Infectious Disease–Related Emergency Department Visits of Elderly Adults in the United States, 2011–2012

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OBJECTIVES: To investigate the frequency of infectious disease (ID)-related emergency department (ED) visits of elderly adults in the United States.

DESIGN: Cross-sectional analysis.

SETTING: Nationwide emergency department sample in 2011–12.

PARTICIPANTS: Individuals in the ED aged 65 and older with a primary diagnosis of an ID.

MEASUREMENTS: ID-related ED visits, hospitalizations, hospital-based mortality.

RESULTS: During 2012, a weighted estimate of 3,123,909 ED visits for IDs was calculated in elderly U.S. adults. This accounted for 13.5% (3.1 million visits) of all ED visits of elderly adults; this burden was higher than that for myocardial infarction and congestive heart failure combined. The rate of ID-related ED visits was 7,231 per 100,000 elderly adults. The most-common diagnoses were lower respiratory infections (26.2%; 95% confidence interval (CI) = 25.7–26.6%), urinary tract infections (25.3%, 95% CI = 25.0–25.7%), and septicemia (18.9%, 95% CI = 18.3–19.6%). Of all ID-related ED visits, 1,786,657 (57.2%, 95% CI = 56.6–57.7%) resulted in hospitalization. The leading cause of hospitalization was septicemia, accounting for 32.2% (95% CI = 31.1–33.3%) of all ID-related hospitalizations through EDs, followed by lower respiratory infections (27.8%, 95% CI = 27.2–28.4%). Overall, 123,894 individuals (4.0%, 95% CI = 3.8–4.1%) died during their ED visit or hospitalization. Of these, septicemia was the leading cause of mortality (74.7%, 95% CI = 73.8–75.6%), followed by lower respiratory infections (15.2%, 95% CI = 14.6–15.9%). Analysis of the 2011 data gave similar results for the burden of ID-related ED visits, hospitalizations, and mortality.

CONCLUSION: Using a nationally representative sample, it was found that the public health burden of IDs in elderly U.S. adults was substantial, as measured by ED visits, subsequent hospitalizations, and hospital-based mortality. J Am Geriatr Soc 2015.

Key words: infectious disease; emergency department; hospitalization; mortality; elderly

Although mortality associated with infectious diseases (IDs) in elderly adults declined dramatically over the 20th century,† IDs remain a major public health burden in the United States; pneumonia, influenza, and septicemia remain the leading causes of mortality in this population.‡ Furthermore, the financial burden of IDs is substantial—for example, pneumonia and septicemia alone accounted for a direct cost of more than $30 billion in 2011.§ In this context, the federal government identified reduction of ID-related morbidity and mortality as a national objective in Healthy People 2020.¶ Quantification and characterization of the epidemiological features of IDs are important to improve national surveillance, prevention, and treatment strategies.

Most epidemiological research on IDs in elderly U.S. adults has focused on hospitalized individuals or on specific diseases.† † For example, a study estimated 21 million ID-related hospitalizations of elderly U.S. adults from 1990 through 2002, with an upward trend in hospitalization rate, but focusing solely on hospitalizations may discount the importance of the upstream ED visits and thereby underestimate the true public health burden. Despite the public health and policy importance, to the best of the authors’ knowledge, there has been no epidemiological research on ID-related ED visits as a whole of elderly U.S. adults.

To address this knowledge gap, a nationally representative ED visit database was used to quantify the rate of...
ID-related ED visits and subsequent hospitalizations and hospital-based mortality in elderly adults.

