Long-Term Cost Consequences of Community-Acquired Pneumonia in Adults

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ABSTRACT

Objectives: To estimate the time required for healthcare costs to revert to baseline levels among adults who had an episode of community-acquired pneumonia (CAP).

Methods: This retrospective study utilized claims data from 14 United States regional health plans currently in the HealthCore Integrated Research Database (HIRD). Pneumonia episodes were identified from January 1, 2008, to May 17, 2010, using *International Classification of Disease, Ninth Revision, Clinical Modification* codes with chest x-ray claims. Study inclusion required continuous enrollment 6 months prior to and 9 months post-diagnosis. The analysis allowed for a 90-day illness episode, and excluded costs but included time during the period to revert to baseline costs. Post-CAP costs, starting at day 91, were followed for 6 months. Results, stratified by age and risk level, were analyzed with the Theil non-parametric regression procedure.

Results: A total of 88,358 CAP patients aged ≥18 years (37% aged 18-49 and 63% ≥50 years) were assessed. In the 18 to 49 years group, 47%, 38%, and 16% were from the low, moderate, and high-risk groups, had monthly pre-diagnosis costs of $423, $1173, and $3520, and required an average of 247, 562, and 574 days to return to pre-CAP cost levels, respectively. Among patients aged ≥50 years, the average monthly pre-diagnosis costs were $527, $1263, and $3411, and costs reverted to pre-CAP levels after an average of 252, 678, and 610 days for the low, moderate, and high-risk groups, respectively.

Conclusions: Despite clinical recovery from a CAP episode in the short term, these results suggest likely long-term cost consequences from a CAP episode, regardless of age or risk.

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Community-acquired pneumonia (CAP), a commonly diagnosed infective disorder, is one of the leading causes of morbidity and mortality worldwide.[1-3] In the United States, an estimated 5 to 6 million cases of CAP are diagnosed every year, which require approximately 1 million hospitalizations and about 10 million visits to physicians' offices.[4-6] CAP affects about 4 million adults in the United States annually, and is considered the country's seventh-leading cause of death together with influenza among individuals older than 65 years.[7] While CAP does not appear to have any gender or racial correlations, it is particularly common among older adults. In a 3-year study that included 46,273 seniors, Jackson et al found rates of CAP ranging from 18.2 to 52.3 cases per thousand person-years among patients aged 65 to 69 years and ≥85 years, respectively.[8] A 2004 review of the total annual cost of CAP in the United States is estimated to be at least $12.2 billion,[9] and in a 2010 study, File et al demonstrated that the overall annual costs associated with CAP had grown to more than $17 billion.[10]

Typically, CAP manifests as acute infections of the pulmonary parenchyma[11] and shows up as an acute infiltrate in chest x-rays.[4] Clinical symptoms include coughing, sputum production, chest pain, and fever in infected patients. Antibiotic treatment remains the dominant therapeutic intervention. An estimated 25% of all CAP patients require inpatient hospitalization,[6] of which the majority are older adults with a wide variety of comorbidities including chronic obstructive pulmonary disease (COPD), or chronic bronchitis (not emphysema), diabetes, heart disease, etc.[6,12] While the use of healthcare services by CAP patients in outpatient settings is quite common,[1] precise quantitative data are less readily available.

In efforts to gauge the effectiveness of treatment interventions, particularly of antibiotic therapy, researchers have employed a range of traditional outcome measures including mortality rates, rehospitalization rates, and healthcare

utilization rates, calculated mostly on the basis of length of hospital stay.[13] These traditional outcomes did not necessarily take into consideration outcomes of importance to the patients.[2] This was overcome in a number of studies that assessed outcomes and recovery from the patient perspective.[14-19] Available evidence suggests that a substantial proportion of CAP patients report pneumonia-associated symptoms 1 month after the initial presentation[7,18,20,21] and these could extend to more than 90 days after diagnosis.[18]

While the aforementioned studies have assessed the time required to recover from an episode of CAP from the perspective of patients by assessing symptom resolution and return to work or normal activities, it would appear that no study has yet evaluated when healthcare resource use returns to pre-CAP levels. The purpose of this study was to estimate the time needed for healthcare resource use to return to pre-CAP baseline levels in adult patients, expressed in terms of costs, and stratified by age and risk in a large commercially insured population.

PRACTICAL IMPLICATIONS

- The results of this study show that the costs of an episode of community-acquired pneumonia extend beyond the 90-day allowance for the illness.
- Differences in the length of time to revert to pre-episode costs depend on the age category and risk stratification of patients at the time the episode started.
- Increased costs for some patients can extend beyond 1 year and may approach 2 years in some cases.

