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Duration of Antibiotic Use Among Adults With Uncomplicated Community-Acquired Pneumonia Requiring Hospitalization in the United States

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Abstract

Background.—Previous studies suggest that duration of antibiotic therapy for community-acquired pneumonia (CAP) often exceeds national recommendations and might represent an important opportunity to improve antibiotic stewardship nationally. Our objective was to determine the average length of antibiotic therapy (LOT) for patients treated for uncomplicated CAP in US hospitals and the proportion of patients with excessive durations.

Methods.—Records of retrospective cohorts of patients aged 18–64 years with private insurance and aged ≥65 years with Medicare hospitalized for CAP in 2012–2013 were used. Inpatient LOT was estimated as a function of length of stay. Outpatient LOT was based on prescriptions filled post discharge based on data from outpatient pharmacy files. Excessive duration was defined as outpatient LOT >3 days.

Results.—Inclusion criteria were met for 22 128 patients aged 18–64 years across 2100 hospitals and 130 746 patients aged ≥65 years across 3227 hospitals. Median total LOT was 9.5 days. LOT exceeded recommended duration for 74% of patients aged 18–64 years and 71% of patients aged ≥65 years. Patients aged 18–64 years had a median (quartile 1–quartile 3) 6 (3–7) days outpatient LOT and those aged ≥65 years had 5 (3–7) days.

Conclusions.—In this nationwide sample of patients hospitalized for CAP, median total LOT was just under 10 days, with more than 70% of patients having likely excessive treatment duration. Better adherence to recommended CAP therapy duration by improving prescribing at hospital discharge may be an important target for antibiotic stewardship programs.

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Supplementary Data

Supplementary materials are available at *Clinical Infectious Diseases* online. Consisting of data provided by the authors to benefit the reader, the posted materials are not copyedited and are the sole responsibility of the authors, so questions or comments should be addressed to the corresponding author.

Notes

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Keywords

antibiotic use; community-acquired pneumonia; length of therapy; treatment duration

Community-onset infections of any kind and lower respiratory tract infections acquired in any setting are the most common indications for antibiotic use among hospitalized patients [1]. Community-acquired pneumonia (CAP), in particular, results in approximately 600 000–800 000 hospitalizations annually among adults in the United States [2, 3].

Through the Core Elements of Antibiotic Stewardship [4], the Centers for Disease Control and Prevention (CDC) advises hospitals to develop and implement recommendations for antibiotic selection and duration based on local antibiotic susceptibilities of infection-causing organisms and national guidelines. The Core Elements cite CAP as an indication for which this strategy may be particularly helpful [4].

In 2007, the Infectious Diseases Society of America (IDSA) and the American Thoracic Society (ATS) published national guidelines for treatment of CAP, recommending a minimum 5 days of therapy, with 7 or more days rarely necessary, and use of clinical stability criteria to determine when to discontinue [5]. Previous studies show that the average length of antibiotic therapy (LOT) for CAP in the United States exceeds IDSA–ATS guidelines of 5–7 days among adults hospitalized for CAP, suggesting a potentially important opportunity to improve antimicrobial stewardship. However, these studies were not generalizable to the US population [6–11]. Here, we used nationwide data to determine the LOT most commonly used for treatment of patients hospitalized for CAP in the United States.

METHODS

Study Design

We used a retrospective cohort design and administrative data to study the duration of antibiotic therapy among adult patients hospitalized for CAP and discharged in 2012 and 2013. This work was conducted under data use agreements with Truven Health Analytics and the Centers for Medicare & Medicaid Services (CMS). The work using MarketScan data was determined not to involve human patients under 45 Code of Federal Regulations (CFR) 46.102(f); therefore, institutional review board review was not required [12]. The work using CMS data was determined to be exempt from the regulations that govern the protection of human patients in research under 45 CFR 46.101(b)(5) [12].

Study Population

CAP hospitalizations were identified by selecting those with a primary diagnosis of bacterial or unspecified pneumonia (*International Classification of Diseases, Ninth Revision, Clinical Modification* [ICD-9-CM], diagnosis codes: 481, 482.0, 482.1, 482.2, 482.30, 482.31, 482.32, 482.39, 482.40, 482.41, 482.42, 482.49, 482.82, 482.83, 482.84, 482.89, 482.9, 483.0, 483.1, 483.8, 485, 486) [13] among patients not hospitalized in the 30 days prior to index hospitalization. We defined complicated CAP as having a complication or lack of

clinical stability that required extended LOT. To operationalize this definition and restrict it to those with uncomplicated CAP, we limited it to patients with hospitalization lengths of 2–10 days, discharged home with self-care, and not rehospitalized within 3 days after the index discharge. We also excluded underlying conditions or complications that potentially warranted prolonged antibiotic courses. Specifically, we excluded patients with a cystic fibrosis diagnosis (ICD-9-CM diagnosis code 277.00, 277.01, 277.02, 277.03, 277.09), human immunodeficiency virus (HIV) diagnosis (ICD-9-CM diagnosis code 042), or an outpatient antibiotic supply that exceeded 28 days [10].

