

Measuring Emergency Department Medical Care Spending in the US by Health Condition, Age,
Sex, and Payer, 2006-2015

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Abstract

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The emergency department (ED) plays a critical role in the US health care system, yet estimates surrounding ED health care spending are limited, and generally are unable to capture ED spending for patients who are ultimately admitted to the inpatient setting. We leverage the Nationwide Emergency Department Sample to disaggregate bundled ED and inpatient spending, and harmonize that data with existing methods measuring US health care spending to generate ED health care spending estimates, broken down by health condition, age and sex demographic group, and payer from 2006 to 2015. Health care spending in the ED, including care for both “treat and release” ED care as well as ED care resulting in admission to the inpatient setting, increased from \$68 billion in 2006 to \$132 billion in 2015. Of the \$132 billion of ED spending in 2015, \$67 billion (UI, \$66-\$67.9) or 50.7% (UI, 50%-51.5%) of total spending was spent by public insurance, \$59.9 billion (UI, \$58.9-\$60.9) or 45.4% (UI, 44.6%-46.1%) was spent by private insurance, and \$5.1 billion (UI, \$5-\$5.3) or 3.9% (UI, 3.8%-4%) was spent out-of-pocket. In 2015, the health conditions with the greatest amount of spending in the ED were falls (\$11.3 billion [UI, \$10.2-\$12.5]), urinary disease and male infertility (\$8.8 billion [UI, \$8.0-\$9.6]), and exposure to mechanical forces (\$8.8 billion [UI, \$7.7-\$10.2]). This study generates estimates for both total ED health spending and ED spending patterns by specific health condition, demographic information, and by payer, and these estimates provide valuable descriptive evidence on which future health policy discussions and research can be based.

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Introduction

The United States (US) spent \$3.5 trillion on health expenditures in 2017. Though this investment into health accounts for 18% of the nation's economy, there is an incomplete understanding of how health care spending is distributed across the different settings of care ("American Health Care," 2018). This is especially true in regard to spending in the emergency department (ED), which is of special interest to policymakers given its unique role in the healthcare system. The emergency room often functions as the only access point of healthcare for the most vulnerable in society and is mandated to provide stabilizing care to patients no matter their clinical situation or financial ability to pay for such care ("EMTALA Fact Sheet," n.d.). Further, it also often serves as a gateway for inpatient (IP) admissions, which can be costly ("Visiting an emergency department," n.d.). As the US works towards policy interventions that aim to improve health outcomes while reducing unnecessary costs, it is important to have robust health spending estimates, including for the ED, to guide value-based health care reform within each setting.

Although the ED plays an important role in the US healthcare system, ED spending estimates have varied widely, ranging from 2% to 15% of overall national health expenditure (Galarraga & Pines, 2016; Lee, Schuur, & Zink, 2013). While there is published literature on ED spending, the results are sparse and inconsistent, highlighting the challenges of measuring ED spending: national datasets are limited to only certain variables, there are numerous sources of data, which can often be expensive to ascertain consistently over time, data are often missing key variables, and data collection methods generate inconsistent time series. Additionally, data on patients who originated from the ED but are ultimately admitted to the IP setting are often bundled together for a single overall charge that is sent to the payer for the overall

hospitalization, making it difficult to disentangle health care spending that stems directly versus the ED.

The objective of this thesis is to estimate how much is spent in the ED, and how that health spending breaks down across health conditions, time, and demographic factors. Building upon previous work by Dieleman et al., this paper outlines a refined method for estimating health spending among hospital-based EDs in the US from 2006 to 2015, including how to account for bundled spending estimates when patients are admitted to the hospital through the ED (Dieleman et al., 2016).

Methods

Overview

This thesis analysis operates within the bounds of the previous framework presented by Dieleman et al. which measures personal health care spending from 1996 through 2013 (Dieleman et al., 2016). This analysis will leverage the existing methods used in the previous paper, but will differ in the following ways: 1) spending will be measured from 2006 to 2015, 2) spending will be disaggregated into an additional payer measurement (either public, private, or out-of-pocket, and 3) the method for measuring ED spending will be iterated and improved upon to address previously known limitations. While these changes exist, this analysis draws strength on the robust methods introduced previously, including novel redistribution and comorbidity processes, as well as adjustments accounting for charges-to-payments and facility-to-total ratios (Dieleman et al., 2017).

