
National Health Statistics Reports

Number 116 ■ August 24, 2018

National Hospital Care Survey Demonstration Projects: Pneumonia Inpatient Hospitalizations and Emergency Department Visits

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Abstract

Objective—This report demonstrates the use of the National Hospital Care Survey (NHCS) for the study of pneumonia inpatient hospitalizations and emergency department (ED) visits. The analysis is based on unweighted data of inpatient and ED encounters from the 2014 NHCS and is intended to illustrate the capabilities of the survey, including the ability to link inpatient hospitalizations or ED visits across settings and with other data sources, once hospital participation allows for nationally representative estimates.

Methods—For the 2014 NHCS data collection, 94 out of a sample of 581 hospitals provided inpatient Uniform Bill (UB)–04 administrative claims data, and 88 of the 94 hospitals that provided inpatient data provided ambulatory claims data. Analyses were conducted to study encounters with a first-listed diagnosis of pneumonia across the inpatient and ED settings, and to evaluate 30-, 60-, and 90-day mortality. Also, new data elements such as use of the intensive care unit (ICU) and diagnostic and physical services received were analyzed. The data are unweighted and are not nationally representative.

Results—Analyses were conducted to examine pneumonia encounters across inpatient and ED settings, and they highlight the analytical capabilities of NHCS not available in previous surveys. Most pneumonia inpatient hospitalizations were for those aged 65 and over, while in the ED, most pneumonia visits were for those under age 15 years. For inpatients, ICU stays increased the overall time spent in the hospitals by 50%, from 4.3 to 7.3 days. In addition, the average age of those who died within 30 days after discharge was 77.

Keywords: mortality • intensive care • National Death Index • National Hospital Care Survey

Introduction

Pneumonia is a lung infection that can be caused by bacteria, viruses, or fungi (1,2). The symptoms of pneumonia

range from mild to severe, and common symptoms include cough with phlegm (“wet cough”), difficulty breathing, fever, chest pain, fatigue, and confusion (2). In 2010, the National Hospital Discharge

Survey (NHDS) reported 1.1 million (3.2%) inpatient hospitalizations for pneumonia in the United States, and the National Hospital Ambulatory Medical Care Survey (NHAMCS) estimated 1.5 million emergency department (ED) visits (1.1%) for pneumonia in 2014. There were about 50,000 deaths caused by pneumonia in the United States in 2014 (3). Although pneumonia is not a leading cause of death for those aged 65 and over, an observational study of a cohort of Medicare patients showed that the mortality rates for those aged 90 and over with pneumonia (15.4%) were double that of those aged 65–69 (7.8%) (4). Pneumonia is one of the conditions listed as a potentially avoidable inpatient hospitalization, which is defined as a condition that could have been prevented or treated outside of the inpatient setting (5).

The National Hospital Care Survey (NHCS) presents unique opportunities to study how pneumonia is diagnosed and treated across the continuum of care for pneumonia patients in U.S. hospitals. Patient identifiers allow for the study of 30-, 60-, and 90-day mortality among hospital discharges and ED visits, while collection of services received (such as use of the intensive care unit [ICU] and diagnostic services) allows for analysis of hospital utilization. This report



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demonstrates the analytical capabilities of NHCS through its study of pneumonia inpatient hospitalizations and ED visits.

Methods

Data source

In an effort to streamline data collection across health care settings and to move toward collecting data on health care utilization electronically, the National Center for Health Statistics (NCHS) launched a new survey, NHCS, which integrates NHDS, NHAMCS, and the Drug Abuse Warning Network, which was previously conducted by the Substance Abuse and Mental Health Services Administration. The goal of NHCS is to provide timely and reliable health care data for hospital-based utilization. More details about the NCHS methodology are available (6).

Uniform Bill–04 administrative claims

NHCS electronically collects Uniform Bill (UB)–04 administrative claims data from participating hospitals. UB–04 is the administrative claim required by the Centers for Medicare & Medicaid Services (CMS) and most commercial insurance payers. Physician and patient identifiers, and data on patient demographics, diagnoses, procedures, and revenue codes are included on the claims. Using claims data presents the challenge of deduplication of claims, since one discharge or ambulatory visit can have multiple claims. The initial deduplication is performed at the hospital level, using processes developed by NCHS to identify duplicate claims for the same discharge or visit within a hospital. Once unique discharges and visits are identified, then patient identifiers are created. See the [Technical Notes](#) for more information about data collection, deduplication, and patient identifiers.

NHCS also uses personally identifiable information (PII) on the claims to link patient data across hospital settings and with other data sources, such as the National Death Index (NDI) (7). With the collection of PII, NHCS is also able to “follow” patients during

an episode of care by linking records within the same hospital. For example, an individual can be traced from an initial visit to the ED, admission to the hospital, discharge from the hospital, and finally, to treatment in the hospital’s outpatient department (OPD). Another benefit of PII is that patients who return to any setting of the hospital at a later time can be identified. Linkage to NDI allows researchers to conduct a wide range of outcome studies (e.g., 30-, 60-, and 90-day mortality after discharge from a hospital) designed to investigate factors that are related to health care mortality.

Sample design

The target universe of NHCS is inpatient discharges, also called inpatient hospitalizations, and in-person visits made to EDs and OPDs, including ambulatory surgery, in noninstitutional nonfederal hospitals in the 50 states and the District of Columbia that have six or more staffed inpatient beds. Average length of stay is not used as an exclusion criterion, as was done in NHDS and NHAMCS, thus expanding the frame beyond short-stay hospitals with an average length of stay of less than 30 days. No geographic primary sampling units are used in this design, and there are no certainty hospitals (hospitals with a 100% selection probability) defined *a priori*. The frame is from the 2010 spring release of “Healthcare Market Index” and “Hospital Market Profiling Solution, Second Quarter, 2010,” both by Verispan. The 2014 sample consists of 581 hospitals: 506 acute care hospitals and 75 other specialty hospitals, including children’s, psychiatric, long-term acute care, and rehabilitation hospitals.

