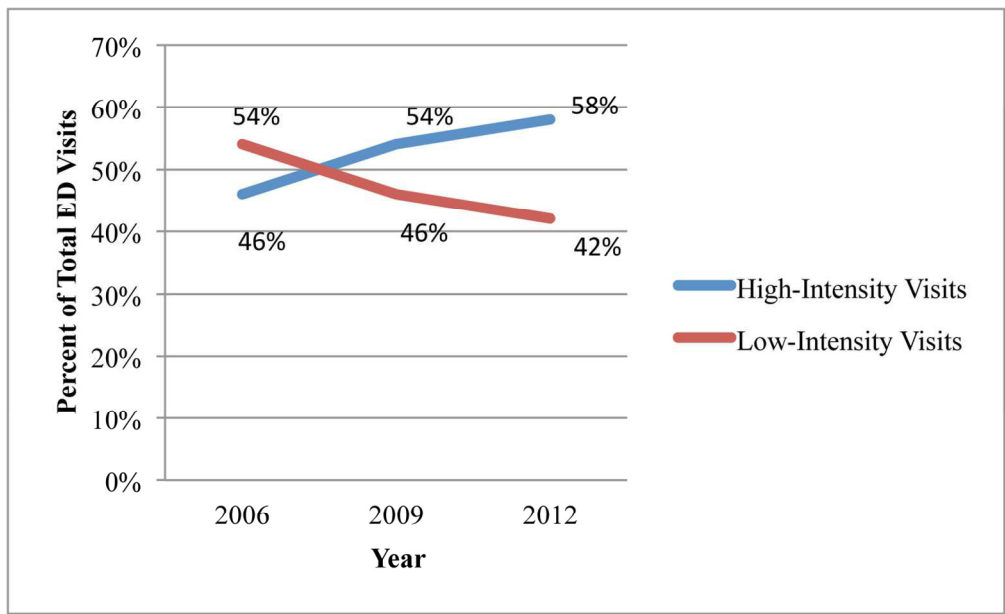
‡ High-intensity visits are coded as 99285 or critical care (99291, 99292). Low-intensity visits are defined by emergency physician billed CPT/HCPCS codes 99281-99284.

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.

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

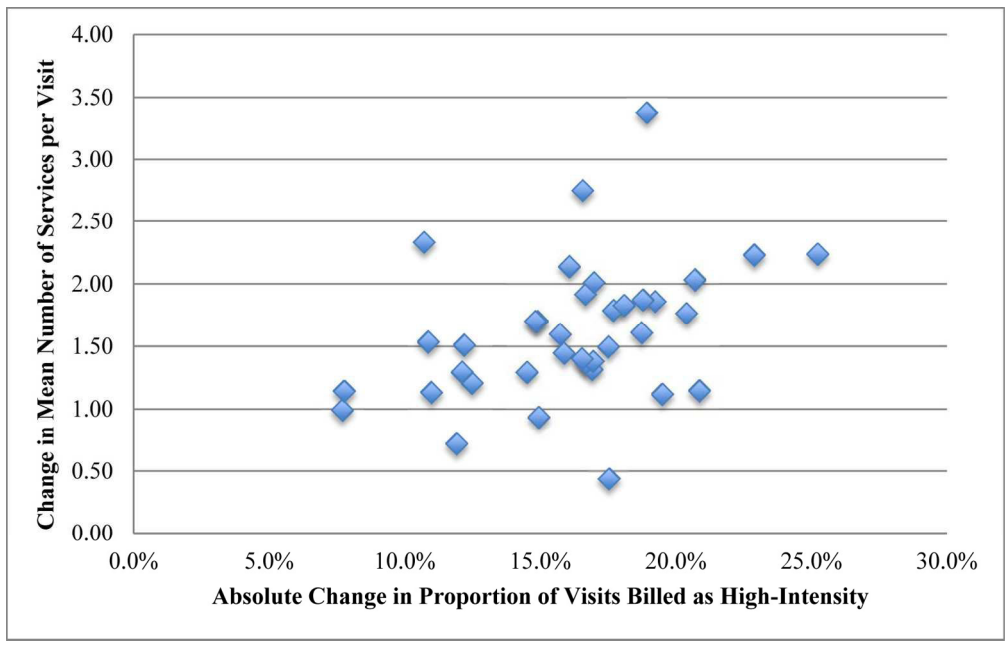


Adjusted Time Trends* in Billing for High- and Low- Intensity† Emergency Care

127x77mm (300 x 300 DPI)

Review only

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60



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)

view only

1
2
3
4
5
6 **Appendices for “Trends in High-Intensity Billing for Emergency Care Accompanied by an**
7
8 **Increase in Services Provided in the Emergency Department”**
9
10

11
12
13 **Appendix 1.** Proportion of Emergency Department Visits Billed as High-Intensity Visits by
14 Diagnosis Category
15

16
17 **Appendix 2.** Trends in Billing* for High-Intensity Emergency Care
18

19 **Appendix 3.** Unadjusted Rate of Emergency Department Visits per 1,000 Medicare*
20 Beneficiaries Overall and Stratified by Intensity
21

22
23 **Appendix 4.** Trends* in the Most Common Services† among Admitted Patients
24

25 **Appendix 5.** Trends* in the Most Common Services† among Patients Discharged from the ED
26

27 **Appendix 6.** Ten Most Frequent Physician Services by Year
28

29
30 **Appendix 7.** Absolute Change in Proportion of High-Intensity Visits versus Baseline Proportion
31 of High-Intensity Visits by Diagnosis Category for Outpatient Emergency Department Visits
32

33 **Appendix 8.** Comparison of Observed versus Expected Number of High-Intensity Visits in 2006
34 Using Multivariable Modeling
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

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 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%	19.8 (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.

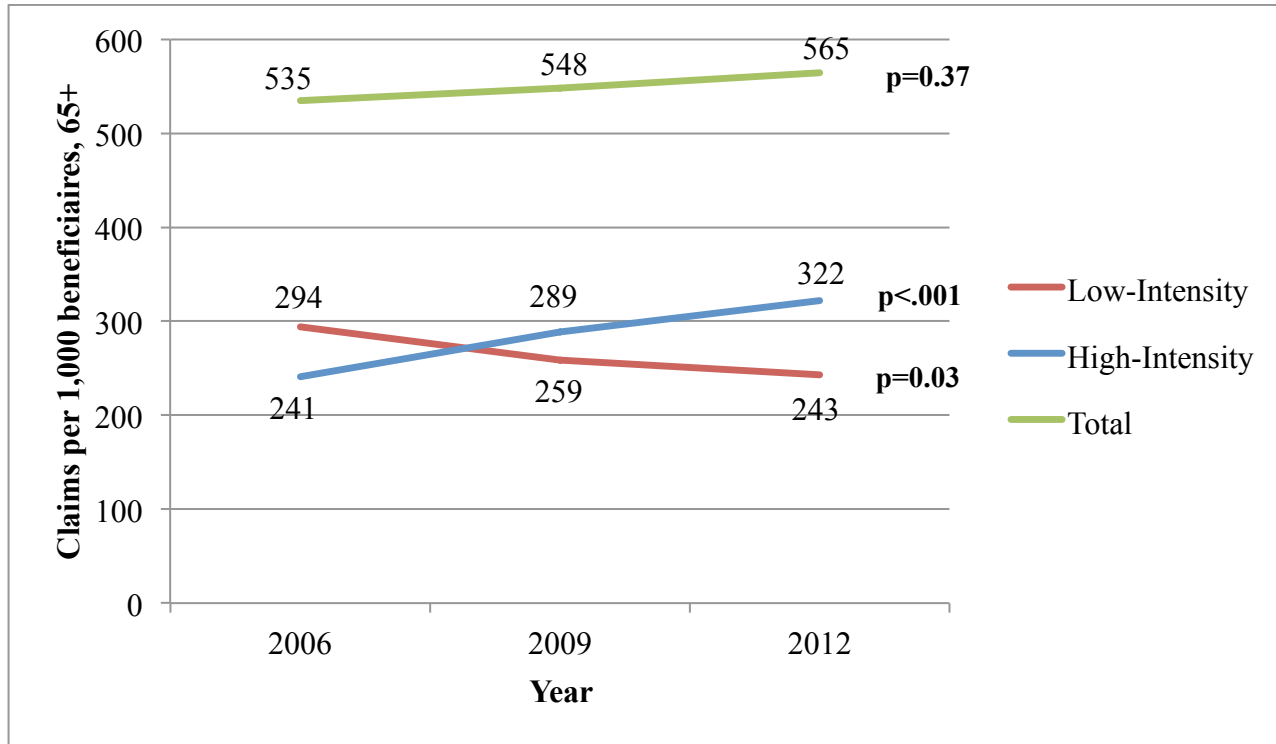
Appendix 2. Trends* in Billing for High-Intensity Emergency Care