One hospitalization was selected at random for inclusion if a patient had multiple eligible hospitalizations >30 days apart during the study period. Due to data source restrictions, patients were stratified into the following 2 demographic cohorts: those aged 18–64 years with private insurance and those aged ≥65 years with Medicare.

Definition of Antibiotics

Antibacterial agents were identified in the drug files through a combination of National Drug Codes, automated text, and manual searching to account for variations in spelling of antibiotics between claims and reference data. Antibiotics were categorized into classes using the American Hospital Formulary Service Drug Information and World Health Organization drug classification systems.

Measures

The primary measures of interest were median (quartile 1–quartile 3) total LOT and proportion of patients with a LOT that exceeded 3 days of outpatient antibiotic therapy following discharge (described further in “Total length of therapy” and “Excessive Length of Therapy” sections).

Total Length of Therapy

Patient-level total LOT was calculated by summing inpatient and outpatient LOTs. Because no single data source contained both inpatient and outpatient antibiotic use information, inpatient LOT was estimated based on a function of length of stay (LOS) derived from prediction models and outpatient LOT consisted of actual days filled.

Inpatient Length of Therapy

Using linear regression, inpatient LOT was modeled as a function of LOS for both demographic cohorts using data from the MarketScan Hospital Drug Database (HDD). The HDD is a relational database developed from hospital charge detail master data that contains all charges accumulated during a hospitalization, including for pharmacy products. Patient discharge information such as diagnosis and procedure codes, patient demographics, and facility characteristics are also included. These data have been used to study inpatient pharmacy use, including probiotics [14] and antibiotics [15]. Data were limited to hospitals that submit antibiotic data directly to Truven Health, patients receiving ≥1 inpatient antibiotic, and restriction criteria listed above.

An inpatient LOT prediction table of mean LOT for each cohort was developed based on the prediction model estimates of LOT using LOS as a categorical predictor. LOS was counted as whole days using admission and discharge dates rather than days present; therefore, LOT exceeds LOS in some instances. Goodness of model fit was assessed using the R^2 value. Inpatient LOT was then assigned to each patient based on the corresponding age group and LOS in the prediction table. We validated the inpatient prediction model by comparing estimated and observed inpatient LOTs among a subset of patients aged 18–64 years for whom inpatient and outpatient prescribing records could be linked for the years 2006–2013.

Outpatient Length of Therapy

To assess outpatient LOT, outpatient drug records were searched for antibiotic prescriptions filled between −1 and +3 days of discharge. If a patient had multiple outpatient antibiotic prescriptions filled during this period, the outpatient LOT was counted as the number of days with ≥1 prescription from the earliest fill date through the latest supply through date, inclusive (Supplementary Figure S1). The average proportion of total LOT contributed by the outpatient LOT was estimated by the median (quartile 1–quartile 3).

For the 18–64 year cohort, MarketScan Commercial Claims and Encounters files, drawing from hundreds of private-sector payers, were used to obtain LOS of the index hospitalization and outpatient LOT following discharge. Patients in this cohort consisted of those enrolled in private insurance with outpatient drug coverage. For the ≥65 year cohort, the 100% Medicare claims and Part D event files were used to obtain index hospitalization LOS and outpatient LOT following discharge. Patients in this ≥65 year cohort included the census of beneficiaries aged ≥65 years with traditional fee-for-service Parts A and B plus Part D Medicare coverage.

Excessive Length of Therapy

Recommended LOT is dependent on time to clinical stability [5]. Since we lacked clinical data to evaluate clinical stability directly, we used hospital discharge as a surrogate based on the assumption that patients were clinically stable at discharge [5, 16]. Our primary standard for exceeding the recommended LOT, therefore, used outpatient LOT >3 days, reasoning that LOS plus 3 days of outpatient therapy following discharge should be a patient-specific approximation of recommended LOT per IDSA–ATS guidelines [5, 9]. Number of days with excessive antibiotic use was quantified by summing patient-level outpatient LOT minus 3 days. We used a secondary standard defining recommended LOT as 7 days, since longer durations are rarely necessary according to IDSA–ATS guidelines [5].

Data Analyses

The association between categorical variables was evaluated using the χ^2 test of independence. Likelihood of an event occurring was compared between 2 groups using an odds ratio. Data management and analyses were conducted using SAS, version 9.4 (SAS Institute Inc., Cary, North Carolina).

RESULTS

Length of Stay

Median (Q1–Q3) LOS was 3 (2–5) days for the 18–64 year cohort and 4 (3–5) days for the ≥65 year cohort.

Inpatient Length of Therapy

To estimate inpatient LOT, 6900 and 19 139 patient hospitalizations were included among those aged 18–64 years and ≥65 years, respectively. Predicted LOTs were generated for each value of LOS stratified by cohort (Figure 1, Supplementary Table S1). The R^2 values for both models were greater than 0.7. Characteristics of the patients used in these models are shown in Supplementary Figure S2 and Supplementary Table S2. Based on these models, the estimated median (Q1–Q3) inpatient LOT was 3.4 (2.5–5.3) days for the 18–64 year cohort and 4.3 (3.4–5.2) days for the ≥65 year cohort.