For the 2014 data collection, 94 hospitals out of the 581-hospital sample provided inpatient claims data, and 88 of the 94 hospitals that provided inpatient data also provided ambulatory claims data (a response rate of 16.2% and 15.1%, respectively). Of the 94 hospitals providing inpatient claims, 92% were general acute care hospitals, 4% were children’s hospitals, 3% were psychiatric hospitals, and 0.4% were rehabilitation or long-term acute care hospitals. Of the 88 hospitals providing ambulatory claims, 88% were general acute care

hospitals, 8% were children’s hospitals, 2% were psychiatric hospitals, and 2% were rehabilitation or long-term acute care hospitals. Participating hospitals were asked to provide all encounters in inpatient and ambulatory settings in the 2014 calendar year. The unweighted total number of encounters was approximately 1.7 million inpatient discharges, or inpatient hospitalizations, (1.5 million non-newborn inpatient discharges), and 4.5 million ED visits. This report only examined first-listed diagnoses of pneumonia in the inpatient and ED encounters. First-listed diagnosis is a diagnosis that is the first diagnosis listed in a record and represents the diagnosis determined to be the chief reason for encounter after study (8). The number of inpatient discharges with a first-listed diagnosis of pneumonia was 30,705, and the number of ED-only visits for first-listed pneumonia was 24,711. Although the data are unweighted and are not nationally representative, this report demonstrates the potential that NHCS has for researchers in future data releases that will be generalizable to the United States. More details about the NCHS sample design are available (6).

Analysis

Considering that the severity of pneumonia increases with age, this report presents characteristics of inpatient hospitalizations and ED visits for pneumonia by age; length of stay, particularly ICU stay; discharge status; and mortality.

Revenue codes, collected through the claims data, are included in the record of an inpatient hospitalization or ED visit. These codes describe services provided during an encounter, from room and board to diagnostic and therapeutic services received by a patient. In this report, revenue codes were used to analyze ICU stay as well as services usually associated with pneumonia ED visits and inpatient discharges.

To track 30-, 60-, and 90-day mortality, patients were first identified using a unique patient ID from encounters whose first-listed diagnosis while hospitalized was pneumonia. These patients were then linked to the NDI through PII included on the claims.

Patients were identified via statistical linkage techniques, described in the [Technical Notes](#). A pneumonia patient's last chronological discharge was the record for classifying patients as "died in hospital" or "discharged alive," and to determine the length of time between discharge and death.

Statistical testing was conducted to demonstrate the statistical techniques that could be used to analyze NHCS data. Because there are a large number of observations, almost any comparison is statistically significant. By using effect sizes in addition to statistical tests, results are more reasonably contextualized. In addition, statistical testing allows researchers to see whether, although not nationally representative, these data are consistent with the nationally representative results from NHDS and NHAMCS for comparable variables.

For proportions, to determine if the differences are statistically significant, a chi-squared two-sample test for equality of proportions with continuity correction ($p < 0.05$) was used. To determine if these differences are substantive, nondirectional Cohen's h effect size ($h \geq 0.20$) was used. For means, such as for the average length of stay, to determine if the differences are statistically significant, Welch's two-tailed unequal variances t test ($p < 0.05$) was used. To determine if these differences are substantive, nondirectional Cohen's d effect size ($d \geq 0.20$) was used. Unless otherwise noted, the differences discussed in the text of this report are both statistically significant ($p < 0.05$) and substantive (h or $d \geq 0.20$). Terms that express differences such as "higher," "lower," "largest," "smallest," "leading," "increased," or "decreased" were used only when the differences were statistically significant and substantive, unless otherwise noted. All counts and percentages in this report are unweighted.

Due to the low response rate of sampled hospitals and unweighted data, it cannot be assumed the data presented in this report are nationally representative; therefore, it is stated throughout the report that the data and results are not nationally representative. Cells (in tables and figures) with fewer than 30 cases in a cell are not reported. Data analyses were

performed using SAS version 9.4 (SAS Institute, Cary, N.C.).

Results

Demographics

NHCS collects data on patient demographics for all settings. Patient age for encounters with first-listed pneumonia diagnoses are shown in [Figure 1](#).

- Pneumonia inpatient hospitalizations accounted for 2.1% of all discharges. Of the 30,705 inpatient hospitalizations for pneumonia, almost one-half (46.7%) were made by those aged 65 and over.
- Pneumonia ED visits accounted for 0.5% of all ED visits. Of the 24,711 ED visits for pneumonia, 46.1% were made by those under age 15 years, which was higher than any other age group for ED visits.

Discharge status of ED and inpatient encounters for pneumonia

The discharge status in NHCS is more detailed than in other data systems. For instance, NHCS can indicate if

a discharge was to home health care. Discharge status for the ED and inpatient settings are described in [Figure 2](#).

- Six out of 10 inpatients (64.6%) were discharged home, while 9 out of 10 ED visits (93.9%) resulted in a discharge to home.
- About 12% of inpatient discharges received home health care.

Diagnostic testing for pneumonia in the ED and inpatient department

NHCS allows analysis of services received during an encounter by analyzing revenue codes, which was not possible in previous NCHS data systems. To construct [Figure 3](#), revenue codes that are usually used in the diagnosis of pneumonia in the ED were used (9).

- Three-quarters of inpatient hospitalizations for pneumonia involved bacteriology and microbiology testing (75.3%), about two-fifths involved a CT scan (41.2%), about two-thirds involved a chest X-ray (65.1%), and one-third involved a pulmonary function test (33.7%) ([Figure 3](#)).