METHODS

Study Design and Settings

This is a serial cross-sectional analysis using data from the 2011 and 2012 releases of the Nationwide Emergency Department Sample (NEDS), a nationally representative sample of all hospital-based EDs in the United States, which is defined by the American Hospital Association as all nonfederal, short-term, general, and other specialty hospitals. The NEDS is a component of the Healthcare Cost and Utilization Project (HCUP) sponsored by the Agency for Healthcare Research and Quality and constructed annually using records from state emergency department databases and state inpatient databases. The state emergency department databases capture information on ED visits that do not result in a hospitalization (treat-and-release visits or transfers to another hospital), and the state inpatient databases contain information on individuals initially seen in the ED and then hospitalized in the same hospital. Taken together, the resulting NEDS data set represents all ED visits regardless of disposition and contains information on short-term outcomes for individuals hospitalized through the ED. In 2012, the NEDS represented an approximately 20% stratified sample of U.S. hospital-based EDs, containing 31.1 million records of ED visits from 950 hospitals and providing nationally representative data on approximately 134 million ED visits. Additional information regarding the NEDS can be found elsewhere.

Study Population

ED visits for individuals aged 65 and older who had an International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) code for an ID in the primary diagnosis field (the first listed diagnosis on the record) were eligible for analysis. IDs were defined using a previously described classification scheme for ICD-9-CM codes. In addition to overall ID-related ED visits, 19 mutually exclusive ID subgroups were examined. (See Table S1 for corresponding codes.) The following ID subgroups were used for subgroup-specific analyses: viral central nervous system infections; meningitis; upper respiratory infections; lower respiratory infections (including pneumonia (ICD-9-CM code 486) and influenza (ICD-9-CM codes 487 and 488)); infections of the heart; enteric infections; abdominal and rectal infections; hepatobiliary infections; urinary tract infections (UTIs); infections of female pelvic organs; infections involving bone; cellulitis; mycoses; septicemia; human immunodeficiency virus and acquired immunodeficiency syndrome; tuberculosis; infections due to internal prosthetic devices, implants, and grafts; postoperative infections; and viral infections not otherwise specified. ED visits with primary diagnosis codes of symptoms (e.g., fever) or inadequately defined diagnosis codes (e.g., diarrheal diseases not otherwise specified) were not defined as ID-related ED visits. The institutional review board of Massachusetts General Hospital classified this analysis of deidentified data as exempt.

Measured Variables

The NEDS includes information on demographic characteristics (e.g., age, sex), ED visit month, diagnoses, ED disposition, and hospital disposition. Primary insurance types were categorized as public (Medicare and Medicaid), private, self-pay, and no change or other. The NEDS also includes hospital characteristics, such as geographic region (Northeast, South, Midwest, and West), which were defined according to Census Bureau boundaries.

Statistical Analyses

The primary outcome measures were ID-related (overall and subgroups) ED visits, hospitalizations through the ED, and hospital-based mortality. The frequencies of these outcomes were estimated using sampling weights. Records for ID-related ED visits were examined according to age (65–74, 75–84, ≥85), sex, hospital region, and ED visit month. The rate of ID-related ED visits and subsequent hospitalizations (overall and subgroups) per 100,000 U.S. elderly adults of the corresponding age group per year (along with 95% confidence intervals (CIs)) was also computed, with the 2012 population estimates obtained from the U.S. Census Bureau as denominator. Hospital-based mortality was computed by dividing the number of ED and inpatient any-cause deaths by the number of ID-related ED visits.

First, the analysis was conducted using data from the 2012 NEDS. Next, this analysis was repeated using data from the 2011 NEDS to assess the consistency of the results in the different years. To obtain proper variance estimations that accounted for the complex sampling design, all analyses used SAS-callable SUDAAN version 11.0 (Research Triangle Institute, Research Triangle Park, NC), and 95% CIs incorporated the standard errors estimated using SUDAAN. Because no unique patient identifiers were provided with ED records, the unit of analysis for the study was an ED visit. If the number of unweighted observations in a stratum was 10 or less, the national estimates were considered to be unreliable and were not presented, according to the HCUP recommendations.