Data

National Emergency Department Sample (NEDS)

NEDS is produced by the Healthcare Cost and Utilization Project, and “is the largest all-payer emergency department (ED) database in the United States, yielding national estimates of hospital-based ED visits” (“NEDS Overview,” n.d.). NEDS draws from a sample of approximately 20-percent of US hospital-based EDs, and is nationally representative when the provided weights are applied. NEDS is a large dataset, with over 32 million ED encounters sampled in year 2016 alone. NEDS data are available from years 2006 through 2016, although this analysis focuses on years 2006 through 2015. While years prior to 2015 is coded entirely in International Classifications of Diseases (ICD) 9 and year 2016 is coded in ICD10, year 2015 has three-quarters of its data coded in ICD9 and the last quarter of its data coded in ICD10. ICD

coding provides guidelines for how diseases are classified and how encounters are billed in the hospital setting (“An Overview of ICD-10-CM,” n.d.). The transition in ICD version provides an additional barrier to ensure consistency estimates for health conditions, while working with a coding system that changed within the time series. Regarding key variables related to healthcare expenditures, NEDS is limited in that it reports ED charges and not payments, and includes facility charges but not physician charges. In spite of these limitations, a critical strength of NEDS is that the dataset provides both an ED charge variable as well as an overall bundled ED and IP charge for those patients who are admitted to the hospital through the ED.

National Inpatient Sample (NIS)

NIS is similar to NEDS in many ways, as both datasets are produced by the Healthcare Costs and Utilization Project and follows the same ICD-coding conventions (e.g. 2015 is split between ICD9 and ICD10), is also nationally representative, and also report charges instead of payments, and do not include physician charges. While NEDS represents the largest ED database, NIS represents the largest IP database. NIS retains a large sample size, and once weighted, the dataset represents more than 97 percent of the US population. In year 2016, NIS had just over 7 million IP encounters sampled. NIS is available for years 1988 through 2016, although this particular analysis is focused on years 2006 through 2016 since NEDS data are only available starting in 2006. While there is a variable in NIS variable describing if care originated in the ED or IP, the charges are not disaggregated (Healthcare Cost and Utilization Project (HCUP) & Agency for Healthcare Research and Quality, 2012).

Medical Expenditure Panel Survey (MEPS)

The MEPS dataset is produced by the Agency for Healthcare Research and Quality and is a “set of large-scale surveys of families and individuals, their medical providers, and employers

across the US,” from 1996 through 2016 (“Medical Expenditure Panel Survey Background,” n.d.). MEPS reports a single charge for ED encounters, regardless of whether or not they resulted in hospital admissions. Thus, using only a combination of MEPS and NIS data does not provide enough information to allow for disaggregation of ED and IP bundled charges. However, the bundled charges can be disaggregated with the introduction of NEDS. Additionally, MEPS has many strengths. First, since NEDS reports only on charges and MEPS reports on both charges and payments, MEPS data can be used to inform this project’s “charges-to-payments” adjustment. Second, because NEDS does not include physician charges, and MEPS includes both physician and facility charges, the MEPS data can be used to run a “facility-to-total” adjustment.

National Health Expenditure Account

The National Health Expenditure Accounts are created by the Centers for Medicare & Medicaid Services and they are the official estimates of total health care spending in the US (*Quick Definitions for National Health Expenditure Accounts (NHEA) Categories*, n.d.). The National Health Expenditure Accounts measures personal health care spending by type of service (e.g. hospital care, dental services, and home health).

Measuring ED spending

Measuring total ED spending

To measure total ED spending, we rely on the National Health Expenditure Account. While the National Health Expenditure account allows policymakers to have an overall sense of total health care spending in the US, it is not a granular resource and its aggregation of services does not allow for specific estimates of ED spending. Instead, the National Health Expenditure Account provides spending for “hospital care” and “physician and clinical services.” Both of these types of care (hospital as well as physician and clinical services) contribute to ED, IP, and

outpatient/ambulatory medicine spending, and thus must be split from the two categories provided by the National Health Expenditure Account to the three categories of interest: ED, IP and ambulatory spending. Because the MEPS data includes data by the three types of care of interest, we are able to use the MEPS data for the ED, IP and ambulatory panels to create fractions and redistribute the spending from the National Health Expenditure Account categories to ED, IP and ambulatory spending totals. Because MEPS provides a single charge for patients whose care originated in the ED and were ultimately admitted, we attributed these bundled charges entirely to the IP total, and then used Equation 1 using NEDS data to create robust estimates for total ED and IP spending:

$$\text{Equation 1: } \frac{ED_{total (adjusted)}}{ED_{total (unadjusted)}} = \frac{NEDS_{(ED \text{ from discharged patients} + ED \text{ from admitted patients})}}{NEDS_{ED \text{ from discharged patients}}}$$