After applying restrictions, 1177 patients aged 18–64 years had linked inpatient and outpatient prescribing records for the years 2006 through 2013 for prediction model validation. Among these, mean estimated inpatient LOT was 4.5 (95% confidence interval [CI], 4.4–4.6) days and mean actual inpatient LOT was 4.6 (95% CI, 4.4–4.7) days (Supplementary Table S3). Eighty-six percent of these patients had a predicted inpatient LOT within 1 day of the actual inpatient LOT (see Supplementary Figure S3 for agreement plot).

Outpatient Length of Therapy

As shown in Figure 2, 22 128 and 130 746 patient hospitalizations were included to estimate outpatient and total LOT among the 18–64 year and ≥65 year cohorts, respectively. Demographic and hospitalization characteristics are listed in Table 1. Eighty percent of patients in both cohorts had at least 1 documented outpatient antibiotic fill within −1 to 3 days of discharge. The median outpatient LOT was 6 (3–7) days in the 18–64 year cohort and 5 (3–7) days in the ≥65 year cohort. Seventy-four percent of patients aged 18–64 years and 71% of patients aged ≥65 years exceeded the recommended LOT, using >3 days to define excessive, translating to 71 474 (3.2 per patient) and 375 289 (2.9 per patient) unnecessary days of antibiotic in the respective cohorts.

Presence of outpatient antibiotic prescription was associated with LOS ($P < .0001$), with a longer LOS being more likely to lack an outpatient prescription (Supplementary Table S4). Of the 20% without outpatient antibiotic, only 3% obtained antibiotic through other measureable means such as outpatient intravenous therapy (Supplementary Tables S5 and S6).

Total Length of Therapy

The median (Q1–Q3) total LOT, a combination of inpatient and outpatient LOT, was 9.5 (7.4–12.3) days in the 18–64 year cohort and 9.5 (7.4–11.4) days in the ≥65 year cohort (Supplementary Table S7). Sixty-nine percent of patients aged 18–64 years and 67% of patients aged ≥65 years had a LOT that exceeded 7 days (Figure 3). The outpatient LOT

comprised a median 59% (41%–70%) of total LOT among those aged 18–64 years and 57% (37%–68%) among those aged ≥65 years.

Antibiotic Selection

Figure 4 shows the ranking of antibiotic classes used for each setting and demographic cohort. In the inpatient setting, the top 3 antibiotic classes, accounting for 65%–75% of days of therapy, were third- and fourth-generation cephalosporins, quinolones, and macrolides for both cohorts (Supplementary Table S8). Eighty-two percent of inpatient antibiotic days of therapy were parenterally administered in both cohorts (Supplementary Figure S4).

In the outpatient setting, the top 3 antibiotic classes were quinolones, macrolides, and first- and second-generation cephalosporins for both cohorts. More than 99% of outpatient prescriptions were orally administered (Supplementary Figure S4, Supplementary Table S9).

DISCUSSION

In this study, adults hospitalized for CAP in the United States received a median of just under 10 days of antibiotic therapy in 2012–2013. More than 70% of patients exceeded the recommended duration of antibiotics according to our definition, translating to 71 474 and 375 289 unnecessary days of antibiotic for the younger and older cohorts, respectively. These findings reveal likely overtreatment with antibiotics among patients hospitalized with CAP and suggest an important target for antibiotic stewardship programs.

The CDC Core Elements for both hospital and outpatient antibiotic stewardship programs call for policies and interventions to improve antibiotic use, including appropriate duration of antibiotic therapy [4, 17]. While data on optimal LOT are lacking for many infections, the data that support effective and safe duration for antibiotic therapy are stronger for CAP. A 2007 metaanalysis of 15 inpatient and outpatient trials showed no difference in clinical failure risk between patients given antibiotic courses ≤7 days vs >7 days (relative risk, 0.89; 95% CI, 0.78–1.02) [18]. Recently, the efficacy and safety of a LOT ≤7 days was affirmed by a noninferiority randomized controlled trial of patients admitted to 4 hospitals in Spain [19]. The trial found no difference in clinical success between patients treated with an average of 5 days of antibiotics according to IDSA–ATS guidelines (day 10, 56% success; day 30, 92% success) vs patients treated based on physician discretion with an average LOT of 10 days (day 10, 49% success; day 30, 89% success). The availability of robust data on appropriate LOT for CAP, combined with CAP being a common indication for antibiotic therapy [1], make this syndrome a particularly compelling target for stewardship.

Resolution of excessively long LOTs may necessitate an approach that addresses antibiotic prescribing at discharge for patients hospitalized with CAP [20]. Based on the findings in this and prior studies, excess outpatient prescribing may be an important reason for excess LOT. As described in the Results section, 57%–59% of the total LOT consisted of outpatient therapy. In a multicenter Veteran's Health Administration (VA) study, median outpatient, not inpatient, LOTs differed between guideline concordant and discordant groups, with median (quartile 1–quartile 3) outpatient LOTs of 3 (2–5) and 6 (4–7) days, respectively [9]. Further supporting the important role of outpatient prescribing on total LOT, other studies have

shown a large portion of total duration as outpatient LOT [7] as well as decreased outpatient LOTs driving successful intervention studies [6, 11].