		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

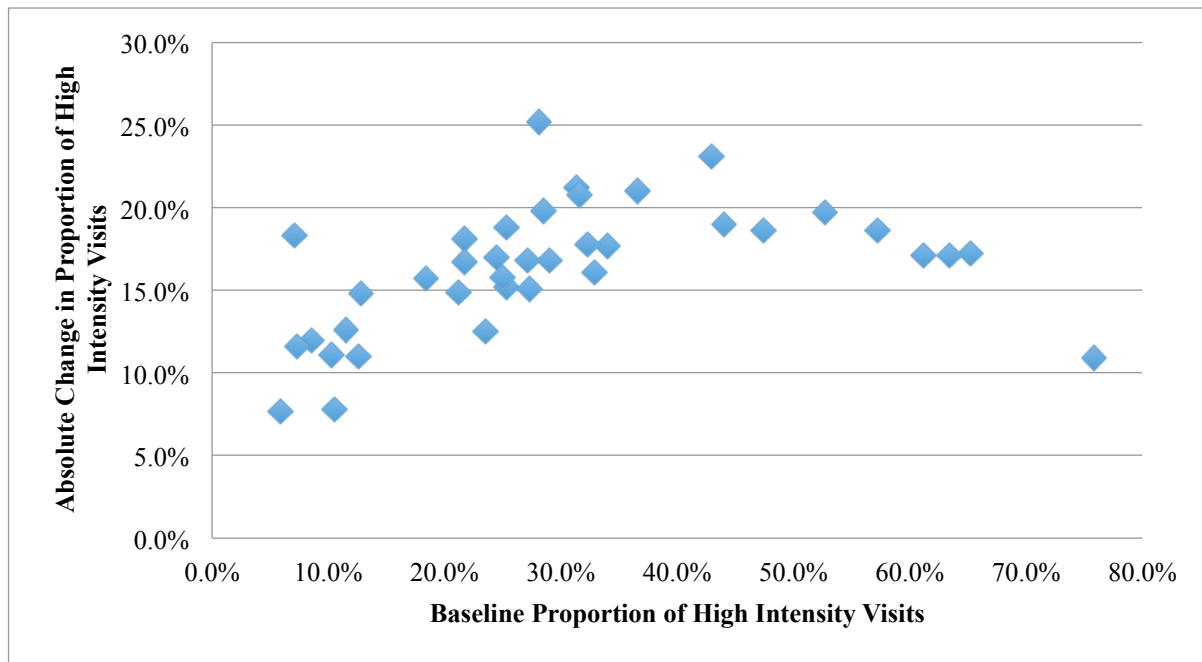
	2006		2009		2012	
	Service	% [†]	Service	%	Service	%
1	Electrocardiogram	63.5%	Electrocardiogram	64.4%	Electrocardiogram	67.4%
2	Suture of skin and subcutaneous tissue	8.3%	Suture of skin and subcutaneous tissue	8.2%	Suture of skin and subcutaneous tissue	7.4%
3	Other therapeutic procedures	6.1%	Routine 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

	<i>Observed High-Intensity Visits 2006</i>	Using 2009 Regression Coefficients[†]		Using 2012 Regression Coefficients	
		<i>Predicted High-Intensity[‡]</i>	<i>Observed - Expected (%)</i>	<i>Predicted High-Intensity</i>	<i>Observed - Expected (%)</i>
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

Laura G. Burke, MD, MPH

Robert C. Wild, MS, MPH

E. John Orav, PhD

Renee Y. Hsia, MD, MSc

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	<i>Cross-sectional study</i> —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) <i>Cross-sectional study</i> —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) <i>Cohort study</i> —Summarise follow-up time (eg, average and total amount)
Outcome data	15*	<i>Cohort study</i> —Report numbers of outcome events or summary measures over time <i>Case-control study</i> —Report numbers in each exposure category, or summary measures of exposure <i>Cross-sectional study</i> —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).

1			
2	Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision.
3			Discuss both direction and magnitude of any potential bias
4			Limitations are outlined in the discussion (page 22).
5	Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity
6			of analyses, results from similar studies, and other relevant evidence
7			An interpretation and implications are discussed (pages 20-23).
8			
9	Generalisability	21	Discuss the generalisability (external validity) of the study results
10			The external validity of this study is discussed in the “Limitations” subsection (page 22).

Other information

11			
12			
13	Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable,
14			for the original study on which the present article is based
15			This study had no funding source.

Continued on next page

BMJ Open

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

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2017-019357.R2
Article Type:	Research
Date Submitted by the Author:	04-Dec-2017
Complete List of Authors:	Burke, Laura; Beth Israel Deaconess Medical Center, Emergency Medicine; Harvard T.H. Chan School of Public Health, Department of Health Policy and Management Wild, Robert; Harvard Medical School Department of Health Care Policy Orav, E. John; Harvard University, Hsia, Renee Y.; Univ Calif San Francisco
Primary Subject Heading:	Emergency medicine
Secondary Subject Heading:	Health policy
Keywords:	Quality in health care < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, Health policy < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, ACCIDENT & EMERGENCY MEDICINE

SCHOLARONE™
Manuscripts

1
2
3 **Are trends in billing for high-intensity emergency care explained by changes in services**
4 **provided in the emergency department? An observational study among US Medicare**
5 **beneficiaries**
6
7
8
9

10
11 Laura G. Burke,^{1,2} MD, MPH

12
13 Robert C. Wild,³ MS, MPH

14
15 E. John Orav,⁴ PhD

16
17
18 Renee Y. Hsia,^{5,6} MD, MSc
19
20
21
22

- 23 1. Beth Israel Deaconess Medical Center, Department of Emergency Medicine. Boston,
24 MA.
25
26
27 2. Harvard T.H. Chan School of Public Health, Department of Health Policy and
28 Management. Boston, MA.
29
30
31
32 3. Harvard Medical School, Department of Health Care Policy. Boston, MA.
33
34
35 4. Harvard T.H. Chan School of Public Health, Department of Biostatistics. Boston, MA.
36
37
38 5. University of California San Francisco, Department of Emergency Medicine. San
39 Francisco, CA.
40
41
42 6. University of California San Francisco, Philip R. Lee Institute of Health Policy Studies.
43 San Francisco, CA.
44
45
46
47