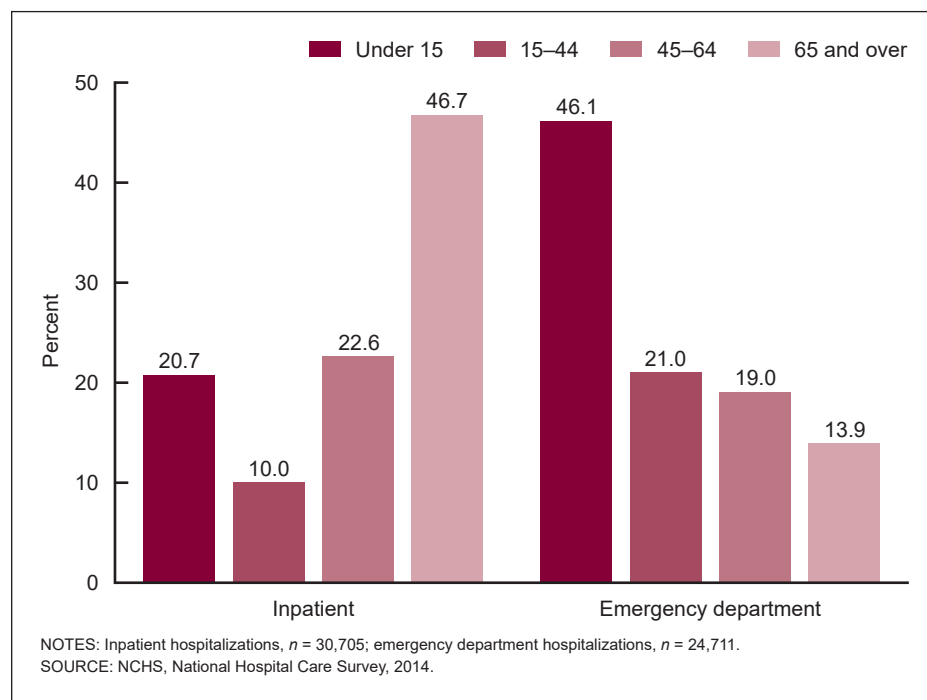


Figure 1. Age distribution of encounters with first-listed diagnosis of pneumonia in inpatient and emergency department settings: National Hospital Care Survey, 2014

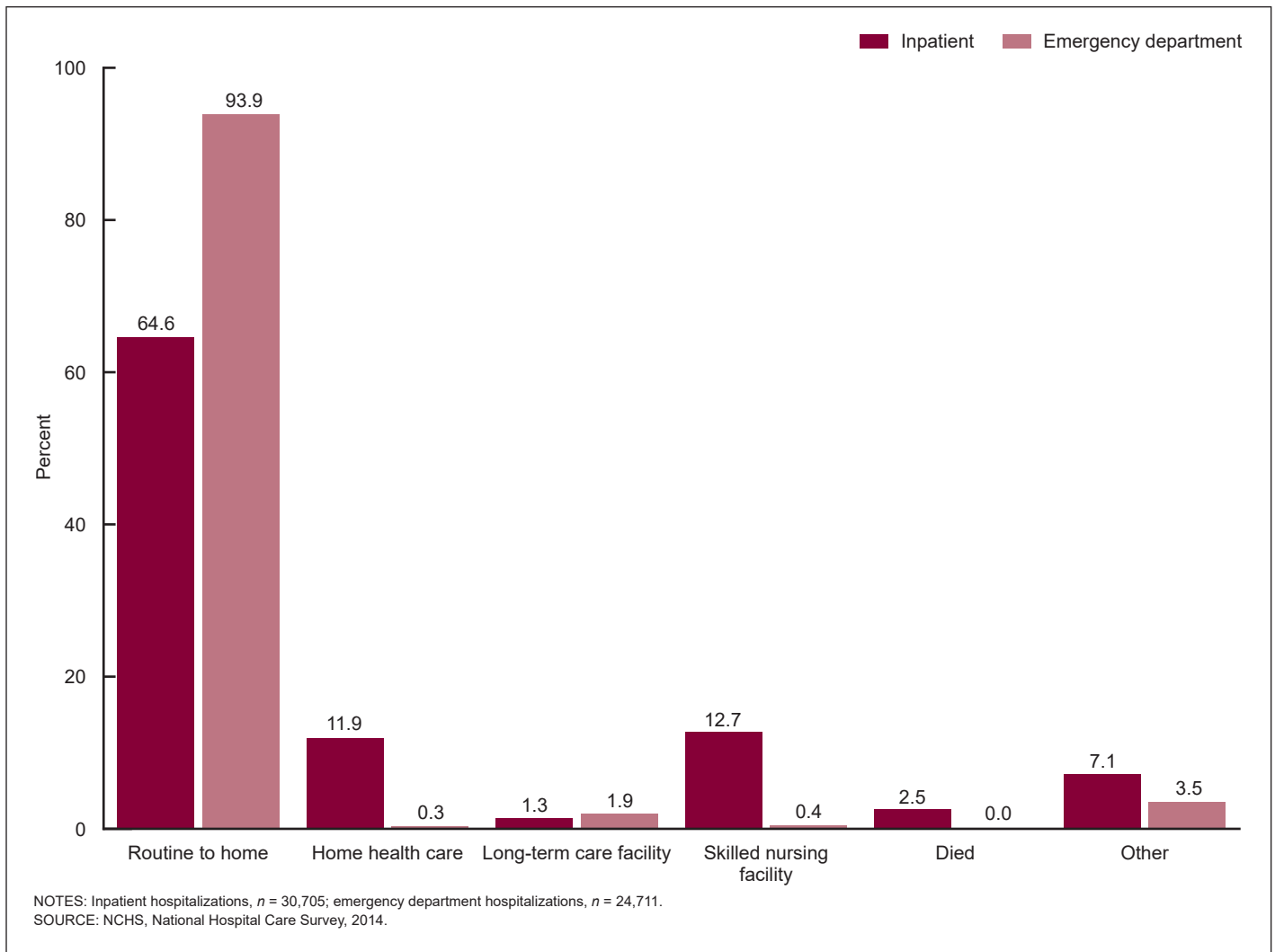


Figure 2. Discharge status of inpatient hospitalizations and emergency department encounters for first-listed pneumonia: National Hospital Care Survey, 2014