Approaches used in single-center antibiotic stewardship interventions have reported average LOT drops of 3 days from baseline among patients treated for CAP [6, 8, 11], which may be a feasible and effective ways to reduce LOT. These interventions include provision of education and direct feedback to medical staff and hospital attending physicians [6]; development of new guidelines with computer support promoted to hospitalists, other clinicians, and pharmacists [11]; and implementation of a patient-centered antimicrobial stewardship program [8].

Our study allows for broader generalizability than previous studies through the use of large, multifacility, nationwide cohorts. In the younger cohort, 22 128 patients across 2100 hospitals in 50 states plus the District of Columbia were represented. In the older cohort, the census of Medicare beneficiaries with traditional fee-for-service plus Part D coverage were represented, tallying to 130 746 patients across 3227 hospitals in 50 states plus the District of Columbia. Previous studies have been limited to predominantly male patients admitted to VA hospitals [8, 9], single hospitals [6–8], or international studies not separately reporting the findings of US hospitals [10]. Despite differences in study design, the findings of this study corroborate with those of the smaller, less representative studies. The largest of the US studies—a retrospective study of 30 US VA hospitals that included more detailed clinical information—had a median LOT of 10 (8–12) days, with 93% of patients exceeding LOT guidelines [9]. Other studies reported median LOTs of 10 days [6, 7] and mean LOTs of 11–12 days [8, 10].

While reliance on administrative data allowed for nationwide estimates, which is a strength of this study, limitations associated with administrative data should be acknowledged. We identified potential CAP patients using a constellation of ICD-9-CM codes. These codes have good sensitivity (84%) and positive predictive value (92%) for pneumonia when listed as the first diagnosis code [21]. However, there is potential for misclassification since we were unable to confirm the diagnosis using clinical data (eg, imaging results, symptoms, and white blood cell count). Furthermore, we may not have captured all discharge antibiotic prescription fills since some may have been obtained without using the outpatient prescription drug benefit, thus the median intended LOT could be underestimated. Also due to data limitations, we were unable to evaluate LOT among patients without health insurance or with health insurance but without drug coverage.

Although clinical data were not available to define clinical stability, we used discharge, a point at which clinical stability should be met, to approximate clinical stability. Prior studies have shown the median time to clinical stability in CAP patients to be 3 days, with most patients reaching clinical stability prior to discharge [16, 22], suggesting our surrogate for clinical stability may be conservative.

We were limited in our ability to exclude healthcare-associated and hospital-acquired pneumonia (HCAP and HAP) since the relevant information was limited or not available across all data sources. Patients classified with HCAP would include those who resided in a

nursing home or long-term care facility or those who received hemodialysis, intravenous (IV) antibiotics, IV chemo-therapy, or wound care in the 30 days [23] before index admission. Patients with HAP due to the index hospitalization would include those newly infected at least 48 hours after hospital admission [23]. Using available data (as shown in Table 1), approximately 12%–13% of patients may have met 1 or more criteria for HCAP. Median LOT did not differ between patients with and without potential HCAP for both age cohorts (data not shown). Only 0.03% of the ≥65 year cohort could be classified as a HAP due to having a primary diagnosis of pneumonia that was not present on admission. Based on these numbers, it is likely that only a small portion of the patients included in this study were misclassified as CAP.

We attempted to exclude patients who may appropriately require prolonged antibiotic therapy, such as patients with cystic fibrosis, symptomatic HIV, or more complicated cases as suggested by prolonged hospitalizations or readmissions. We did not, however, exclude all risk factors for complicated CAP that might merit longer treatment durations, such as other immune deficiencies, structural lung disease/bronchiectasis, empyema/lung abscess, and chronic steroid use. Nevertheless, as shown in Table 1, other HIV/AIDS, bronchiectasis, empyema, and lung abscesses were rare across the cohorts and therefore should not account for the overall long treatment durations.

The majority of adult patients treated for CAP in US hospitals in 2012–2013 had antibiotic therapy durations that exceeded recommendations. These findings suggest prolonged and potentially excessive antibiotic treatment among patients hospitalized with uncomplicated CAP. Stewardship at the time of discharge may be an important target for antibiotic stewardship programs. Optimization of the duration of therapy, combined with optimal antibiotic selection and dosing, should help to maximize benefits to the patient while minimizing potential harms.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