48 Corresponding Author: Laura G. Burke, MD, MPH, 1 Deaconess Road, Boston MA 02215. Tel
49 774-218-9514, email lgburke@bidmc.harvard.edu
50
51
52
53
54
55
56
57

Word Count

4,545 words

Funding

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

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,

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

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

For peer review only

1
2
3 **ABSTRACT** (409 words)
4
5
6
7

8 **Objective:** There has been concern that an increase in billing for high-intensity emergency care
9
10 is due to changes in coding practices facilitated by electronic health records. We sought to
11
12 characterize the trends in billing for high-intensity emergency care among Medicare
13
14 beneficiaries and to examine the degree to which trends in high-intensity billing are explained by
15
16 changes in patient characteristics and services provided in the emergency department (ED).
17
18
19

20
21 **Design, Setting, and Participants:** Observational study using traditional Medicare claims to
22
23 identify ED visits at nonfederal acute care hospitals for elderly beneficiaries in 2006, 2009, and
24
25 2012.
26
27
28
29

30
31 **Outcomes Measures:** Billing intensity was defined by emergency physician evaluation and
32
33 management (E&M) codes. We tested for overall trends in high-intensity billing (E&M codes
34
35 99285, 99291 and 99292) and in services provided over time using linear regression models,
36
37 adjusting for patient characteristics. Additionally, we tested for time trends in rates of admission
38
39 to the hospital and to the intensive care unit. Next we classified outpatient visits into 39
40
41 diagnosis categories and analyzed the change in proportion of high-intensity visits versus the
42
43 change in number of services. Finally, we quantified the extent to which trends in high-intensity
44
45 billing are explained by changes in patient demographics and services provided in the ED using
46
47 multivariable modeling.
48
49
50
51
52
53

54 **Results:** High-intensity visits grew from 45.8% of 671,103 visits in 2006 to 57.8% of 629,010
55
56
57
58
59
60

1
2
3 visits in 2012 (2.0% absolute increase per year; 95% CI, 1.97% to 2.03%) as did the mean
4
5 number of services provided for admitted (1.28 to 1.41; +0.02 increase in procedures per year;
6
7 95% CI, 0.018 to 0.021) and discharged ED patients (7.1 to 8.6; +0.25 increase in procedures per
8
9 year; 95% CI, 0.245 to 0.255). There was a reduction in hospital admission rate from 40.1% to
10
11 35.9% (-0.68% per year; 95% CI, -0.71% to -0.65%; $p < .001$), while the ICU rate of admission
12
13 rose from 11.7% to 12.3% (+0.11% per year; 95% CI, 0.09% to 0.12%; $p < .001$). When we
14
15 stratified by diagnosis category, there was a moderate correlation between change in visits billed
16
17 as high intensity and the change in mean number of services provided per visit ($\rho = 0.38$; 95% CI,
18
19 0.07 to 0.63). Trends in patient characteristics and services provided accounted moderately for
20
21 the trend in practice intensity for outpatient visits (pseudo R^2 of 0.47) but very little for inpatient
22
23 visits (0.051 and visits overall (0.148).
24
25
26
27
28
29
30

31 **Conclusions:** Increases in services provided in the ED moderately account for the trends in
32
33 billing for high-intensity emergency care for outpatient visits.
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

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 attention¹ 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.

1
2
3 Thus, we sought to evaluate the trends in billing for high-intensity emergency care and
4 the underlying mechanism for these trends by addressing three questions. First, what are the
5 trends in billing for high-intensity care in the Medicare fee-for-service population, and to what
6 extent are these trends accompanied by changes in patient characteristics and practice patterns?
7
8 Second, do particular diagnoses or conditions have greater changes in intensity over time, and, if
9 so, are these variations associated with trends in services? Finally, how much of the trend in
10 high-intensity billing is explained by trends in services provided and patient characteristics when
11 using multivariable modeling?
12
13
14
15
16
17
18
19
20
21
22
23

24 **METHODS**

25 **Study Design and Setting**

26
27 We used a five percent sample of national Medicare fee-for-service claims to identify ED
28 visits in 2006, 2009, and 2012. We examined ED visits by beneficiaries age 65 and older who
29 were continuously-enrolled in traditional Medicare and presented to nonfederal acute care
30 hospitals. The billing intensity level was obtained by identifying all emergency physician
31 professional claims in the Carrier file for Current Procedural Terminology (CPT) Healthcare
32 Common Procedure Coding System (HCPCS) evaluation and management codes 99281-99285,
33 99291 and 99292. Patient characteristics (age, sex, race, Medicaid eligibility) were obtained
34 from the Master Beneficiary Summary File. Patient chronic conditions were assigned using
35 software from the Centers for Medicare and Medicaid Services that allows for the creation of
36 Hierarchical Condition Categories (HCCs)¹⁷ based on conditions coded in claims for that year.
37
38 Information such as visit diagnosis and services provided were obtained from the inpatient file
39 for admitted patients and the outpatient file for visits resulting in discharge or observation status.
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3 Procedures were denoted by International Classification of Diseases, Ninth Revision (ICD9)
4 procedure codes for inpatient visits and CPT/HCPCS codes for outpatient visits and physician
5 professional claims. Since claims for substance abuse related visits were no longer available in
6 Medicare data in 2012,¹⁸ we dropped substance abuse claims from the prior years. We used the
7 American Hospital Association survey from 2012 to obtain data on hospital characteristics
8 (region, rural vs. urban location [RUCA], size, as well as trauma center, profit, and teaching
9 status) and linked this to ED claims using Medicare provider identification numbers.
10
11
12
13
14
15
16
17
18
19
20

21 **Outcomes**

22 ***High-Intensity Billing***

23
24
25 Our primary outcome was the ED visit level of billing intensity, defined by CPT codes as
26 selected by the treating emergency physician or designee. CPT codes 99281 and 99282 represent
27 low complexity, 99283 and 99284 represent moderate complexity, 99285 represents high
28 complexity, while codes 99291 and 99292 are used to denote that critical care services were
29 provided. While prior studies have used 99285 alone to define high-intensity ED visits,^{19 20} we
30 chose to also define ED visits with critical care billing as high intensity as these were available in
31 our dataset and have been evaluated in prior research on ED visit acuity.²¹ Thus, we created a
32 binary intensity outcome variable, categorizing visits with codes 99281-99284 as low-intensity
33 and those with codes 99285, 99291, and 99292 as high-intensity.
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48

49 ***Clinical Services Provided***

50
51 If a rise in high-intensity billing was due to upcoding alone rather than trends in actual
52 practice, we might expect relatively little change in the frequency and type of services provided
53
54
55
56
57
58
59
60

1
2
3 in the ED. As such, we determined the mean number of services provided per visit according to
4
5 the ED facility claims. For discharged patients, we identified all services on outpatient ED
6
7 facility claims (outpatient services) such as laboratory and radiology tests and clinical procedures
8
9 that occurred in the ED. For admitted patients, services from inpatient facility claims (inpatient
10
11 services) may have been provided at any time during that hospitalization, including during
12
13 treatment in the ED, as we could not readily distinguish the location of services provided for
14
15 admitted patients in this dataset. We also determined the mean number of physician professional
16
17 claims for services other than evaluation and management for all visits (physician services).
18
19
20
21
22
23