RESULTS

Characteristics of ID-Related ED Visits

In 2012, there was a weighted estimate of 3,123,909 ED visits for IDs in elderly U.S. adults (Table S2), which accounted for 13.5% of all U.S. ED visits of elderly adults. The proportion admitted to hospital was higher in the ID group (18.5%) than the non-ID group (13.4%) (P < .001). Likewise, hospital-based mortality was higher in the ID group (0.82%) than the non-ID group (0.44%) (P < .001). The proportion of ID-related ED visits increased with patient age (65–74, 12.3%; 75–84, 13.7%; ≥85, 15.5%). The rate of overall ID-related ED visits was 7,231 visits per 100,000 elderly adults (Table 1). Individuals aged 85 and older had the highest rate (13,770 visits per 100,000
elderly adults). In the analysis using the 2011 data, there was a weighted estimate of 3,102,246 ED visits for IDs in elderly U.S. adults, accounting for 13.5% of all U.S. ED visits of elderly adults. The rate of overall ID-related ED visits was 7,918 visits per 100,000 elderly adults.

**ED Visits by ID Subgroup**

In 2012, the most frequently listed ID subgroup was lower respiratory infections, accounting for 26.2% (Table 2) of all ID-related ED visits made by elderly U.S. adults. Specifically, pneumonia accounted for 17.5% and influenza for 1.1%. The rate of lower respiratory infections was 1,893 ED visits per 100,000 elderly adults (Table S2). There was a seasonality of ID-related ED visits, with a peak occurring in December, for all age groups (Figure 1). The national estimate of overall ID-related ED visits according to month ranged from 207,109 visits in July to 285,603 visits in December. Likewise, there was a seasonality of lower respiratory infections, with a peak occurring in December (Figure S1). The national estimate of ED visits for lower respiratory infections according to month ranged from 41,583 in July to 101,990 in December. The next most commonly listed subgroup was UTIs, which accounted for 25.3% of all ID-related ED visits, followed by septicemia (18.9%). Likewise, in the analysis of ID-related ED visits in 2011, lower respiratory infections (26.6%), UTIs (24.9%), and septicemia (19.3%) remained the most frequently listed ID subgroups in elderly adults.

There were modest differences in the proportion of ID-related ED visits attributable to the ID subgroups according to age. For example, lower respiratory infections were the leading cause of ID-related ED visits in individuals aged 65 to 74 and 75 to 84, whereas UTIs were the leading cause in individuals aged 85 and older (Table 2).

**Hospitalizations**

Of 3,123,909 ID-related ED visits in 2012, 1,786,657 resulted in hospitalizations (57.1%), with the highest hospitalization rate in individuals aged 85 and older (66.5%). The overall rate of ID-related hospitalizations through the ED was 4,136 per 100,000 elderly adults, with the highest rate in individuals aged 85 and older (9,159 hospitalizations per 100,000 elderly adults; Table S3).

Overall, the most frequently listed subgroup in ID-related hospitalizations was septicemia, accounting for 32.2%, followed by lower respiratory infections (27.8%, Table 2). Although UTIs accounted for a higher proportion of ED visits (25.3%), the hospitalization rate was 17.0%. Likewise, in the analysis using the 2011 data, septicemia (30.8%), lower respiratory infection (28.8%), and UTIs (17.2%) remained the most frequently listed ID subgroups in elderly adults.

**Table 1. Infectious Disease-Related Emergency Department (ED) Visits of Elderly Adults in the United States in 2012 According to Individual and Hospital Characteristics**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Rate of ED Visits per 100,000 U.S. Elderly Adults (95% Confidence Interval)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall</td>
<td>7,231 (6,870–7,591)</td>
</tr>
<tr>
<td>Age</td>
<td></td>
</tr>
<tr>
<td>65 – 74</td>
<td>4,981 (4,732–5,231)</td>
</tr>
<tr>
<td>75 – 84</td>
<td>8,369 (7,943–8,795)</td>
</tr>
<tr>
<td>≥ 85</td>
<td>13,770 (13,023–14,516)</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>2,934 (2,786–3,082)</td>
</tr>
<tr>
<td>Female</td>
<td>4,297 (4,082–4,512)</td>
</tr>
<tr>
<td>Region</td>
<td></td>
</tr>
<tr>
<td>Northeast</td>
<td>8,234 (7,265–9,203)</td>
</tr>
<tr>
<td>Midwest</td>
<td>7,619 (6,953–8,285)</td>
</tr>
<tr>
<td>South</td>
<td>7,292 (6,650–7,934)</td>
</tr>
<tr>
<td>West</td>
<td>6,018 (5,381–6,656)</td>
</tr>
</tbody>
</table>