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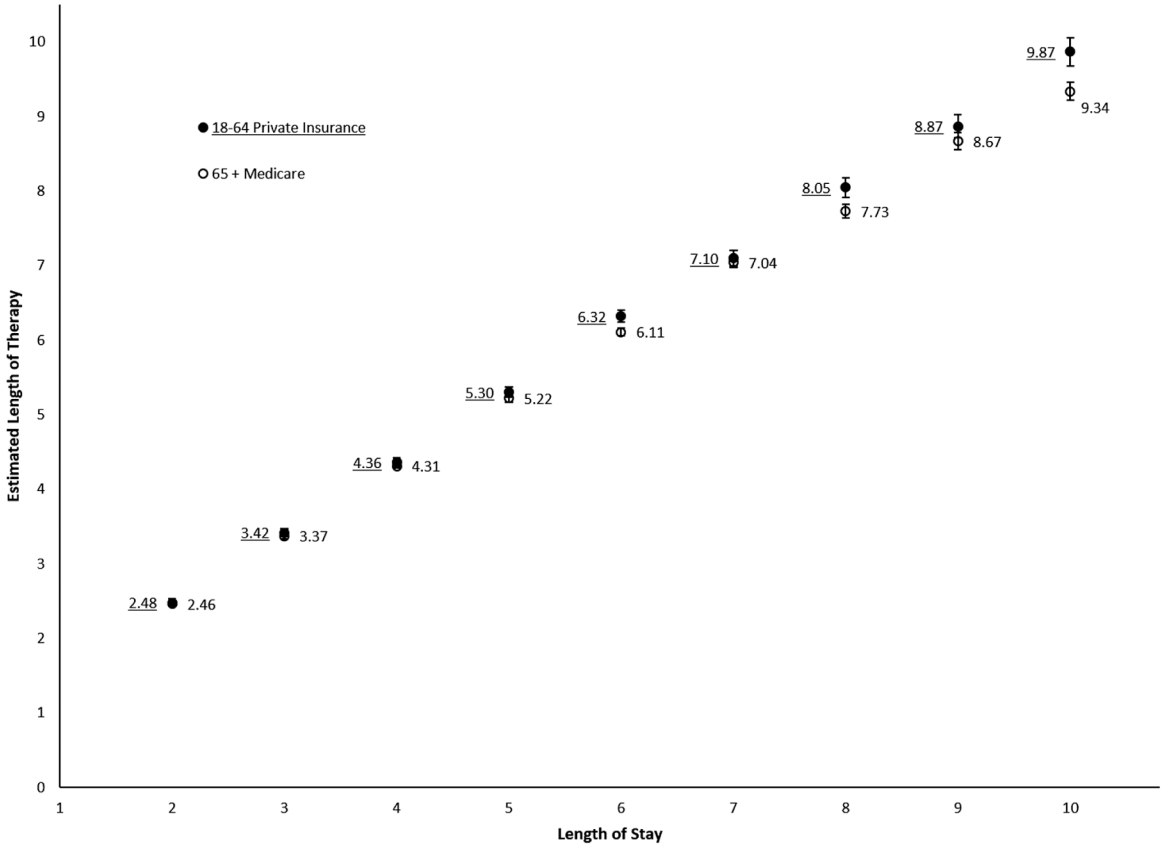

Figure 1.

Prediction model of inpatient length of therapy in adults hospitalized for community-acquired pneumonia. Data were obtained from the MarketScan Hospital Drug Database. Restricted to patients receiving ≥1 inpatient antibiotic plus restriction criteria listed in the Methods section. Using linear regression, inpatient length of therapy (LOT) was modeled as a function of length of stay (LOS) as follows: $LOT = \beta_1 LOS_{2days} + \beta_2 LOS_{3days} + \beta_3 LOS_{4days} + \beta_4 LOS_{5days} + \beta_5 LOS_{6days} + \beta_6 LOS_{7days} + \beta_7 LOS_{8days} + \beta_8 LOS_{9days} + \beta_9 LOS_{10\ days}$. R^2 values: 18–64 years, 0.78; 65+ years, 0.73.