Because the right hand side of Equation 1 is always greater than 1, the total ED spending after adjustment will always increase, and takes into account the ED spending for those who were ultimately admitted. To ensure that total health care dollars were not being created or deleted, it is necessary to move money away from the total IP spending, which can be done by subtracting the amount that was added to the total ED spending from the total IP spending. Equation 2 calculates the new total for IP spending (i.e., the proportion of overall the National Health Expenditure Account personal health spending that is attributable to the IP setting):

Equation 2:

$$IP_{total (adjusted)} = IP_{total (unadjusted)} - (ED_{total (adjusted)} - ED_{total (unadjusted)})$$

This ensures that the total spending remains unchanged (net balance of \$0), while the estimate for total ED spending increases and the estimate for total IP spending decreases.

Measuring the proportion of ED spending in bundled ED and IP charges

Since the NIS dataset provides one overall charge for the event hospitalization - regardless of where care originated from – it would be inaccurate to either include or exclude data that originated in the ED for IP health expenditure estimates. Previous methods by Dieleman et al., attributed these bundled charges to IP spending (Dieleman et al., 2016). Thus, we know that previous IP spending is actually an overestimate (since it is known that patients admitted to the hospital through the ED are being entirely bundled into IP spending), thereby making ED estimates artificially deflated. To account for this and estimate the proportion of spending that should be attributed to the ED in these bundled charges, we leveraged the NEDS dataset. NEDS includes two separate variables for charges: 1) charges incurred in the ED only, and 2) bundled charges in the ED and IP settings of care. By combining these two NEDS variables, we can generate scalars that are representative of the proportion of spending in the ED for patients who started in the ED and were ultimately admitted. Equation 3 generates these scalars and will be calculated by health condition, age, sex, and year:

$$\text{Equation 3: } \frac{\text{ED charges only from NEDS}}{\text{ED and IP bundled charges from NEDS}} = \frac{x}{\text{ED and IP bundled charges from NIS}}$$

where x represents the ED charge from the ED and IP bundled NIS charge.

Adjusting ED data and scaling

Once we have the total ED charge for each ED and IP bundled charge by health condition, age, sex, and year, we must apply these scalars to our existing dataset. To do this, we must determine the total amount of charges should be attributable to the ED that is originally attributed to the IP setting of care. Leveraging previous estimates, Equation 4 generates adjusted ED estimates:

$$\text{Equation 4: } ED_{adjusted} = ED_{unadjusted} + \left(\frac{NIS_{ED+IP} \text{ bundled charges}}{NIS_{ED+IP} \text{ all charges}} * \frac{NEDS_{ED} \text{ bundled charges}}{NEDS_{ED+IP} \text{ bundled charges}} \right),$$

and this equation will be applied by health condition, age, sex, and year. After adjusting the ED estimates to include the proportion spent in ED for each ED and IP bundled charge, we will scale our final estimates to total ED spending by year.

Limitations

This study is an observational, secondary analysis using data that was previously collected by different groups. Neither NIS, MEPS, nor NEDS represent a census of all possible encounters with hospitals, but instead are samples and surveys, indicating that the data are only as robust as the survey methods and sampling techniques. Due to its survey design and reliance on speaking with individuals about their experiences with healthcare after their visits, MEPS is subject to selection bias, response bias, and recall bias. We acknowledge this by completing every step at 100 draws to include uncertainty with our estimations. While the data are nationally representative, there are known limitations, such as MEPS excluding institutionalized people in their study design (Lee et al., 2013). Because they systematically exclude a sub-population of patients, this brings into the question of generalizability. We address this by introducing NEDS to create our scalars, as NEDS is a much larger data set. As far as nationally representative samples of hospital data, NEDS and NIS are two of the most robust and comprehensive samples that exist. A potential improvement to this analysis in an effort to include as much data as possible is to incorporate and use MarketScan claims data (“IBM MarketScan Research Databases - Overview - United States,” 2019).