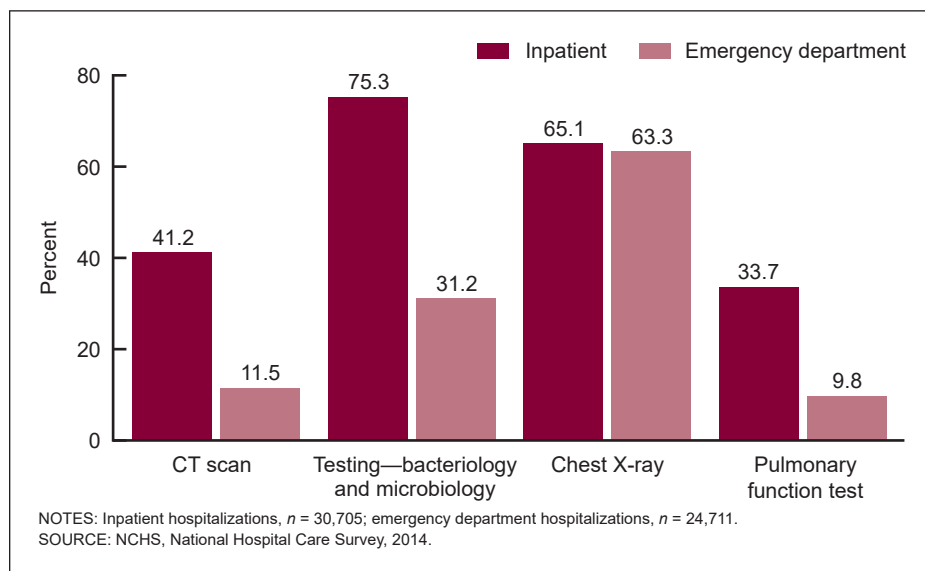


Figure 3. Percentage of first-listed diagnosis for pneumonia encounters receiving diagnostic and therapeutic services in inpatient and emergency department settings: National Hospital Care Survey, 2014

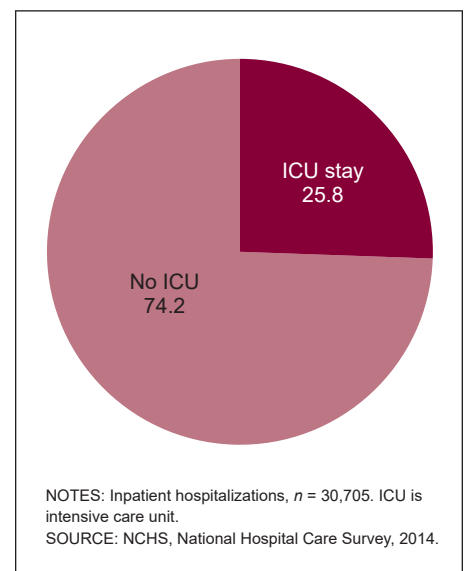


Figure 4. Percentage of intensive care unit usage for inpatients hospitalized with a first-listed diagnosis of pneumonia: National Hospital Care Survey, 2014

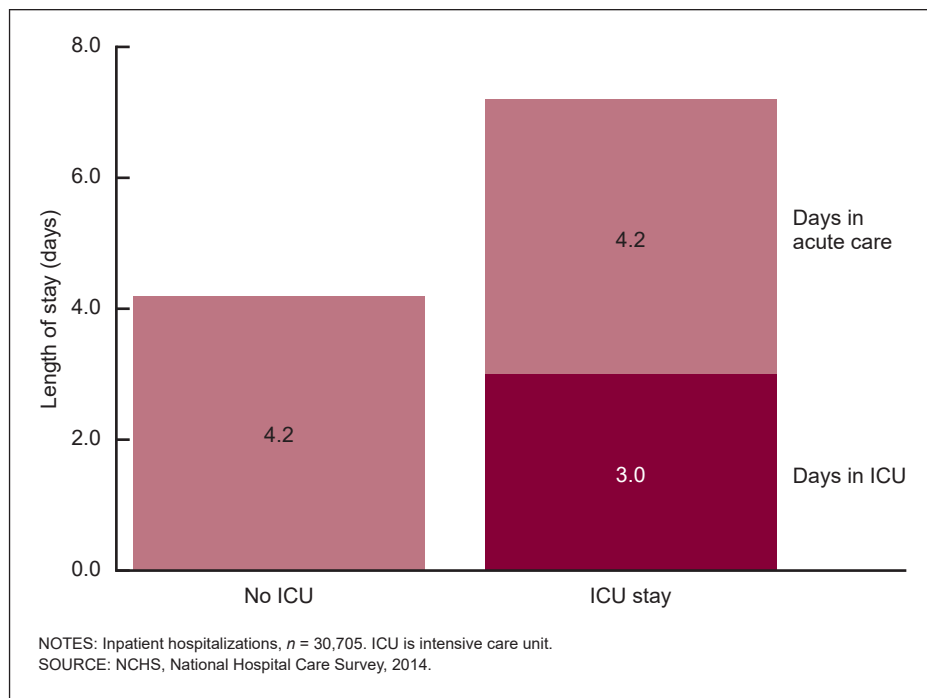


Figure 5. Average length of stay for inpatients hospitalized with first-listed pneumonia, by intensive care unit usage: National Hospital Care Survey, 2014