**Table 2. Most Frequently Listed Diagnostic Subgroups in Infectious Disease–Related Emergency Department (ED) Visits and Hospitalizations of Elderly Adults in the United States, 2012**

<table>
<thead>
<tr>
<th>Subgroup</th>
<th>Overall</th>
<th>Aged 65–74</th>
<th>Aged 75–84</th>
<th>Aged ≥85</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ED visits</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lower respiratory infection</td>
<td>1 (26.2)</td>
<td>1 (25.4)</td>
<td>1 (26.5)</td>
<td>2 (26.9)</td>
</tr>
<tr>
<td>Pneumoniaa</td>
<td>17.5 (17.2–17.9)</td>
<td>15.5 (15.2–15.9)</td>
<td>18.0 (17.6–18.4)</td>
<td>19.8 (19.4–20.3)</td>
</tr>
<tr>
<td>Influenzb</td>
<td>1.1 (1.0–1.2)</td>
<td>1.2 (1.1–1.3)</td>
<td>1.1 (1.0–1.2)</td>
<td>1.0 (0.9–1.1)</td>
</tr>
<tr>
<td>Urinary tract infection</td>
<td>25.3 (25.0–25.7)</td>
<td>21.0 (20.7–21.4)</td>
<td>26.4 (26.0–26.9)</td>
<td>30.1 (29.6–30.6)</td>
</tr>
<tr>
<td>Septicemia</td>
<td>18.9 (18.3–19.6)</td>
<td>16.5 (15.9–17.1)</td>
<td>19.6 (18.8–20.3)</td>
<td>21.7 (20.9–22.5)</td>
</tr>
<tr>
<td>Cellulitis</td>
<td>12.7 (12.4–12.9)</td>
<td>15.8 (15.4–16.1)</td>
<td>11.6 (11.3–11.9)</td>
<td>9.5 (9.3–9.8)</td>
</tr>
<tr>
<td>Upper respiratory infection</td>
<td>5 (5.3–5.7)</td>
<td>5 (8.0–7.7)</td>
<td>5 (4.7–4.5)</td>
<td>5 (2.9–2.7)</td>
</tr>
<tr>
<td><strong>Hospitalizations</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Septicemia</td>
<td>32.2 (31.1–33.3)</td>
<td>32.7 (31.6–33.8)</td>
<td>32.2 (31.1–33.3)</td>
<td>31.7 (30.6–32.8)</td>
</tr>
<tr>
<td>Lower respiratory infection</td>
<td>27.8 (27.2–28.4)</td>
<td>26.6 (26.0–27.3)</td>
<td>28.1 (27.4–28.8)</td>
<td>28.7 (28.0–29.4)</td>
</tr>
<tr>
<td>Pneumoniaa</td>
<td>22.0 (21.5–22.6)</td>
<td>20.8 (20.2–21.4)</td>
<td>22.2 (21.6–22.9)</td>
<td>23.1 (22.5–23.8)</td>
</tr>
<tr>
<td>Influenzb</td>
<td>0.8 (0.7–0.9)</td>
<td>0.8 (0.7–0.9)</td>
<td>0.9 (0.8–1.0)</td>
<td>0.9 (0.8–1.0)</td>
</tr>
<tr>
<td>Urinary tract infection</td>
<td>17.0 (16.5–17.6)</td>
<td>12.1 (11.6–12.6)</td>
<td>17.5 (16.9–18.1)</td>
<td>21.8 (21.2–22.4)</td>
</tr>
<tr>
<td>Cellulitis</td>
<td>8.1 (7.9–8.3)</td>
<td>9.9 (9.6–10.2)</td>
<td>7.6 (7.4–7.9)</td>
<td>6.7 (6.5–6.9)</td>
</tr>
<tr>
<td>Enteric infections</td>
<td>5.7 (5.5–5.9)</td>
<td>5.7 (5.5–6.0)</td>
<td>6.0 (5.7–6.2)</td>
<td>5.3 (5.1–5.6)</td>
</tr>
</tbody>
</table>