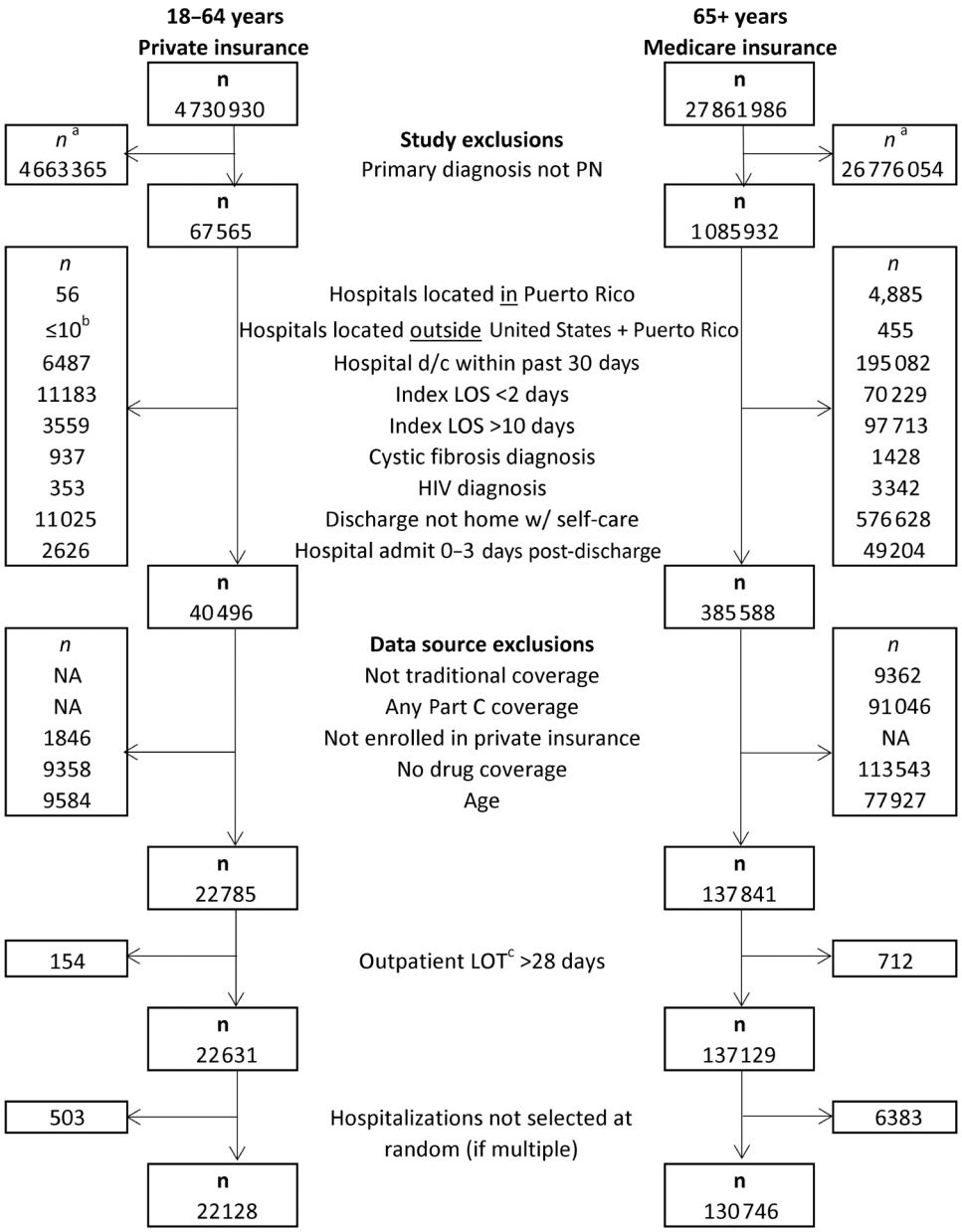

Figure 2.

Flow diagram of eligibility and inclusion of adults hospitalized for community-acquired pneumonia. [a]Reasons for exclusion are not mutually exclusive. [b]In accordance with the Centers for Medicare & Medicaid Services data use agreement and for consistency in presentation, actual number and corresponding percent of total were not displayed when cell sizes ≤10. [c]Outpatient antibiotic prescription filled within −1 to +3 days of discharge from index hospitalization. Abbreviations: d/c, discharge; HIV, human immunodeficiency virus; LOS, length of stay; LOT, length of therapy; NA, not available; PN, pneumonia.

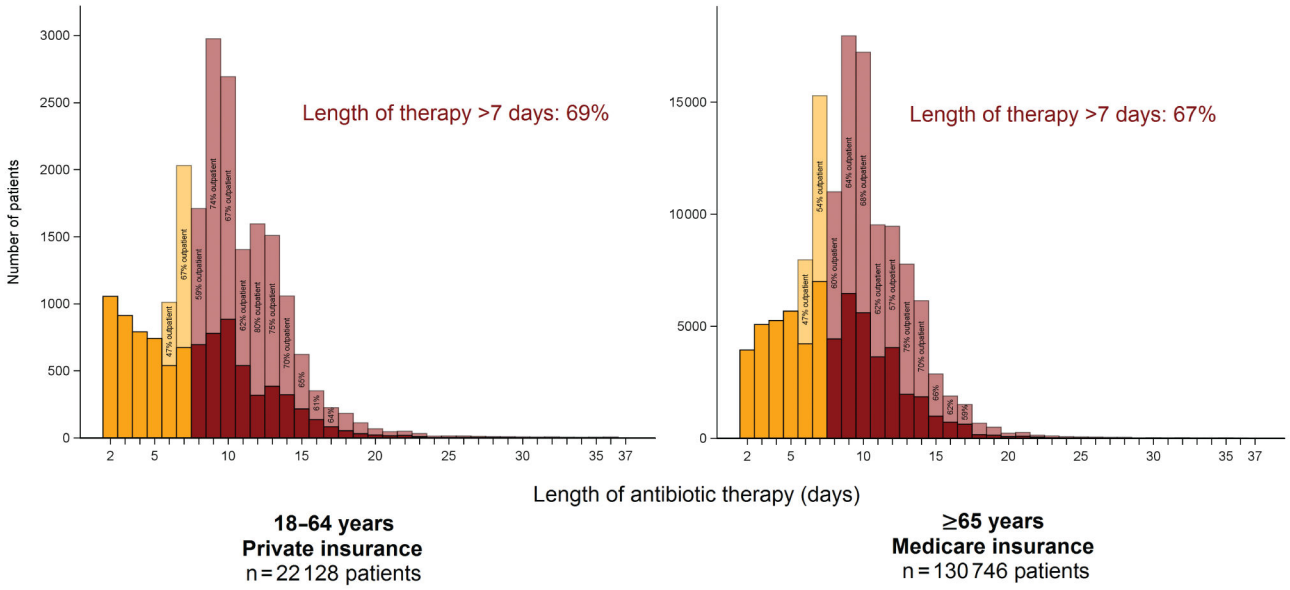

Figure 3.
Total length of antibiotic therapy of adults hospitalized for community-acquired pneumonia.