24 ***Hospital and Intensive Care Unit Admission Rate***

25
26 We also evaluated trends in rates of admission to the hospital and to the intensive care
27
28 unit (ICU) as additional indicators of clinical practice and patient acuity. Hospital utilization
29
30 rates in the United States have fallen²² as the number of inpatient beds per capita has declined.
31
32 Thus, temporal trends in hospital admission may reflect changing practice patterns in response to
33
34 a variety of incentives to admit fewer patients rather than patient acuity alone. More intensive
35
36 ED evaluation and treatment may allow emergency physicians to safely discharge a greater
37
38 number of patients of moderate acuity or complexity. ICU admission, however, is generally
39
40 reserved for the most seriously-ill patients and is less likely to be avoided by an intensive ED
41
42 work-up. Thus, we hypothesized that any increase in high-intensity billing would be
43
44 accompanied by a reduction in hospital admission and stable or increasing rates of ICU
45
46 admission.²³
47
48
49
50
51
52
53

54 **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

1
2
3 physician services into clinically meaningful categories and determined the frequency of each
4
5 procedure type. We tested for time trends in mean number and type of services per visit for
6
7 admitted and discharged patients using linear regression adjusting for age, sex, race, and
8
9 Medicaid eligibility. The yearly estimates for rates of procedures were obtained using negative
10
11 binomial regression using generalized estimating equations to account for patient clustering at
12
13 the level of the ED and with time as a categorical predictor. We tested for time trends in the
14
15 overall hospital admission rate (percentage of ED visits leading to a hospital admission) and the
16
17 ICU admission rate (percentage of ED visits leading to an ICU admission), again using linear
18
19 regression, adjusting for age, race, sex, and Medicaid coverage. The yearly estimates for these
20
21 outcomes were obtained from binomial regression using generalized estimating equations to
22
23 account for patient clustering at the level of the ED.
24
25
26
27
28
29
30

31 ***Trends in Practice Intensity by Diagnosis Category***

32
33 Next, we evaluated if trends in billing for high-intensity emergency care varied by
34
35 condition treated and if those conditions with the greatest changes in high-intensity emergency
36
37 care also saw the greatest changes in services over time. We categorized the principal diagnosis
38
39 for each outpatient visit into one of 39 diagnosis categories, previously described in the
40
41 emergency medicine literature (Appendix 1),²⁵ and used the analogous adjusted longitudinal
42
43 linear regression model for each diagnosis to estimate the percentage of total visits in each year
44
45 categorized as high-intensity as well as the absolute change in proportion of high-intensity visits.
46
47 We limited this analysis to outpatient visits because of the limited detail regarding ED services
48
49 for admitted patients. For each diagnostic category, we calculated the change in high-intensity
50
51 visit rate and the change in ED services between 2006 and 2012. The changes were graphed
52
53
54
55
56
57
58
59
60

1
2
3 against each other and a correlation coefficient was calculated to capture the degree to which the
4
5 two were associated with each other. Additionally, for each diagnosis category, we graphed the
6
7 change in proportion of high-intensity visits against the baseline proportion of high-intensity
8
9 visits in 2006. We did this in order to determine if high- or low-complexity conditions saw
10
11 greater changes over time.
12
13

14 15 16 17 ***Multivariable Modeling*** 18

19 We used generalized logistic regression modeling, controlling for repeated hospital
20
21 measures, to investigate the extent to which trends in practice intensity are explained by
22
23 concomitant changes in patient characteristics, chronic conditions, and services provided in the
24
25 ED. We specified four models with the initial model having the binary variable intensity as the
26
27 outcome and time as the predictor. The second model incorporated beneficiary characteristics.
28
29 The third model incorporated number of chronic conditions. The fourth model further
30
31 incorporated inpatient, outpatient, and physician-billed services (CPT codes) for all visits. We
32
33 calculated a pseudo R^2 for each model^{26 27} as a measure of the proportion of total variation
34
35 explained by the model. We ran these models for all visits and for inpatient and outpatient visits
36
37 separately.
38
39
40
41

42 As a complementary analysis examining the degree to which trends in coding are
43
44 explained by the variables in our model, we ran two logistic regression models separately for
45
46 2009 and 2012 and obtained the coefficients for each variable in the model for those years. We
47
48 then applied those coefficients to ED visits in 2006 to obtain an expected number of visits in
49
50 2006. The difference between the observed and predicted number of visits billed as high-
51
52 intensity in 2006 using coefficients from the later years represents the degree to which high-
53
54
55
56
57

1
2
3 intensity billing has changed in ways that cannot be explained by the variables in our model. We
4
5 performed this analysis for outpatient and inpatient visits separately.
6
7
8
9

10 *Sensitivity Analysis*

11
12 There has been a growth in use of observation services for Medicare beneficiaries^{28 29}
13
14 both in the ED and the inpatient setting.³⁰ There has been some concern that the concomitant
15
16 growth in observation status and decline in hospital admissions may represent substitution in
17
18 response to Medicare payment policies.²⁸ To evaluate if our results were sensitive to inclusion of
19
20 observations visits in our sample, we recalculated the admission rate and mean number of
21
22 inpatient and outpatient services and repeated our mediation analysis after reclassifying all
23
24 observation claims as admissions.
25
26
27

28 Analyses were conducted using SAS version 9.3 (SAS institute). The Office of Human
29
30 Research Administration approved this study.
31
32
33
34

35 **RESULTS**

36 **Characteristics of Study Sample**

37
38 We examined 1,883,650 ED total visits. Patient and hospital characteristics are
39
40 summarized for all ED visits in Table 1. There was a decrease in the proportion of ED visits by
41
42 women (66.1% to 60.6%; -0.94% absolute decrease per year [95%CI, -0.97% to -0.91%];
43
44 p<.001) and whites (85.9% to 84.1%; -0.29% absolute decrease per year [95%CI, -0.31% to -
45
46 0.27%]; p<.001) while all other racial groups saw a slight increase. The proportion of visits by
47
48 Medicaid beneficiaries rose from 22.4% in 2006 to 23.1% in 2012 (+0.12% absolute increase per
49
50 year [95% CI, 0.09% to 0.14%]; p<.001). The average number of chronic conditions per
51
52
53
54
55
56
57
58
59
60

1
2
3 beneficiary increased slightly from 4.61 in 2006 to 4.91 in 2012 (+0.05 conditions/per year [95%
4 CI, 0.049 to 0.054]; $p < .001$). When we stratified by high- and low-intensity ED visits, the
5
6 number of chronic conditions (HCCs) was higher for beneficiaries with a high-intensity visit
7
8 than for those with a low-intensity visit (5.66 HCCs vs. 3.93 HCCs, respectively in 2012; Table
9
10 1). Over the study period there was an increase in proportion of visits to urban (71.5% in 2006 to
11
12 73.1% in 2012; +0.26% absolute increase per year [95% CI, 0.24% to 0.29%]; $p < .001$), large
13
14 (23.6 to 26.4%; +0.48% per year [95% CI, 0.46% to 0.50%]; $p < .001$), minor teaching (26.4% to
15
16 30.8%; +0.74% per year [95% CI, 0.72% to 0.77%]; $p < .001$), and for-profit hospitals (12.9% to
17
18 14.9%; +0.33% per year [95% CI, 0.31% to 0.35%]; $p < .001$), as well as trauma centers (38.2%
19
20 to 43.7%; +0.91% per year [95% CI, 0.88% to 0.93%]; $p < .001$).
21
22
23
24
25
26
27

28 ***Trends in Practice Intensity***

29
30 High-intensity visits overall rose from 45.8% in 2006 to 57.8% in 2012 (+2.0% per year
31
32 [95% CI, 1.97% to 2.03%]; $p < .001$; Figure 1). The most frequent intensity code in all three years
33
34 was 99285, also known as a level 5 visit (Appendix 2). Level 5 visits represented 39.7% of all
35
36 ED visits in 2006 and 49.4% in 2012 (+1.6% per year [95% CI, 1.57% to 1.63%]; $p < .001$). There
37
38 was also an increase in visits that were billed at a critical care level (CPT 99291) from 5.0% of
39
40 all visits in 2006 to 7.6% in 2012 (+0.4% increase per year [95% CI, 0.39% to 0.41%]; $p < .001$).
41
42 CPT 99292 comprised of less than 1% of all visits in both years and showed a small increase that
43
44 was not statistically significant (+0.004% increase per year [95% CI, -0.0003% to +0.009%];
45
46 $p = .07$). We observed a concomitant decrease over time in each of the four CPT codes
47
48 categorized as low-intensity (Appendix 2).
49
50
51
52
53
54
55
56
57
58
59
60

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%]; $p<.001$).