METHODS

Data Source

This was a retrospective study that utilized medical and pharmacy claims, and eligibility data for commercially insured patients to evaluate the burden of CAP at the patient level for the period January 1, 2008, to May 17, 2010. All study data were retrieved from the HealthCore Integrated Data Base (HIRD), a comprehensive repository of clinically rich longitudinal claims data drawn from 14 health plans operating in most major population centers across the United States. The HIRD houses data from different types of benefit designs including health maintenance organizations, point of service, preferred provider organizations, and indemnity plans, and tracks enrollment, medical care, prescription drug use, and health care utilization for each patient. All study data were de-identified and accessed using protocols compliant with the regulations of the Health Insurance Portability and Accountability Act of 1996 (HIPAA). Patient confidentiality and the anonymity were safeguarded throughout the study.

Inclusion and Exclusion Criteria

Included patients had 1 or more medical claims with a primary or secondary diagnosis of pneumonia for an inpatient claim, or a pneumonia diagnosis in any position for an outpatient claim during the study period. Pneumonia was identified based on *International Classification of Disease, Ninth Revision, Clinical Modification* (*ICD-9-CM*) codes of 480.xx to 486.xx and 487.0. The service date of the first observed claim for pneumonia was defined as the index date. Other inclusion criteria included a chest x-ray claim within 14 days of the index date, age 18 years or older, and continuous medical and pharmacy eligibility for 6 months before and 9 months after the index date. To refine CAP identification, patients were excluded if they were hospitalized or institutionalized for any reason in the 14 days prior to the index date. To distinguish one pneumonia episode from another, patients who had a pneumonia diagnosis in the 90 days before the index were also excluded.

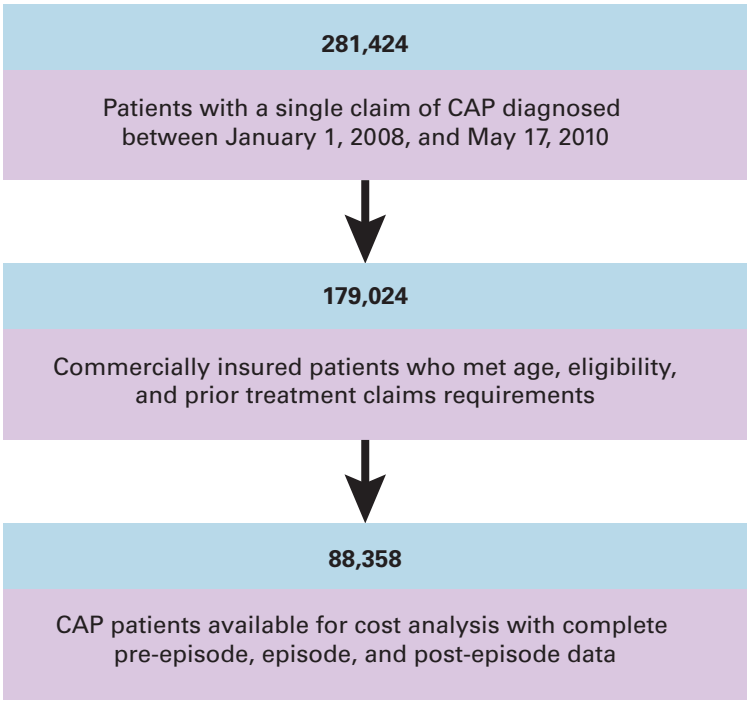
Outcome Measures

The primary outcome measures were all-cause related healthcare resource utilization and costs. All-cause costs represented the total amounts paid by the health plan and by patients for medical treatment, pharmaceuticals, office, outpatient, and emergency department (ED) and inpatient services. Costs for office visits, outpatient facility visits, and ED visits were defined as the total cost for all claims at the service location for patients who met the eligibility criteria—diagnosis for pneumonia. In addition, all-cause costs for hospitalizations were defined as the total cost for all claims at an inpatient facility regardless of the primary or secondary diagnosis. The same methods were used to compute pharmacy costs as well. Antibiotic administration costs were included in inpatient, outpatient, office visit, or ED, depending on the site where the treatment was provided.

Statistical Analysis

Because the cost to treat CAP differs by age and underlying comorbidities, data analyses were stratified on these variables. Three risk groups were defined: high risk—immunocompromising conditions; moderate risk—immunocompetent but with chronic medical conditions; and low risk—immunocompetent without any chronic medical conditions.[22,23]

Figure 1. Patient Disposition During Study Duration



CAP indicates community-acquired pneumonia.

Descriptive statistical methodologies and trend analysis were used in this study. Continuous data were reported out as mean ± standard deviation (SD) and discrete data were reported as the percent in each category and the percent of the total count of patients. Cognizant of the potential limitations of the ordinary least squares (OLS) estimator in a straight-line regression analysis where outliers are present in the data, we opted to utilize the Theil regression method to estimate the time needed for healthcare resource use to return to pre-CAP baseline levels. The Theil approach offers a simple yet robust way to address such issues as outliers and non-normality of the dependent variable, which in this application is the number of days required for the patient to return to normal, pre-episode cost. OLS regression was not used, as it is frequently influenced by outliers and carries assumptions of distribution normality. Theil regression takes each X and Y pair of data within a data set and calculates all combinations of slope values for every X and Y pair. In the current study, the X variable is time and the Y variable is all-cause costs. The slope values are ordered from highest to lowest, and the median slope value is taken as the slope for that data set. The theory is that high or low X Y pairs of data (due to outliers) will yield very high or low slope values. By taking the median slope value as the estimate for a data set, the outliers are naturally eliminated while still being included in the data set. This eliminates any bias that might occur by (1) including outliers in data sets that are remote by error, and (2) eliminating the effect of outliers by not being forced to have arbitrary decision rules for what data are included because the Theil regression method uses all data.[24]