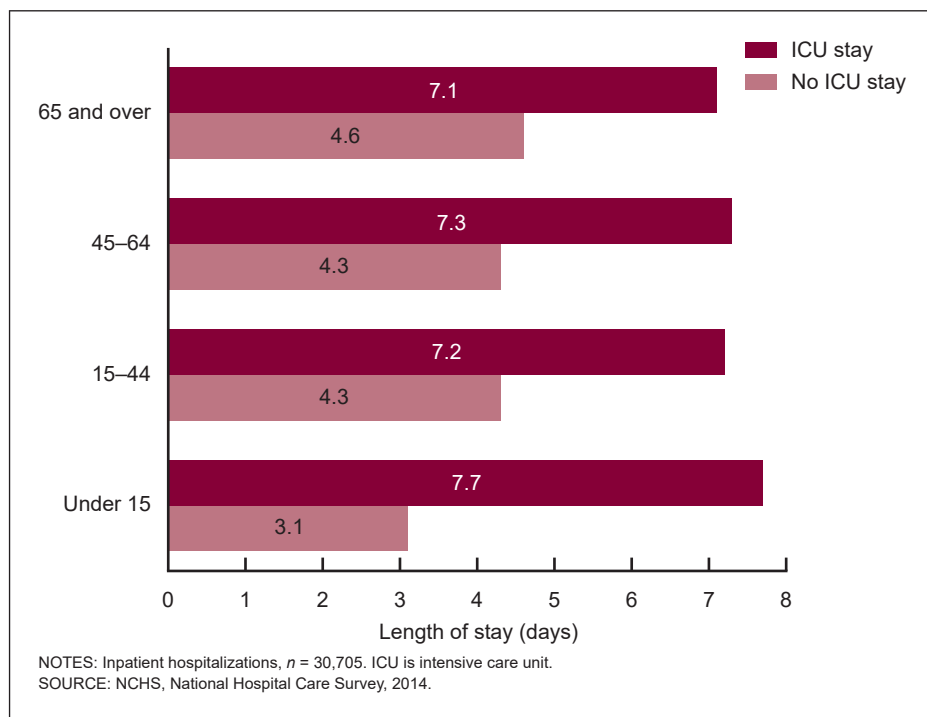


Figure 6. Average length of stay for inpatients hospitalized with first-listed pneumonia, by intensive care unit usage and age group: National Hospital Care Survey, 2014

- For ED visits involving the same diagnostic tests, a lower percentage involved bacteriology and microbiology testing (31.2%), CT scans (11.5%), and pulmonary function tests (9.8%) compared with inpatient hospitalizations.

Average length of stay and ICU usage

Figures 4–6 describe the average length of stay (ALOS) and ICU usage for pneumonia inpatient hospitalizations.

- Three-quarters of inpatients who were hospitalized for pneumonia (74.2%) did not have an ICU stay (Figure 4).
- Pneumonia inpatient hospitalizations resulting in acute care (short-term care received in hospital) instead of an ICU stay had an ALOS of 4.2 days. If the inpatient hospitalization included time in the ICU, average length of stay increased to 7.2 days. ICU stays for pneumonia (3 days) increased the overall time in the hospital by 50% (Figure 5).
- The shortest length of stay for any age group without an ICU stay was 3.1 days for those under age 15 years (Figure 6).
- For pneumonia inpatient hospitalizations without an ICU stay, those aged 65 and over had an ALOS of 4.6 days compared with 4.3 days among those aged 15–64 and 3.1 days among those under age 15 (Figure 6). Although the result for those aged 65 and over was statistically significantly higher compared with the other groups, it was not substantively different.

30-, 60-, and 90-day mortality for inpatients with first-listed pneumonia

NHCS allows 30-, 60-, and 90-day mortality to be examined via linkage to the 2014 and 2015 NDI. Figures 7 and 8 and the Table describe deaths of former patients whose first-listed diagnosis while at the hospital was pneumonia.

- Of the 30,705 inpatient hospitalizations for pneumonia, there were 29,005 (100%) unique individuals. (Figure 7).
- Nearly 3% of patients (2.6% or 751) with a pneumonia inpatient hospitalization had a disposition status of died in the hospital (Figure 7).
- Of those who died in the hospital, 86% (646 patients) had a death record in the NDI. Of those not found in the NDI (14% or 105 patients), 46% were patients in hospitals that did not provide PII data (Figure 7).