Results

Total ED spending over time

Total ED spending, inclusive of spending on ED services provided to patients who were ultimately admitted, was \$78 billion in 2006 and increased to \$132 billion in 2015. Figure 1 depicts total ED spending over time before and after the proportion of ED bundled spending bundled with IP spending for patients who were admitted. Between 2006 and 2015, ED spending for patients ultimately admitted to the hospital averaged \$7.9 billion, or 7.6% of total ED spending.

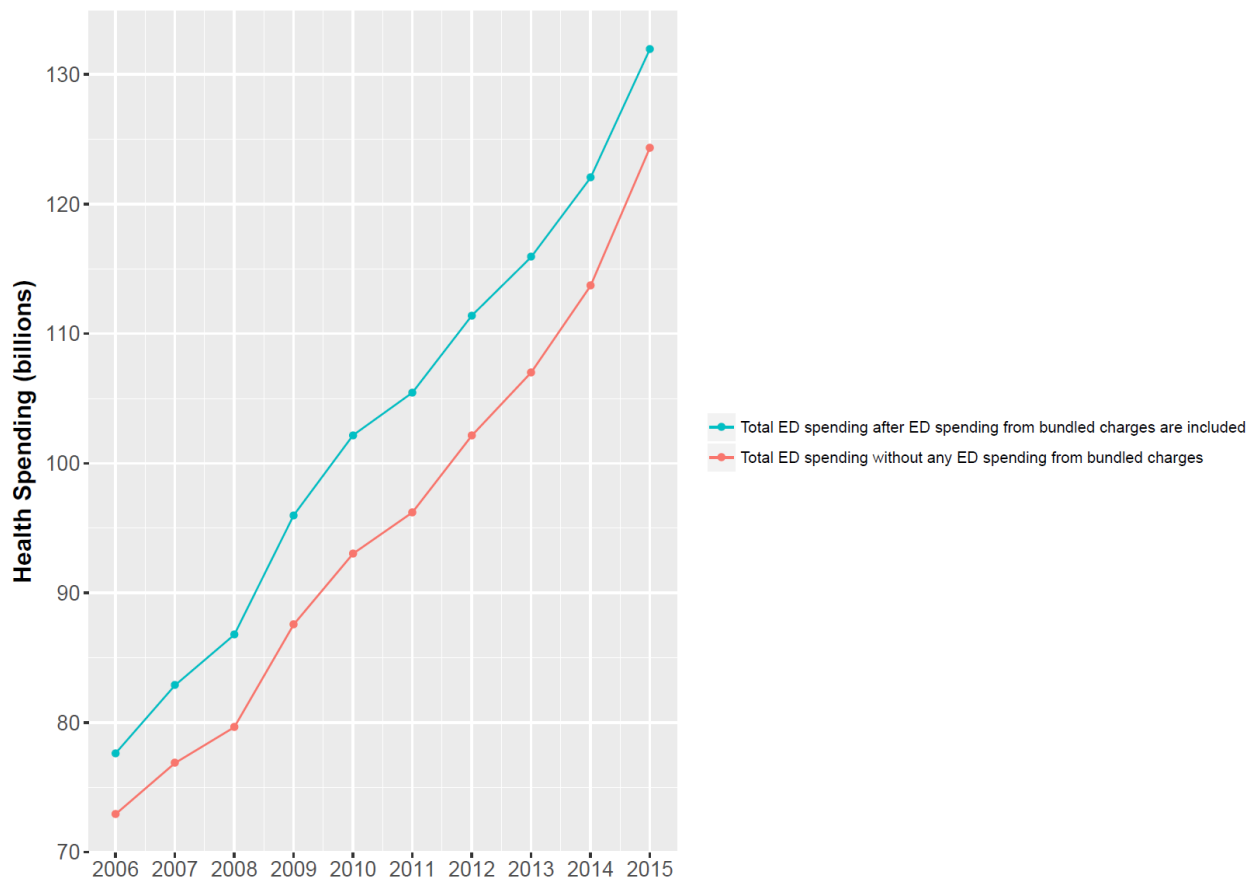


Figure 1: Total ED health care spending over time. The red line shows total ED spending without any ED spending from bundled charges, and the blue line shows total ED spending after ED spending from bundled charges are included.