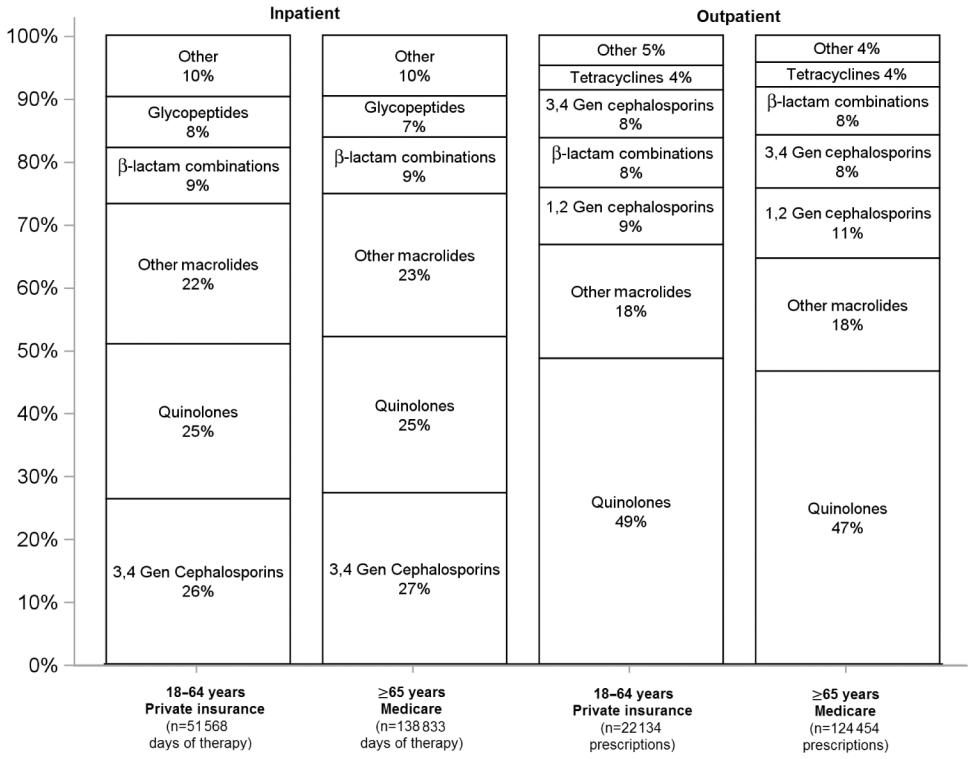

Figure 4.

Antibiotic selection by setting and demographic among adults hospitalized for community-acquired pneumonia. Inpatient antibiotic class selection data were ranked by days of therapy. Outpatient antibiotic class selection was ranked at the prescription level. Antibiotics from separate classes that may have been used in combination therapy are treated independently. Percent selection for a given antibiotic class was calculated as follows: inpatient setting: number of days of therapy for given antibiotic class/total number of days of therapy and outpatient setting: number of prescriptions for a given antibiotic class/total number of prescriptions. β-lactam combinations refers only to β-lactam/β-lactamase combinations. Abbreviation: gen, generation.

Table 1.

Characteristics of Adults Hospitalized for Community-Acquired Pneumonia

Category	Value	Aged 18–64 Years, Private Insurance (n = 22 128)		Aged ≥65Years, Medicare Insurance (n = 130 746)	
		No.	(%)	No.	(%)
Age, y	18–44	5849	26	NA	
	45–64	16 279	74	NA	
	65–84	NA		104 033	80
	85+	NA		26 713	20
Sex					
	Male	10 014	45	57 945	44
	Female	12 114	55	72 801	56
Race					
	White	NA		110 330	84
	Black	NA		10 406	8
	Other	NA		10 010	8
Healthcare use 30 d prior to hospitalization					
Outpatient claims		8955	40	54 147	41
Hospice claims		28	0	188	0.1
Potential healthcare-associated pneumonia					
	Total	2581	12	16 565	13
	IV antimicrobial therapy[a]	1609	7	7314	6
	IV chemotherapy[a]	754	3	4566	3
	Hemodialysis	313	1	4922	4
	Skilled nursing facility claims	19	0	1134	0.9
Index hospitalization (2–10 day LOS)					
Admission type[b]					
	Medical	21 371	97	129 130	99
	Surgical	752	3	1615	1
Admission type					