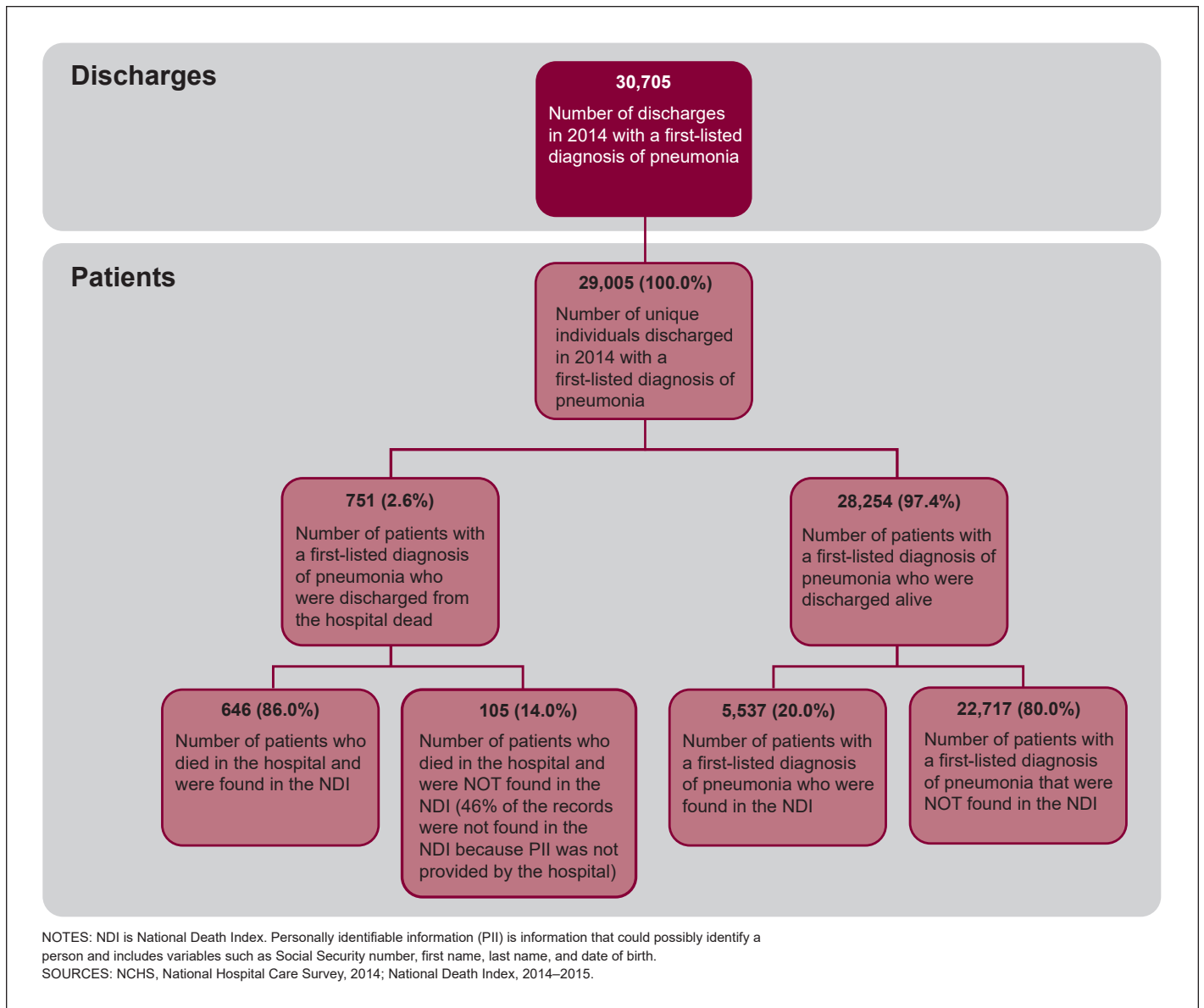


Figure 7. The relationship between first-listed pneumonia inpatient discharges, first-listed pneumonia inpatients, and patient deaths in 2014 and 2015: National Hospital Care Survey, 2014

- Of the 29,005 patients with a pneumonia inpatient hospitalization, 28,254 (97.4%) were discharged alive (Figure 7).
- Patients who died within 30 days of discharge had a mean age of 77 (Table).
- The top five underlying causes of death (malignant neoplasm of unspecified part of bronchus or lung; chronic obstructive pulmonary disease; pneumonia, unspecified organism; atherosclerotic heart disease of native coronary artery; and unspecified dementia) for those who died within 30 days of their pneumonia discharge comprised

Table. 30-, 60-, and 90-day mortality, with mean age for inpatients with first-listed pneumonia: National Hospital Care Survey, 2014

Mortality	Percent of total patients matched	Mean age
Died within 30 days	4.2	76.9
Died between 30 and 60 days	2.2	74.0
Died between 60 and 90 days	1.6	73.4
Alive after 90 days	92.0	51.6

NOTE: Inpatient (excluding those who died in the hospital), n = 28,254.
SOURCE: NCHS, National Hospital Care Survey, 2014

- more than one-third of all underlying causes of death (Figure 8).
- Malignant neoplasm of unspecified part of bronchus or lung was the most common underlying cause of death for inpatients who died within

30 days of discharge (14.1%). The second most common underlying cause of death was chronic obstructive pulmonary disease, which accounted for 8.2% of deaths (Figure 8).