Health care spending by payer, age, and health condition; 2015

Figure 2 shows that of the \$132 billion of ED spending in 2015, \$67 billion (UI, \$66-\$67.9) or 50.7% (UI, 50%-51.5%) of total spending was spent by public insurance, \$59.9 billion (UI, \$58.9-\$60.9) or 45.4% (UI, 44.6%-46.1%) was spent by private insurance, and \$5.1 billion (UI, \$5-\$5.3) or 3.9% (UI, 3.8%-4%) was spent out-of-pocket. There was great variability in the fraction of ED spending across the out-of-pocket group by age group, ranging from 0.9% (UI, 0.8%-1.1%) for the 0-1 age category to 10.1% (UI, 9.6%-10.5%) for the 25-30 age category. Across health categories, falls was the aggregated health category with the largest fraction of the spending coming from public insurance (3.8% [UI, 3.2%-4.5%]). Exposure to mechanical forces (which includes injuries from noise, firearms, and falling objects) was the health condition with the largest fraction of the spending coming from private insurance (4.5% [UI, 3.9%-5.8%]). Urinary diseases and male infertility (which includes emergency conditions such as testicular torsion and complications associated with urinary tract infections and the passing of kidney stones) was the health condition with the largest fraction of the spending coming from out-of-pocket insurance (0.3% [UI, 0.2%-0.4%]).

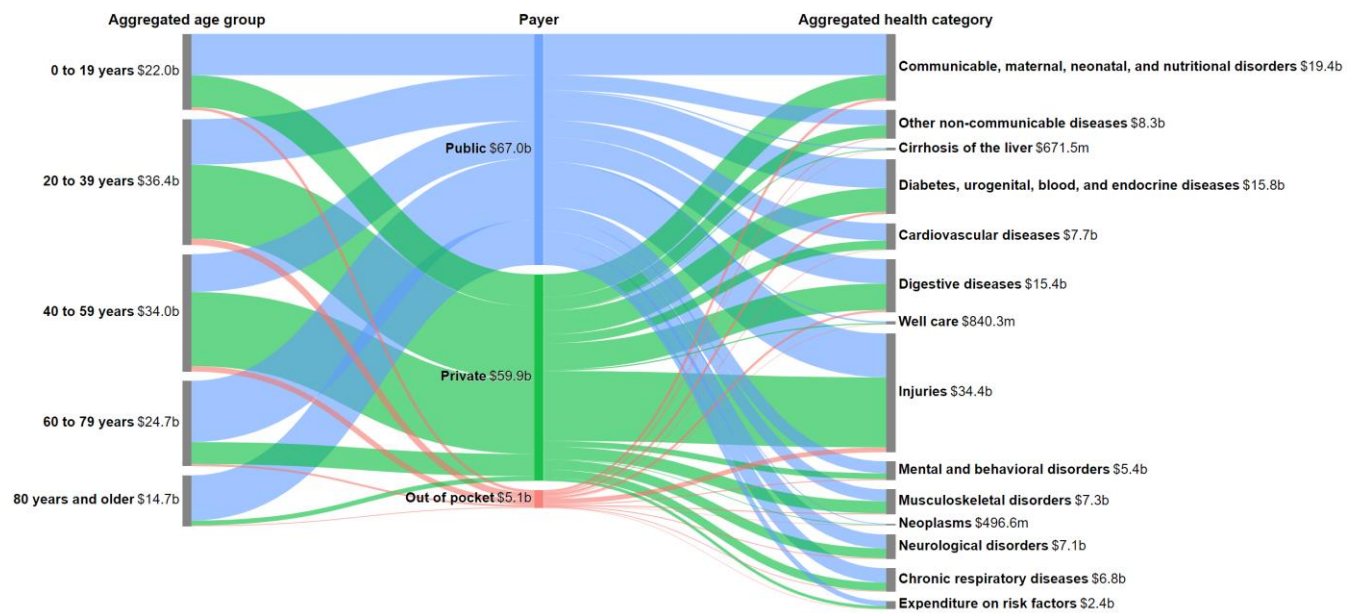


Figure 2: Sankey diagram tracking the flow of 2015 ED health care spending by aggregated age group, payer, and aggregated health category. Blue represents spending paid for by public insurance, green represents spending paid for by private insurance, and red represents spending paid for by out-of-pocket.