International Classification of Diseases, Ninth Revision, Clinical Modification, codes a486 and b487 and 488. CI = confidence interval.
Hospital-Based Mortality
Overall, an estimated 123,800 elderly adults died during their ID-related ED visits and associated hospitalizations in 2012, corresponding to the hospital-based mortality of 4.0% in the current study (Table S4). Of these, the most common ID subgroup was septicemia (74.7%), followed by lower respiratory infections (15%) and UTIs (2%). This rank order was similar in all age groups. Similarly, in the analysis using the 2011 data, septicemia (72.8%) and lower respiratory infections (18.1%) remained the most frequently listed ID subgroups in elderly adults.

With respect to mortality in each diagnostic subgroup, ED visits with septicemia (15.6%), tuberculosis (9.8%), and meningitis (9.4%) had the highest rate of hospital-based mortality (Table S4).

DISCUSSION
The public health burden of IDs in the U.S. elderly population—as measured by ED visits, subsequent hospitalizations, and hospital-based mortality—was substantial in a recent nationally representative sample of ED visits. It was estimated that, in 2012 alone, there were more than 3.1 million ID-related ED visits. The analysis also demonstrated that the hospitalization rate was 55%, resulting in 1.8 million subsequent hospitalizations with 120,000 inpatient deaths in 2012. The leading causes of ID-related ED visits, hospitalizations, and hospital-based mortality were lower respiratory infections and sepsis. These findings were consistent in 2011 and 2012. To the authors’ knowledge, this is the first study to investigate the comprehensive epidemiological features of ID-related ED visits of elderly U.S. adults—findings of public health importance.

Most of the previous studies of elderly adults with IDs focused on hospitalizations.6,7 For example, an analysis of the National Hospital Discharge Survey estimated that there were 21.4 million ID-related hospitalizations in elderly U.S. adults between 1990 and 2002.7 Although these hospitalization statistics reflect the burden of more-severe IDs, focusing solely on these events provides an incomplete picture of healthcare use and discounts the importance of the upstream events, such as ED visits. The current analysis demonstrated that approximately 45% of ID-related ED visits did not result in hospitalization. In addition, estimates indicate that one-quarter of all acute outpatient visit in the United States occur in EDs, a proportion that has been growing since 2001.16 Therefore, ED visits provide a unique perspective that complements hospitalization statistics. Moreover, EDs are increasingly recognized not only as acute diagnostic and treatment centers, but also as important centers of ID surveillance, prevention, and control.17–19 The current study revealed the enormous burden of ID-related ED visits that elderly adults made—13.5% of overall ED visits (3.1 million ID-related ED visits) in 2012. This burden of ID-related ED visits (3.1 million individuals) was higher than that of myocardial infarction (515,000 individuals) and congestive heart failure (410,580 individuals) combined.20 Previous small, single-center studies in Europe (sample size <1,300) reported that approximately 4% of ED visits of elderly adults were ID-related visits.21,22 This discrepancy might be attributable to a difference in study design, population, setting, and healthcare systems. Nevertheless, it is likely that the current analysis of a nationally representative sample of ED visits reflects an accurate burden of ED visits in elderly adults in the United States.