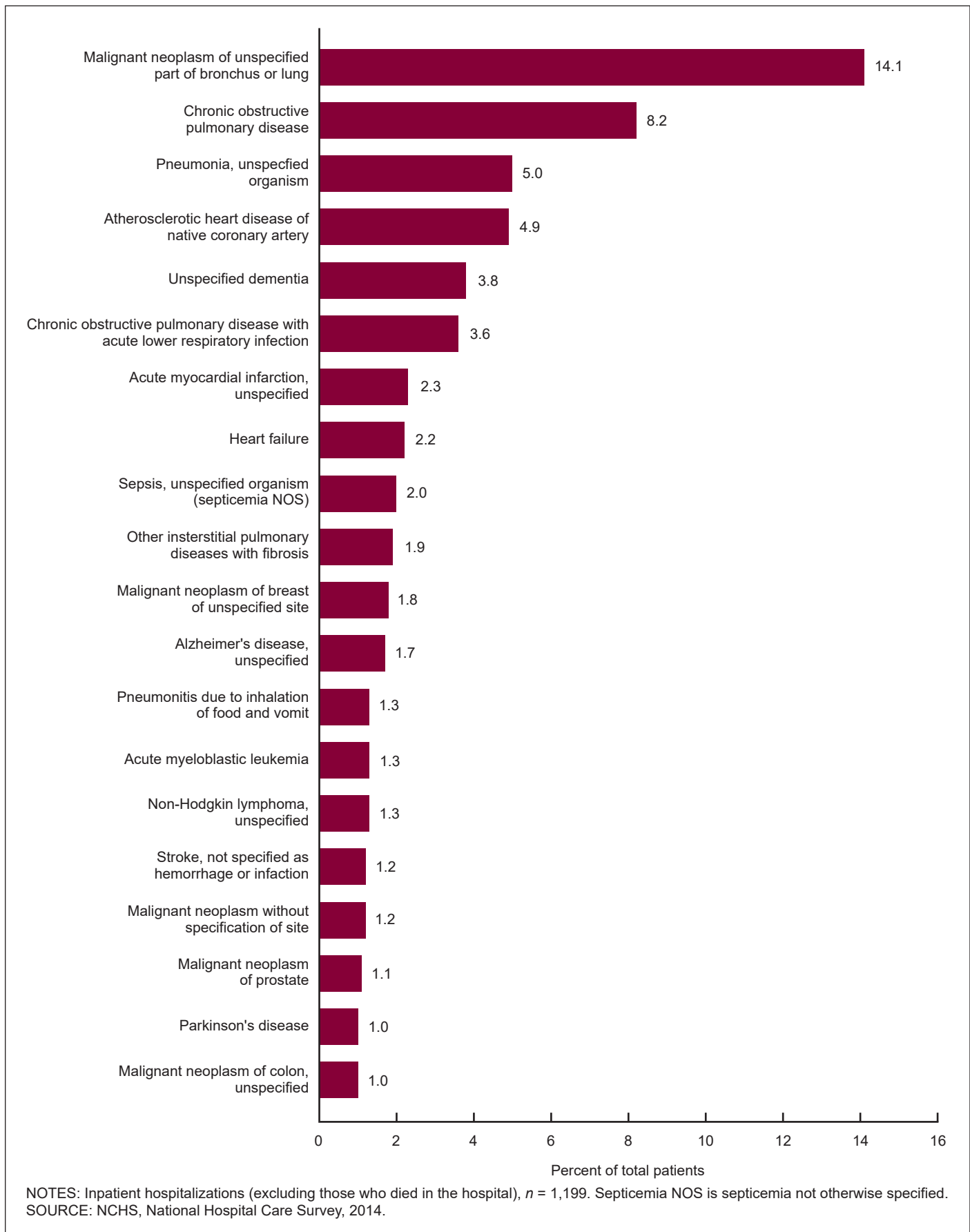


Figure 8. Top 20 underlying causes of death for those who died within 30 days of their inpatient hospitalization for first-listed pneumonia: National Hospital Care Survey, 2014

Discussion

This report illustrates the use of NHCS to examine first-listed pneumonia encounters in the inpatient and ED settings. Although NHCS is not yet nationally representative, the number of encounters and the inclusion of PII allow an example of analysis that was not previously possible. Overall, nearly one-half of pneumonia inpatient hospitalizations were for those aged 65 and over, unlike the ED where about one-half of pneumonia visits were for those under age 15. These results are consistent with the nationally representative results from NHDS and NHAMCS. According to NHDS, in 2010, the last year in which the survey was fielded, 55% of pneumonia cases were among those aged 65 and over. According to NHAMCS, in 2014, 52% of ED visits were for those under age 15.

For inpatients, ICU stays increased the overall time spent in the hospital by 50%, from 4.3 to 7.3 days. Three-quarters of inpatients with pneumonia received bacteriology and microbiology testing. A small percentage of patients died in the hospital (4%) and most went on to live past 90 days post discharge. The average age of those who died within 30 days after discharge was 77, while those who died between 61 and 90 days of discharge were aged 73.

This report demonstrates the types of analyses that are possible with NHCS data. In particular, NHCS provides a unique opportunity to track ICU use and diagnostic services received. Additionally, this demonstration paper highlights the ability to link individuals in NHCS to outside sources, such as the NDI, to evaluate 30-, 60-, and 90-day mortality, which cannot be done in other nationally representative health care surveys currently. As NHCS continues to collect data from more hospitals and moves toward the collection of electronic health records, the value of NHCS data to researchers and the public will continue to grow.

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Technical Notes

Data collection

Although hospitals are required to submit claims to the Centers for Medicare & Medicaid Services (CMS) in the 837 file format, submission of claims in this format to the National Center for Health Statistics (NCHS) has been challenging. First, many hospitals use clearinghouses to process and submit their claims to CMS and other commercial insurance companies. In many instances, the small payment NCHS offers for each year of data collection is not enough to offset the cost the clearinghouse charges for constructing a file for the National Hospital Care Survey (NHCS). As an alternative, NCHS has accepted nonadjudicated data files directly from hospitals, which are cleaned and processed by the NHCS data collection contractor.

Second, hospitals that process their own claims sometimes do not know how to output the data from their systems for submission to NHCS. Even for hospitals that are able to output digital data in-house, some are not necessarily able to output in the 837 format to the data collection contractor. Although not preferred, other file formats such as XML, Excel, and ASCII are accepted.

Third, larger hospitals handle volume by archiving their claims data daily, which makes obtaining the data for this study difficult or costly. With the technological capabilities of the NHCS data collection contractor, automation of daily data transmission has provided a solution for obtaining archived data.

All inpatient and ambulatory claims data are transmitted through the contractor's secure transfer system. These data are compiled, processed, and sent to NCHS.