Health care spending by payer and health condition; 2015

In 2015 in the ED (for both treat and release as well as admitted patients), more spending was on falls than any other health condition. Falls accounted for \$11.3 billion (UI, \$10.2-\$12.5) of spending and in terms of payer group, 44.1% (UI, 38.9%-49.9%) was from public insurance, 52.5% (UI, 46.9%-58.4%) was from private insurance, and 3.3% (UI 2.4%-4.6%) was out-of-pocket. Urinary diseases and male infertility had the second most amount of health care spending in 2015, with \$8.8 billion (UI, \$8.0-\$9.6). 46.8% (UI, 38.0%-56.8%) of urinary diseases and male infertility was from public insurance, 48.3% (UI, 38.4%-57.8%) was from private insurance, and 4.9% (UI 3.4%-6.2%) was out-of-pocket. Exposure to mechanical forces, skin and subcutaneous diseases, road injuries were the third, fourth, and fifth health conditions with the most ED spending in 2015, with \$8.8 billion (UI, \$7.7-\$10.2), \$6.3 billion (UI, \$5.7-\$6.8), and \$5.2 billion (UI, \$4.5-\$6.1), respectively.

The health conditions accounting for the greatest public insurance ED spending were falls, urinary diseases and male infertility, and skin and subcutaneous diseases, with \$5 billion (UI, \$4.3-\$5.9), \$4.1 billion (UI, \$3.3-\$4.9), and \$2.9 billion (UI, \$2.3-\$3.9) spending respectively. The health conditions seen in the ED accounting for the greatest private insurance spending were exposure to mechanical forces, falls, and urinary diseases and male infertility, with \$6 billion (UI, \$5.1-\$7.7), \$6 billion (UI, \$5.1-\$7), and \$4.3 billion (UI, \$3.2-\$5.3) spending respectively. The health conditions with the most out-of-pocket insurance spending were urinary diseases and male infertility, exposure to mechanical forces, and falls, with \$433.4 million (UI, \$310.1-\$546.5), \$383.5 million (UI, \$295.8-\$511.9), and \$378.2 million (UI, \$280.4-\$518.9) spending respectively.

ED estimates on discharged vs. admitted patients by health condition

Our analysis is able to disaggregate bundled ED and IP charges for those whose care originate in the ED and are ultimately admitted. As an intermediate step, we generate the proportion that should be attributed to the ED by health condition and demographic factors, which provides insight on the synergy between care within the ED and IP settings. The health conditions that were most affected by the addition of the ED portion of bundled charges were septicemia, heart failure, and chronic obstructive pulmonary disease with an additional \$4.3 billion (UI, \$3.54-\$5.01), \$1.5 billion (UI, \$1.3-\$1.7), and \$1.1 billion (UI, \$0.8-\$1.4) absolute amount of spending, respectively. The health conditions with the greatest percentage change were other nutritional deficiencies, protein-energy malnutrition, and septicemia with an additional 41334.2% (UI, 16682.7%-109967.8%), 31663.6% (UI, 13021.3%-89610.8%), and 14429.4% (UI, 3298.6%-37586.5%), respectively. Table 1 highlights the top 20 health conditions with either the greatest absolute amount of change.

Table 1. ED spending before and after adjusting for bundled charges for the top 20 health conditions with the greatest absolute change.

Health condition	ED spending before adjustment (millions)	ED spending after adjustment (millions)	Change (millions)
Septicemia	55.8	4356.4	4300.5
Heart Failure	703.9	2168.8	1464.8
Chronic obstructive pulmonary disease	1306.9	2389.0	1082.1
Appendicitis	111.7	1158.4	1046.6
Road injuries	4173.3	5217.2	1043.9
Ischemic heart disease	944.6	1954.7	1010.1
Acute renal failure	58.7	977.5	918.8
Cerebrovascular disease	384.9	1279.6	894.6
Diabetes mellitus	638.7	1501.0	862.3
Paralytic ileus and intestinal obstruction	258.0	1117.8	859.8
Diarrheal diseases	366.0	1175.3	809.3
Pancreatitis	145.7	951.0	805.2
Self-harm	179.3	905.6	726.2
Gallbladder and biliary diseases	1186.7	1883.0	696.2
Alcohol use disorders	919.8	1490.7	570.9
Atrial fibrillation and flutter	614.6	1170.2	555.6
Iron-deficiency anemia	221.8	687.3	465.5
Peptic ulcer disease	112.3	529.3	417.0
Cirrhosis of the liver	303.3	671.4	368.0
Bipolar disorder	147.1	490.9	343.7

Discussion

This study estimated health care spending from three payers, on 154 health conditions and 38 age and sex groups in the ED, from 2006 to 2015. The strength of this study compared to existing literature is we measured total spending in the ED, inclusive of spending on patients who were ultimately admitted, and compared the ED spending for patients who were discharged from the ED versus those who were admitted. These estimates provide valuable descriptive evidence on which future health policy discussions and research can be based.