Consistent with previous hospitalization and mortality statistics in the United States,6 the current study found that lower respiratory infections were the leading cause of ED visits and subsequent hospitalizations, accounting for one-fourth of ED visits and hospitalizations. Because of evidence that these illnesses can be prevented with vaccines (e.g., pneumococcal conjugate vaccines, influenza vaccines),23–27 it may be that some ID-related ED visits and associated hospitalizations can be prevented and the public
health burden reduced, but in the elderly population, pneumococcal vaccination coverage was lower than the national goal indicated in Healthy People 2020—approximately 40% of this population did not receive this vaccination in 2008.28 Likewise, influenza vaccination coverage remained suboptimal; one-third of elderly U.S. adults did not receive an influenza vaccination in 2008.29 Studies have also reported racial, ethnic, and socioeconomic disparity in vaccination coverage; vaccination rates in minority populations (African American, Hispanic) were substantially lower than in whites, and socioeconomic factors posed barriers to optimal vaccine use.30–32 These data underscore the importance of continued efforts to increase vaccination implementation to reduce ID-related morbidity and healthcare use in the United States.

Limitations

This study had several potential limitations. First, as with any study using administrative data, there is potential for errors in recording diagnoses at the ED visit, so misclassification of ED visits is possible. For instance, some of ED visits with infectious gastroenteritis might have been classified as nonspecific diarrheal diseases and thereby underestimated the disease burden. By contrast, when rigorous criteria were applied for UTI in nursing home residents, most did not have a UTI, although clinicians often diagnose and treat asymptomatic bacteruria as UTI33 and the disease burden was thereby overestimated. Nevertheless, the HCUP data are accurate and widely used to estimate diagnoses and visit frequency.34–36 In addition, ID-related ED visits were identified using a previously applied approach (with an ID listed as the primary diagnosis)5 in an effort to limit potential misclassification of IDs, although this might have led to underestimation of the burden of ID-related ED visits. Second, it was not possible to examine long-term outcomes, such as ED revisits and readmissions in the same year, because of a lack of patient identifiers in the data set. Nevertheless, this study focused on the ID-related healthcare use as measured by ED visits and subsequent hospitalizations. Finally, the study focused on ED use; many elderly adults might have presented to non-ED settings (e.g., urgent care offices) with IDs. Hence, these findings do not represent the total burden of ID-related acute care use but rather the burden of ED visits for IDs with related hospitalizations and mortality. Nevertheless, because the burden of the ID-related ED visits was focused on, the observations are highly relevant to the millions of elderly U.S. adults visiting the ED each year.

CONCLUSION

Using a nationally representative sample of ED visits, it was found that the public health burden of ID-related ED visits of elderly U.S. adults was substantial. Lower respiratory infections and septicemia were the leading causes of ED visits, hospitalization, and hospital-based mortality. These findings reinforce the fact that IDs continue to be an important problem in elderly adults—the fastest-growing population in the U.S. population37—in an already stressed healthcare system. These observations underscore the importance of integrated strategies aimed at reducing ID-related morbidity and healthcare use of elderly adults as a national priority for research, health policy, and community action.

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Author Contributions: Goto: planning of study. Yoshida, Tsugawa, Camargo, Hasegawa: statistical advice on study design. Yoshida, Hasegawa: data analysis. Goto: drafting the manuscript. All authors: revision. Tadahiro Goto takes responsibility for the paper as a whole.

Sponsor’s Role: None.

REFERENCES


SUPPORTING INFORMATION

Additional Supporting Information may be found in the online version of this article:

Figure S1. Frequency of lower respiratory infection–related emergency department (ED) visits of elderly adults in the United States in 2012 according to month of visit.

Table S1. Infectious Disease Subgroup Definitions and Corresponding International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) Code.

Table S2. Frequency and Rate of Infectious Disease–Related Emergency Department (ED) Visits of Elderly Adults in the United States, 2012.

Table S3. Frequency and Rate of Infectious Disease–Related Hospitalizations in Elderly Adults in the United States, 2012.

Table S4. Hospital-Based Mortality Overall and According to Diagnostic Group in Elderly Adults with Infectious Disease–Related Emergency Department Visits in the United States, 2012.

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