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32

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).

33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

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,

1
2
3 it still explained only 5.1% of the variation for inpatient visits and 14.8% for visits overall. When
4
5 we reclassified observation claims as admissions, our results were similar (pseudo R^2 of 0.14 for
6
7 visits overall, 0.05 for inpatient visits, and 0.44 for outpatient visits for the final model
8
9 incorporating time, patient demographics and chronic conditions, and services).

10
11
12 Additionally, we calculated the predicted number of high-intensity visits that would have
13
14 occurred in 2006 using coefficients for the variables in our models from 2009 and 2012. We
15
16 calculated the difference between the predicted and observed number of high-intensity visits in
17
18 2006. For inpatient ED visits, this difference revealed an additional 24,819 visits that would
19
20 have been classified as high-intensity using 2009 coefficients (9.5% of all inpatient visits;
21
22 Appendix 8) and 35,504 inpatient visits (13.6%) that would have been classified as high-
23
24 intensity using 2012 coefficients. For outpatient visits, this difference revealed an additional
25
26 1,101 visits (0.3%) that would have been classified as high-intensity using 2009 coefficients, and
27
28 16,905 (4.1%) would have been classified as high-intensity using 2012 coefficients. These
29
30 additional visits represent the degree to which billing for high-intensity emergency care has
31
32 changed in ways that are not explained by the variables in our model and may represent
33
34 upcoding.
35
36
37
38
39
40
41

42 **DISCUSSION**

43
44 In our study of elderly Medicare beneficiaries, we found that ED visits are increasingly
45
46 billed at the highest levels of intensity, with nearly 60% of ED visits in our sample coded at a
47
48 level 5 or as critical care in 2012, up from 46% in 2006. We found a concomitant increase in
49
50 services provided in the ED and during an associated inpatient stay. While overall admission rate
51
52 decreased over time, a greater fraction of ED visits resulted in admission to intensive care. We
53
54
55
56
57

1
2
3 found that trends in high intensity billing varied by clinical condition; diagnoses with the greatest
4 change in high-intensity billing also had the greatest increase in number of services. These
5 findings persisted when we repeated our analyses reclassifying observation claims as admissions.
6
7 Finally, using multivariable modeling, we found that trends in patient characteristics as well as in
8 services provided during the visit moderately accounted for the increase in practice intensity for
9 outpatient ED visits. If the process for determining high-intensity visits in 2012 were applied to
10 visits in 2006, we would have seen an additional 4.1% of outpatient visits and 13.6% of inpatient
11 visits coded as high-intensity. In other words, those additional increases were unexplained in our
12 model, and could potentially represent secular changes such as upcoding.
13
14

15
16 Our results are consistent with other work showing a growth in high-intensity emergency
17 care. A study of all ED visits in California²⁰ also demonstrated a growth in physician billing for
18 high-intensity visits, particularly among safety net hospitals. Other studies using national
19 datasets have documented greater use of tests and treatments in the ED such as advanced
20 imaging, blood tests, and IV fluids.^{15 16} Exploring the idea that doing more in the ED can prevent
21 hospitalizations, one study found that greater use of CT scans was associated with a reduction in
22 admissions and transfers.³¹ Our study adds to this literature by linking physician billing for high-
23 intensity emergency care to services provided during the ED visit for a national sample of
24 Medicare beneficiaries. Our findings suggest that the growth in high-intensity billing has been
25 accompanied by an observable increase in diagnostic and treatment intensity while admission
26 rates have fallen.
27
28

29
30 While prior studies have suggested that the fears of upcoding due to EHRs may not be
31 fully warranted,¹⁴ there has been concern that the trend in billing for high-intensity emergency
32 care may represent trends in coding rather than actual changes in practice. Using multivariable
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48

1
2
3 modeling, we found that observable factors such as patient characteristics and numbers of
4 services and procedures moderately explained, but did not fully account for, the trends in high-
5 intensity billing for outpatient visits. It is possible that part of the residual trend could be
6 attributed to upcoding; our study, however, is unable to identify conclusively whether this is the
7 case.
8
9
10
11
12
13

14 ED visits in the U.S. have continued to rise^{10 32-34} despite health insurance expansion and
15 cost control efforts that were predicted to reduce ED utilization. The role of emergency medicine
16 in the acute care landscape has also expanded,³⁵ with EDs assuming greater responsibility for
17 managing complex problems while reserving limited and costly hospital capacity for those truly
18 requiring inpatient care. With the growth of alternative payment models, reducing admissions
19 for ED patients with moderate severity problems has been proposed as a strategy to reduce
20 costs.³⁶ Our findings are consistent with this new model of emergency care. We found an
21 increase in services while admission rates fell, even after accounting for the growth in
22 observation stays. We found the greatest increases in high-intensity billing and services among
23 conditions with moderate baseline intensity such as pneumonia and intestinal infections, for
24 which the decision to admit likely involves greater provider discretion relative to higher acuity
25 conditions. While our study was not designed to assess the relationship between intensity of
26 emergency care and admission rate, it is possible that doing more for patients in the ED may
27 have allowed a greater number to be safely discharged. The rise in number of services, including
28 critical care procedures, provided during hospital admission suggests that the average acuity of
29 patients who ultimately are admitted may be increasing over time.
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50

51 Our study has a number of limitations. Given the use of administrative data, clinical
52 markers of acuity, such as vital signs and laboratory data, that may have been helpful in further
53
54
55
56
57
58
59
60

1
2
3 detailing any trends in patient acuity over time, were not available. Also, time spent observing
4 and treating patients is another key component of practice intensity that we could not measure
5
6 with our dataset and could potentially account for some of the remaining time trend in practice
7
8 intensity. Additionally, our modeling explained relatively little of the variation for inpatient visits
9
10 and ED visits overall. This is likely due to the fact that, unlike for outpatient visits, there is
11
12 substantially less detail in the dataset regarding services provided in the ED. Also, while
13
14 national in scope, our analysis is limited to elderly fee-for-service Medicare beneficiaries and
15
16 may not be generalizable to other populations.
17
18
19
20

21
22 In summary, the rise in billing for high-intensity emergency care has been portrayed as an
23
24 unintended consequence of the growth of health information technology rather than reflecting a
25
26 change in practice. However, this trend has been accompanied by an increase in the provision of
27
28 services in the hospital as well as in the ED. Multivariable modeling incorporating patient
29
30 characteristics, comorbidities, and services provided moderately explained the trends in high-
31
32 intensity billing. It is unclear the degree to which changes in coding practices explain the
33
34 remaining variation. This rise in high-intensity emergency care has occurred while rates of
35
36 admission from the ED have fallen, raising the possibility that a greater amount of work
37
38 performed in the ED may have allowed more patients to avoid inpatient treatment during an
39
40 acute episode. Further study may be useful in determining what impact the trend in high-
41
42 intensity emergency care has had on total costs of care as well as patient outcomes.
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