Claims deduplication

Using claims data presented a challenge, since one encounter, both for inpatient discharges and ambulatory visits, can have multiple claims. Therefore, deduplication processes were developed. The initial deduplication was performed at the hospital level, using processes to identify duplicate

claims for the same encounter, inpatient or emergency department (ED), within a hospital. In order to develop the deduplication method for a hospital, claims were grouped in three ways: (1) by patient control number (PCN); (2) by beginning date of encounter and medical record number (MRN); and (3) by beginning date of encounter, date of birth, and patient name. The purpose of this processing was to evaluate whether PCN could be used to accurately identify duplicate claims for the same encounter, controlling for matching data elements for beginning date of encounter, MRN, date of birth, and patient name. If the number of duplicate groups of claims identified by PCN was close to the other counts produced, PCN was used to deduplicate the claims. However, if the values of these variables in a group of duplicates were not similar, then the hospital's claims were further assessed through a manual review of the duplicate groups, and a final determination of the deduplication method to be used at that hospital was made.

Although the vast majority of ambulatory (outpatient and ED) visits involve a single day, many cases of ambulatory claims spanning two or more dates were detected among ambulatory claims. Multiple-date claims were examined, and some cases had evidence that they were justifiably multiple-day visits. Three types of cases were identified as probably being valid multiple-day visits to the ambulatory department: (1) an ED visit could span several days, starting in the late evening, continuing into the next day and would appear as a 2-day visit; (2) a patient who receives "observation services" is periodically monitored by hospital staff to determine the need for possible admission, and this period of monitoring could involve several days; and (3) patients undergoing ambulatory surgery might be kept in the ambulatory center for longer periods of time pre- or postsurgery.

A claim for multiple dates that should not have been treated as a single visit spanning multiple days was split into two or more subclaims. Examples of multiple-date claims that should have been split were repeated treatments over a period of time (e.g., weekly speech

therapy or regular dialysis) for which some hospitals apparently preferred to submit just one claim covering a period of time. Any claim with nonconsecutive dates in the ED or the outpatient department was split into two or more claims for single-day stays (or for consecutive-day stays). All consecutive-day claims were then separated into one claim per day assuming there was no evidence of a justifiable longer stay, such as for visits to the ED, for patients receiving observation services, or for ambulatory surgery. Any consecutive-day visits with evidence of any of these three conditions were not split.

Patient identification

After deduplication of claims, a probability-based record linkage method was used to identify patients. In the first round of patient identification, two records were compared by name (first, last, middle initial), date of birth, sex, hospital identifier, MRN, Social Security number (SSN), and ZIP code. If there was sufficient agreement of data elements between the two records, the records were retained as a pair (i.e., record pair) for further analysis. The second round compared the record pairs, controlling for agreement in the hospital identifier and MRN (Pass 1), SSN if reported (Pass 2), and for agreement in sex, year, and month of birth; soundex (a phonetic coding system designed to suppress spelling variations) of last name; and state abbreviation (Pass 3). The record pairs compared in the three passes had match weights assigned to 11 matching variables. The match weights were likelihood ratio scores based on the probability of agreement in the records retained as record pairs and the probability of agreement in the records that were not included in any record pairs. A match weight of 60.98 indicated perfect agreement in all the comparison fields. Pairs with a match weight above a threshold of 30 were retained as likely matches, based on selection thresholds suggested in Winglee, Valliant, and Scheuren (10).

Two additional reviews were conducted for record pairs of children under age 10 years at the time of discharge. The first review targeted

newborn infants whose first names contained “BABY,” “GIRL,” “BOY,” “FEMALE,” and “MALE.” The newborn pairs were then subject to one of three adjustments. Pairs that contained records where names may be “BABYGIRL” in one record and a real name (e.g., “JANE”) in another were accepted as a match when the hospital identifier and MRN were the same. Pairs with the same hospital identifier, service date, and patient address, but different MRNs, were identified as twin or multiple-birth records and manually split. And pairs with different last names and MRNs were manually reviewed and split if the pair was determined to be false.

commonly associated with the diagnosis of pneumonia in the ED were used in the analysis:

- Computerized tomography (CT) scan: 035x
- Pulmonary function testing: 046x
- Laboratory testing—bacteriology and microbiology: 0306
- Chest X-ray—diagnostic: 0324
- Other radiology—diagnostic: 0329

Definition of terms

ED visit—Describes events that occur in the emergency department of a hospital.

Encounter—Describes the combination of ambulatory visits and inpatient hospitalizations.

Inpatient hospitalization—Describes events that occur in the inpatient setting of a hospital.

Pneumonia—A lung infection that can be caused by bacteria, viruses, or fungi. Pneumonia is identified as a first-listed diagnosis, or the main cause of the encounter, when the following *International Classification of Diseases 9th Revision Clinical Modification* (ICD-9-CM) codes were found in the first-listed diagnoses: 480, 481, 482, 483, 484, 485, and 486. Preventable hospitalizations for pneumonia are included in the definition of pneumonia in this report.

Preventable hospitalization—Admission to hospitals for certain acute illnesses and some chronic conditions that may not have required hospitalization if managed or treated adequately in outpatient settings. Preventable hospitalizations for pneumonia are classified by the following ICD-9-CM codes: 481x, 482.2, 482.3, 482.9, 483x, 485x, and 486x (where x = all possible codes) (11).

Revenue codes—Four-digit numbers used on claims data that identify billable services provided during an inpatient stay or an ambulatory visit. The following revenue codes that are

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National Health Statistics Reports ■ Number 116 ■ August 24, 2018

Acknowledgment

The authors thank Naga Shanmugam of the U.S. Food and Drug Administration for initial verification of selected results and literature review.

Suggested citation

Williams S, Gousen S, DeFrances C. National Hospital Care Survey demonstration projects: Pneumonia inpatient hospitalizations and emergency department visits. National Health Statistics Reports; no 116. Hyattsville, MD: National Center for Health Statistics. 2018.

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