Category	Value	Aged 18–64 Years, Private Insurance (n = 22 128)		Aged ≥65Years, Medicare Insurance (n = 130 746)	
		No.	(%)	No.	(%)
	Elective	NA		8989	7
	Urgent	NA		22 963	18
	Emergency	NA		98 425	75
	Other (trauma or unknown)	NA		369	<1
Admission diagnosis					
	Rank 1: Pneumonia, organism unspecified[C]	NA		67 102	51
	Rank 2: Shortness of breath[C]	NA		18 596	14
	Rank 3: Cough[C]	NA		6603	5
	Pneumonia: 481–486	NA		69 781	53
Pneumonia, present on admission					
	Present	NA		129 415	99
	Not present	NA		43	0.03
	Other (undetermined, insufficient info, exempt)	NA		1288	1
Intensive care unit status					
	Any stay	1396	6	25 551	20
	No stay	20 732	94	105 195	80
LOS, d					
	2	6466	29	30 958	24
	3	5868	27	33 762	26
	4	3848	17	24 560	19
	5	2264	10	15 815	12
	6	1441	7	10 325	8
	7	960	4	6801	5
	8	608	3	4251	3
	9	424	2	2642	2
	10	259	1	1632	1
Diagnosis-related group					
	Median (Q1–Q3) weight	1.0	1.0–1.5	1.0	1.0–1.5

Category	Value	Aged 18–64 Years, Private Insurance (n = 22 128)		Aged ≥65Years, Medicare Insurance (n = 130 746)	
		No.	(%)	No.	(%)
	193 Simple pneumonia and pleurisy with MCC	5191	23	30999	24
	194 Simple pneumonia and pleurisy with CC	9801	44	60 917	47
	195 Simple pneumonia and pleurisy without CC/MCC	5440	25	30 661	23
Hospitals		2100		3227	
States, districts[b,d]		51		51	
Hospital census region					
	Northeast	3247	15	21 115	16
	South	9657	44	58 944	45
	Midwest	5726	26	30 405	23
	West	2608	12	20 279	16
	Unknown	890	4	≤10[e]	0
Hospital size, number of beds[b]					
	1–199	NA		46 758	36
	200–299	NA		24 645	19
	300–499	NA		33 275	25
	≥500	NA		26 065	20
Discharge diagnoses[f]					
	Heart failure	1668	8	30 785	24
	Chronic obstructive pulmonary disease and bronchiectasis	4944	22	54 236	41
	Bronchiectasis	313	1	3181	2
	Empyema/lung abscess	238	1	216	0.2
	Asthma	3623	16	13 886	11
	Diabetes	3796	17	43 327	33
	Chronic kidney disease	1108	5	27 311	21
	End stage renal disease	484	2	5371	4
	Stroke	248	1	5227	4
	Liver disease, cirrhosis, and other liver conditions, viral hepatitis	906	4	2988	2
	Cancer/malignancy	2571	12	32 090	25

Category	Value	Aged 18–64 Years, Private Insurance (n = 22 128)		Aged ≥65Years, Medicare Insurance (n = 130 746)	
		No.	(%)	No.	(%)
	Other human immunodeficiency virus/AIDS	24	0	111	0
Procedures[f]					
	Hemodialysis	308	1	4566	3
	Mechanical ventilation	111	0.5	482	0.4
Discharge quarter					
	January-March	6354	29	40 680	31
	April-June	5490	25	33 147	25
	July-September	4646	21	25 291	19
	October-December	5638	25	31 628	24
Follow-up (−1 to +3 days following discharge)					
Number of outpatient prescriptions[g]					
	0	4419	20	26 390	20
	1	13 927	63	85 012	65
	2	3609	16	18 647	14
	≥3	173	0.8	697	0.5
Number of deaths following discharge		NA		258	0.2

Abbreviations: CC, complication or comorbidity; IV, intravenous; LOS, length of stay; MCC, major complication or comorbidity; NA, not available; Q, quartile.

[a] Includes durable medical equipment, home health, hospice, outpatient hospital, and skilled nursing services.

[b] Missing values—Admission type: 18–64 years, n ≤ 10; ≥65 years, n ≤ 10. Hospital size: ≥65 years, n ≤ 10. Number of states: ≥65 years, n ≤ 10 patient hospitalizations.

[c] 486, pneumonia, organism unspecified; 786.05, shortness of breath; 786.2, cough.

[d] Maximum number of states and districts is 51 due to the inclusion of the District of Columbia.

[e] In accordance with the Centers for Medicare & Medicaid Services data use agreement and for consistency in presentation, actual number and corresponding percent of total were not displayed when cell sizes ≤10.

[f] Constellations of diagnosis and procedure codes for each diagnosis and procedure based on the following resources:

-CCW chronic conditions: https://www.ccwdata.org/cs/groups/public/documents/document/ccw_chronic_cond_algos.pdf

-Other chronic or potentially disabling conditions: https://www.ccwdata.org/cs/groups/public/documents/document/other_cond_algos_consolidated.pdf

-Clinical classifications software for ICD-9-CM: https://www.hcup-us.ahrq.gov/toolssoftware/ccs/ccs.jsp

[g]Antibiotic prescriptions filled between −1 and +3 days following discharge.