REFERENCES

1. Brill S. Bitter Pill: Why Medical Bills Are Killing Us. *Time*, 2013.
2. Boyd D. The Potential Impact of Alternative Health Care Spending Scenarios on Future and Local Government Budgets: Brookings Institute, 2014.
3. Orszag PR, Ellis P. The challenge of rising health care costs--a view from the Congressional Budget Office. *The New England Journal of Medicine* 2007;357(18):1793-5. doi: 10.1056/NEJMp078190
4. Auerbach DI, Kellermann AL. A decade of health care cost growth has wiped out real income gains for an average US family. *Health Affairs* 2011;30(9):1630-6. doi: 10.1377/hlthaff.2011.0585
5. Weinick RM, Burns RM, Mehrotra A. Many emergency department visits could be managed at urgent care centers and retail clinics. *Health Affairs* 2010;29(9):1630-6. doi: 10.1377/hlthaff.2009.0748
6. Baker LC, Baker LS. Excess cost of emergency department visits for nonurgent care. *Health Affairs* 1994;13(5):162-71.
7. Bamezai A, Melnick G, Nawathe A. The cost of an emergency department visit and its relationship to emergency department volume. *Annals of Emergency Medicine* 2005;45(5):483-90. doi: 10.1016/j.annemergmed.2004.08.029
8. Ostrom CM. State Medicaid program to stop paying for unneeded ER visits. *The Seattle Times* 2012 February 9, 2012.
9. Whitman E. Reducing Emergency Room Visits In Houston: Texas Firefighters Use Tablets To Connect Patients With Doctors, Not ERs. *International Business Times* 2015 April 9, 2015.
10. Skinner HG, Blanchard J, Elixhauser A. Trends in Emergency Department Visits, 2006-2011: Statistical Brief #179. Healthcare Cost and Utilization Project (HCUP) Statistical Briefs. Rockville (MD)2006.
11. Rui PK, K; Albert, M. . National Hospital Ambulatory Medical Care Survey: 2013 Emergency Department Summary Tables.
12. Levinson DR. Coding Trends of Medicare Evaluation and Management: Department of Health and Human Services, USA, 2012.
13. Abelson RC, J. ; Palmer, G. Medicare Bills Rise as Records Turn Electronic. *The New York Times* 2012 September 21, 2012.

- 1
2
3 14. Adler-Milstein J, Jha AK. No evidence found that hospitals are using new electronic health
4 records to increase Medicare reimbursements. *Health Affairs* 2014;33(7):1271-7. doi:
5 10.1377/hlthaff.2014.0023
6
- 7
8 15. Pitts SR, Pines JM, Handrigan MT, et al. National trends in emergency department
9 occupancy, 2001 to 2008: effect of inpatient admissions versus emergency department
10 practice intensity. *Annals of Emergency Medicine* 2012;60(6):679-86 e3. doi:
11 10.1016/j.annemergmed.2012.05.014
12
- 13
14 16. Pitts SR. Higher-complexity ED billing codes--sicker patients, more intensive practice, or
15 improper payments? *The New England Journal of Medicine* 2012;367(26):2465-7. doi:
16 10.1056/NEJMp1211315
17
- 18
19 17. Li P, Kim MM, Doshi JA. Comparison of the performance of the CMS Hierarchical
20 Condition Category (CMS-HCC) risk adjuster with the Charlson and Elixhauser
21 comorbidity measures in predicting mortality. *BMC Health Serv Res* 2010;10:245. doi:
22 10.1186/1472-6963-10-245
- 23
24 18. Frakt AB, Bagley N. Protection or harm? Suppressing substance-use data. *The New England*
25 *Journal of Medicine* 2015;372(20):1879-81. doi: 10.1056/NEJMp1501362
26
- 27
28 19. Kaskie B, Obrizan M, Cook EA, et al. Defining emergency department episodes by severity
29 and intensity: A 15-year study of Medicare beneficiaries. *BMC Health Serv Res*
30 2010;10:173. doi: 10.1186/1472-6963-10-173
- 31
32 20. Herring AA, Johnson B, Ginde AA, et al. High-intensity emergency department visits
33 increased in California, 2002-09. *Health Affairs* 2013;32(10):1811-9. doi:
34 10.1377/hlthaff.2013.0397
- 35
36 21. Wiler JL, Poirier RF, Farley H, et al. Emergency severity index triage system correlation
37 with emergency department evaluation and management billing codes and total
38 professional charges. *Acad Emerg Med* 2011;18(11):1161-6. doi: 10.1111/j.1553-
39 2712.2011.01203.x
40
- 41
42 22. McDermott K.W. EE, Sun R. Trends in Hospital Inpatient Stays in the United States, 2005-
43 2014: Healthcare Cost and Utilization Project, 2017.
- 44
45 23. Mullins PM, Goyal M, Pines JM. National growth in intensive care unit admissions from
46 emergency departments in the United States from 2002 to 2009. *Acad Emerg Med*
47 2013;20(5):479-86. doi: 10.1111/acem.12134
48
- 49
50 24. Uscher-Pines L, Pines J, Kellermann A, et al. Emergency department visits for nonurgent
51 conditions: systematic literature review. *Am J Manag Care* 2013;19(1):47-59.
- 52
53 25. Gabayan GZ, Derose SF, Asch SM, et al. Patterns and predictors of short-term death after
54 emergency department discharge. *Annals of Emergency Medicine* 2011;58(6):551-58 e2.
55 doi: 10.1016/j.annemergmed.2011.07.001
56
57
58
59
60

- 1
- 2
- 3 26. Cragg J. The Demand for Automobiles. *Canadian Journal of Economics* 1970;3:20.
- 4
- 5 27. Veall MR ZK. Pseudo-R2 Measures for Some Common Limited Dependent Variable
- 6 Pseudo-R2 Measures for Some Common Limited Dependent Variable
- 7 Models. *Journal of Economic Surveys* 1996;10(3):18.
- 8
- 9 28. Feng Z, Wright B, Mor V. Sharp rise in Medicare enrollees being held in hospitals for
- 10 observation raises concerns about causes and consequences. *Health Affairs*
- 11 2012;31(6):1251-9. doi: 10.1377/hlthaff.2012.0129
- 12
- 13 29. Zuckerman RB, Sheingold SH, Orav EJ, et al. Readmissions, Observation, and the Hospital
- 14 Readmissions Reduction Program. *The New England Journal of Medicine* 2016 doi:
- 15 10.1056/NEJMsa1513024
- 16
- 17 30. Venkatesh AK, Geisler BP, Gibson Chambers JJ, et al. Use of observation care in US
- 18 emergency departments, 2001 to 2008. *PLoS One* 2011;6(9):e24326. doi:
- 19 10.1371/journal.pone.0024326
- 20
- 21 31. Kocher KE, Meurer WJ, Fazel R, et al. National trends in use of computed tomography in the
- 22 emergency department. *Annals of Emergency Medicine* 2011;58(5):452-62 e3. doi:
- 23 10.1016/j.annemergmed.2011.05.020
- 24
- 25 32. Chen C, Scheffler G, Chandra A. Massachusetts' health care reform and emergency
- 26 department utilization. *The New England Journal of Medicine* 2011;365(12):e25. doi:
- 27 10.1056/NEJMp1109273
- 28
- 29 33. Pines JM, Mullins PM, Cooper JK, et al. National trends in emergency department use, care
- 30 patterns, and quality of care of older adults in the United States. *Journal of the American*
- 31 *Geriatrics Society* 2013;61(1):12-7. doi: 10.1111/jgs.12072
- 32
- 33 34. Trendwatch Chartbook: Trends Affecting Hospitals and Health Systems: American Hospital
- 34 Association, 2015.
- 35
- 36 35. Gonzalez Morganti K, Sebastian, B., Blanchard, J.C., Abir, M., Smith, A., Vesely, J.V.,
- 37 Okeke, E. N., Kellermann, A.L., Iyer, N. The Evolving Roles of Emergency
- 38 Departments. Santa Monica, CA: RAND Corporation, 2013.
- 39
- 40 36. Smulowitz PB, Honigman L, Landon BE. A novel approach to identifying targets for cost
- 41 reduction in the emergency department. *Annals of Emergency Medicine* 2013;61(3):293-
- 42 300. doi: 10.1016/j.annemergmed.2012.05.042
- 43
- 44
- 45
- 46
- 47
- 48
- 49
- 50
- 51
- 52
- 53
- 54
- 55
- 56
- 57
- 58
- 59
- 60