In 2015, total health spending in the ED was \$132 billion, which represents 4.4% of national health expenditure. This finding is within range of prior literature on the topic of ED spending in the US. Specifically, Galarraga and Pines estimated ED spending at 12.5% of national health expenditure; however, this was felt to be an overestimate as they technically estimated ED episodes of care (patients who started in the ED and admitted to the hospital) and their result included both ED and IP bundled spending for the entire hospitalization (Galarraga & Pines, 2016). Prior to this work, the well-known “Just 2% campaign” from the American College of Emergency Physicians states that health spending in the ED accounts for 2% of national health expenditure (American College of Emergency Physicians, 2011). However, the 2% is derived solely from MEPS data which has been shown to under-estimate ED volume and spending (Owens et al., 2010). In 2010, the National Hospital Ambulatory Medical Care Survey estimated 129.8 million ED visits, which was higher than the MEPS estimate, at 48.9 million (“NAMCS/NHAMCS - Web Tables,” 2017). Finally, Lee et al., adjusted for bundled health spending data by creating spending ratios between admitted and discharged patients. However, these ratios were not informed by data directly measuring health spending. Instead, they used the ED Evaluation and Management data set and proxy indicators to create their fractions (Lee et al., 2013). Using these proxy indicators, Lee et al. found ED spending to be 5.0%-5.2% of national

health expenditure. While previous research provides a foundation for ED health spending estimates, this current study presents the most contemporary estimates for ED health spending and across an array of health conditions and demographic groups. These robust estimates have been adjusted for bundled charges, and build upon the foundation presented by Dieleman, et al., which already account for comorbidity and apply charges-to-payment and facility-to-total adjustments.

In addition to providing the descriptive evidence regarding total ED spending over time, these estimates are disaggregated by health condition, demographic factors, and payer information. Understanding the ED health spending patterns by specific health condition allows for important hypothesis generation for why variation might exist across conditions and build meaningful interventions for promoting greater value-based care. For example, our findings highlight that in 2015, there was more health care spending on falls, urinary diseases and male infertility (which includes emergency conditions such as testicular torsion and complications due to urinary tract infections), exposure to mechanical forces, skin and subcutaneous diseases, and road injuries than other health conditions in the ED. The age group with the most health care spending in the ED are those ages 25-30, and women accounted for 54.8% of all health spending in the ED. While we understand that falls, exposure to mechanical forces, and road injuries may be more difficult to prevent, how can we decrease the amount of spending on skin and subcutaneous diseases and urinary diseases and male infertility? Knowing that young adults are spending the most in hospital EDs, how can we design financial systems that protect them from catastrophic spending, and how can we build efficient insurance models for young adults?

Finally, this study provides the critical foundation for building effective ED policies and the broader US health system. The US spends more on healthcare than any other country, yet

performs below par on critical health outcomes (Anderson & Poullier, 1999; Reinhardt, Hussey, & Anderson, 2004; Squires & Anderson, 2015). The ED plays a pivotal role in our expensive healthcare system, thus having a better sense of how much spending is attributable to this setting of care will be helpful to inform ongoing and future policy discussions. Whether our finding that 4.4% of national health expenditure being spent in the ED is considered too much or too little, it is important to have a better sense of what this number is and how it appears to be changing over time. As our healthcare system evolves, we will constantly be thinking about how to divide, shrink, and change the pie that represents total healthcare spending. However, in order to make evidence-driven decisions, we must first understand the current state of the pie. Health spending in the ED is a small percentage of national health expenditure and the ED provides critical services. When trying to change health spending in the ED, it is imperative that we understand the spending patterns broken down by health condition, demographic factors, and payer. This study offers the descriptive evidence that is necessary, yet has been previously lacking, for engaging future policy discussions, spurring advocacy, and catalyzing important research.

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