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)	
<i>All Admissions</i>	1.28	1.31	1.41	+0.02 (0.018 to 0.021)	<.001
<i>Low-Intensity</i>	1.22	1.25	1.37	+0.02 (0.017 to 0.025)	<.001
<i>High-Intensity</i>	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)	
<i>All Outpatient Visits</i>	7.11	8.05	8.60	+0.25 (0.25 to 0.26)	<.001
<i>Low-Intensity Outpatient Visits</i>	5.28	5.39	5.22	-0.008 (-0.01 to -0.003)	0.001
<i>High-Intensity Outpatient Visits</i>	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 R² 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.

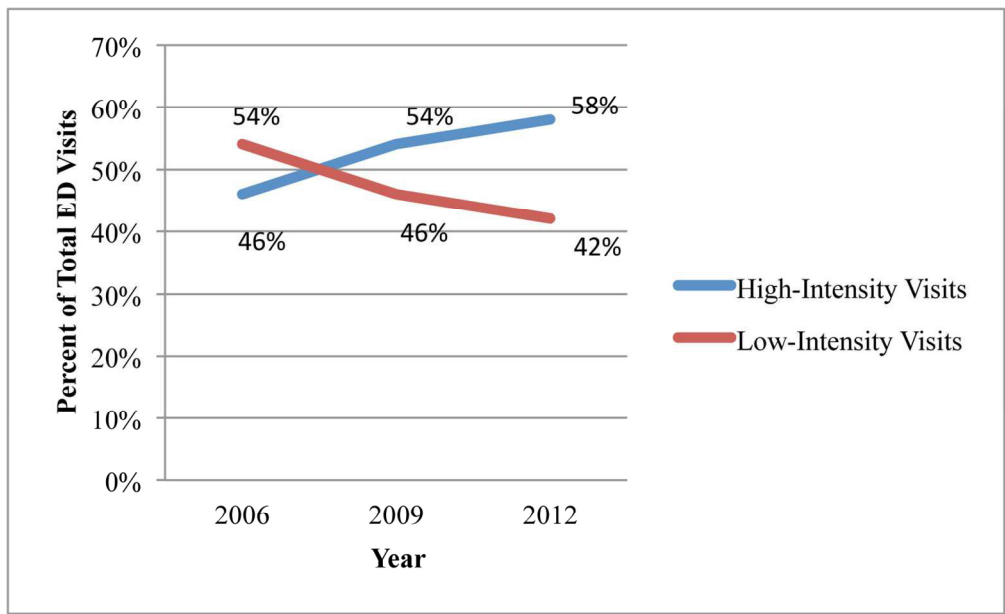
‡ High-intensity visits are coded as 99285 or critical care (99291, 99292). Low-intensity visits are defined by emergency physician billed CPT/HCPCS codes 99281-99284.

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.

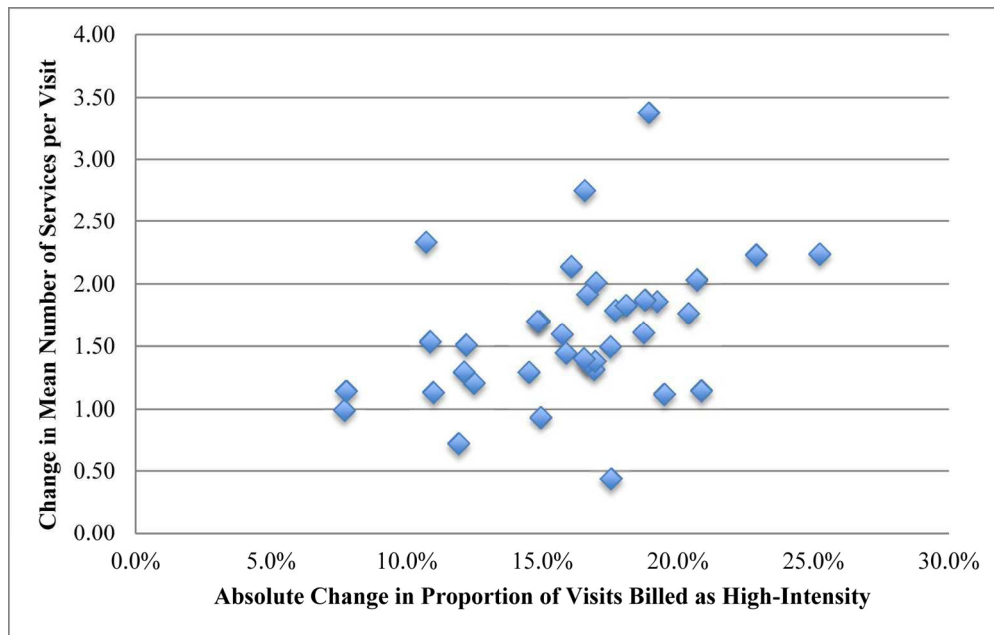
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60



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

127x77mm (300 x 300 DPI)

Review only



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)

view only

1
2
3
4
5
6 **Appendices for “Trends in High-Intensity Billing for Emergency Care Accompanied by an**
7
8 **Increase in Services Provided in the Emergency Department”**
9

10
11
12
13 **Appendix 1.** Proportion of Outpatient Emergency Department Visits Billed as High-Intensity
14 Visits by Diagnosis Category
15

16
17 **Appendix 2.** Trends in Billing* for High-Intensity Emergency Care
18

19 **Appendix 3.** Unadjusted Rate of Emergency Department Visits per 1,000 Medicare*
20 Beneficiaries Overall and Stratified by Intensity
21

22
23 **Appendix 4.** Trends* in the Most Common Services† among Admitted Patients
24

25 **Appendix 5.** Trends* in the Most Common Services† among Patients Discharged from the ED
26

27 **Appendix 6.** Ten Most Frequent Physician Services by Year
28

29
30 **Appendix 7.** Absolute Change in Proportion of High-Intensity Visits versus Baseline Proportion
31 of High-Intensity Visits by Diagnosis Category for Outpatient Emergency Department Visits
32

33 **Appendix 8.** Comparison of Observed versus Expected Number of High-Intensity Visits in 2006
34 Using Multivariable Modeling
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

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

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

1
2
3 † Categories defined by Gabayan, G.Z., et al *Annals of emergency medicine* 2011;58(6):551-58
4 e2). Category 36, pregnancy and childbirth related disorders, is omitted as it is not applicable to
5 the elderly, Medicare population.
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

For peer review only

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

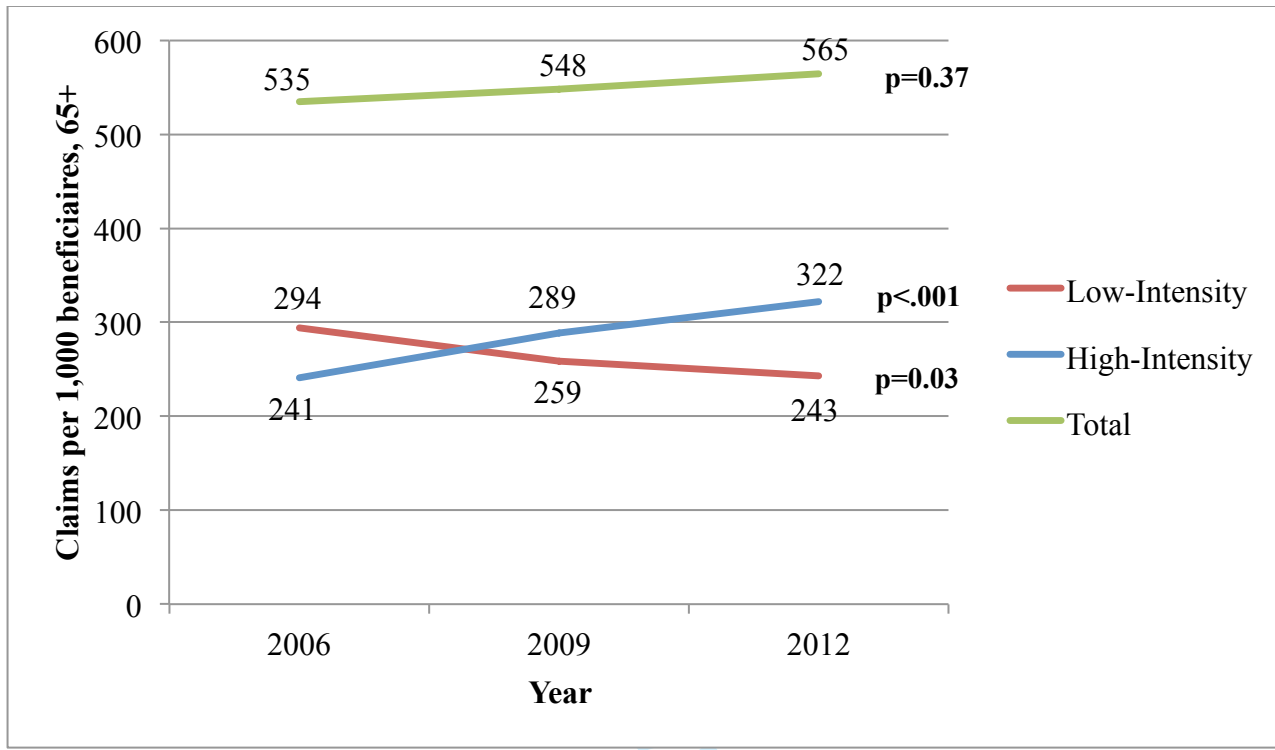
		2006	2009	2012	Trend, % change per year (95% CI)	P-Value
Proportion of ED Visits by Intensity Level CPT Code‡	99281	0.60%	0.40%	0.40%	-0.03 (-0.04 to -0.03)	<.001
	99282	3.70%	2.60%	2.00%	-0.30 (-0.31 to -0.29)	<.001
	99283	22.20%	17.50%	14.80%	-1.25 (-1.27 to -1.22)	<.001
	99284	27.10%	25.60%	24.70%	-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.

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

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.

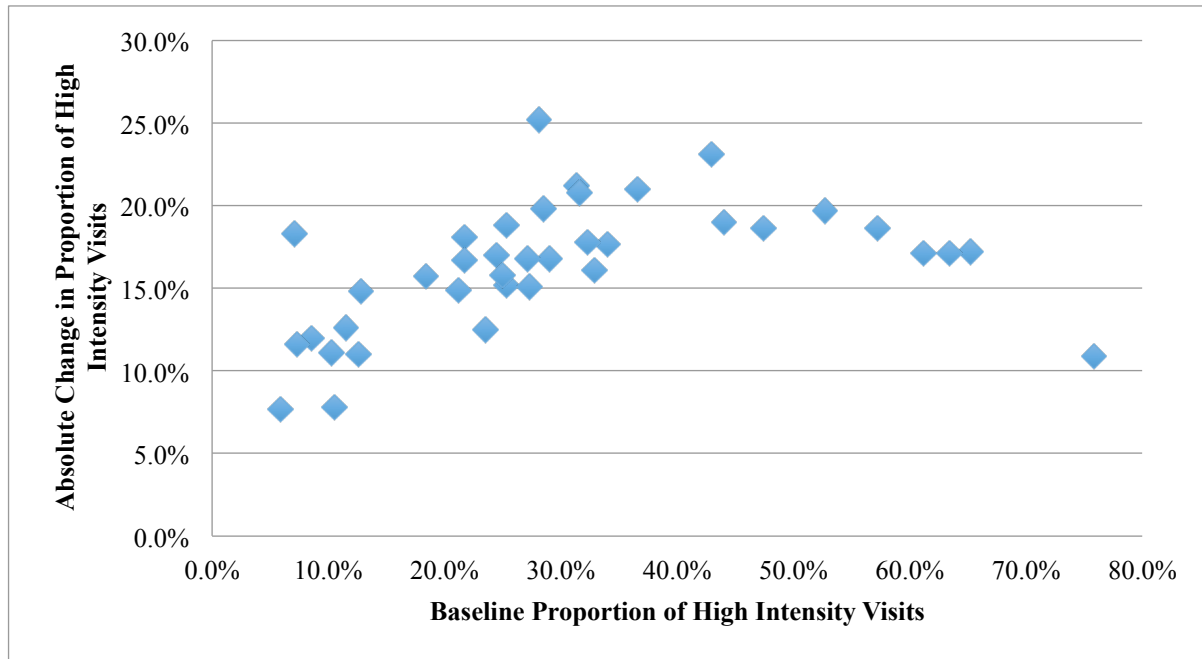
Appendix 6. Ten Most Frequent Physician Services* by Year for Emergency Department Visits

	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

	<i>Observed High-Intensity Visits 2006</i>	Using 2009 Regression Coefficients[†]		Using 2012 Regression Coefficients	
		<i>Predicted High-Intensity[‡]</i>	<i>Observed - Expected (%)</i>	<i>Predicted High-Intensity</i>	<i>Observed - Expected (%)</i>
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

Laura G. Burke, MD, MPH

Robert C. Wild, MS, MPH

E. John Orav, PhD

Renee Y. Hsia, MD, MSc

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	<i>Cross-sectional study</i> —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) <i>Cross-sectional study</i> —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) <i>Cohort study</i> —Summarise follow-up time (eg, average and total amount)
Outcome data	15*	<i>Cohort study</i> —Report numbers of outcome events or summary measures over time <i>Case-control study</i> —Report numbers in each exposure category, or summary measures of exposure <i>Cross-sectional study</i> —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).

1			
2	Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision.
3			Discuss both direction and magnitude of any potential bias
4			Limitations are outlined in the discussion (page 22).
5	Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity
6			of analyses, results from similar studies, and other relevant evidence
7			An interpretation and implications are discussed (pages 20-23).
8			
9	Generalisability	21	Discuss the generalisability (external validity) of the study results
10			The external validity of this study is discussed in the “Limitations” subsection (page 22).
11			
12	Other information		
13	Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable,
14			for the original study on which the present article is based
15			This study had no funding source.

Continued on next page