This study used 3 defined time periods, and all patients were required to have complete data for all time periods to be included in the analysis. First, the "episode" of illness was defined as the 90-day period that began when the diagnosis of CAP appeared in the claim. Post-episode data began when this 90-day episode period concluded and continued for 6 months. The pre-episode period began 6 months prior to the appearance of the CAP diagnosis in the claims.

Theil regression was applied beginning with the first cost value 90 days after the index date (defined as the post-episode period), and continued for 6 months. The slope and intercept for each risk stratum by age group were calculated and the slope of the regression line was used as the rate of cost recovery. Using this regression methodology, it was then possible to calculate the number of days required after the CAP episode for costs to return to normal baseline values. From this analysis the days and the total costs post episode were calculated and reported.

RESULTS

Patient Disposition

Of the patients diagnosed with CAP who satisfied the conditions for inclusion during the intake period (N = 281,424), a total of 179,024 were commercially insured and met the age, eligibility, no prior treatment, and service claims requirements. Of those, a total of 88,358 CAP patients were available for assessment because they had complete data for the 6-month pre-episode, 90-day episode, and the 6-month post episode periods—a total of 15 months, as displayed in **Figure 1**.

Clinical and Demographic Characteristics at Baseline

Of the included CAP patients, the mean (± SD) age was 55.8 (± 17.9) years. There was a slightly larger proportion

Table 1. Demographic by Age and Risk for All Commercially Insured CAP Patients

	Low Risk		Moderate Risk		High Risk		Total	
Age, y	N	%	N	%	N	%	N	%
18-49	23,385	56.7	7454	22.4	1402	10.1	32,241	36.5
50-64	12,941	31.4	11,556	34.8	4752	34.3	29,249	33.1
65-74	2451	5.9	5542	16.7	3035	21.9	11,028	12.5
75-84	1573	3.8	5467	16.4	3205	23.2	10,245	11.6
≥85	922	2.2	3231	9.7	1442	10.4	5595	6.3
Total	41,272	100.0	33,250	100.0	13,836	100.0	88,358	100.0

CAP indicates community-acquired pneumonia.
Low risk: immunocompetent without chronic medical condition. Moderate risk: immunocompetent but with chronic medical condition. High risk: immunocompromising conditions.

of females (52.2%). The age group and risk stratification data are presented in **Table 1**.

Greater proportions of patients were located in the central (32.5%) and southern (31.3%) regions of the United States than in the west (20.2%) and northeast (15.9%). More than one-half (58.4%) of the patients had a 0 Deyo-Charlson Comorbidity Index (DCI) score, which indicates a healthy population without specified chronic conditions. The DCI includes 17 diagnoses identified by *ICD-9-CM* codes, each with a weighting from 1 to 6. Higher scores represent greater comorbidity burden.[25] Slightly more than one-fifth (22.0%) of the patients had a DCI score of 1 and only 3.4% of the study group had a score that exceeded 5. The most commonly occurring comorbidity was heart disease (among 10.6% of the patients) followed by cancer with 4.9%.

In the overall study population, 46.7% of the patients were classified as low risk, 37.6% as moderate risk, and 15.7% as high risk. Among the patients who were 50 years and older, there was a smaller proportion of patients classified as low risk (31.9%), although the proportions of moderate- (46.0%) and high-risk (22.2%) patients were greater in this age category.

Time to Revert to Pre-Diagnosis Costs

Age Stratification

The average monthly costs for all risk groups combined in the pre-diagnosis period for the 18 to 49 years age group was $1190, which was substantially lower than the $1487 per month in the 50 years and older group. After the 90 days allowed for the episode of CAP, patients in the younger group reverted to baseline cost levels in a shorter time (446 days) versus 491 days among the patients who were 50 years and older.

Our next step was to define the cost during the episode of the 90-day CAP illness and the 6-month post-episode period for the 2 age groups. For the 18 to 49 years of age cohort, the mean total cost of the CAP episode from beginning to end was $12,453. Of this $9117 (73.2%) accumulated during the 3-month episode period and an additional $3336 (26.8%) accumulated until the cost returned to pre-CAP episode baseline costs. For the 50 years and older cohort the mean total cost of the CAP episode from beginning to end was $15,908. Of this, $11,233 (70.6%) accumulated during the 3-month episode period and $4675 accumulated in the 491 days needed to return to the baseline costs.

Risk Stratification

Among the patients aged 18 to 49 years, the average costs per month before they were diagnosed with CAP were $423, $1173, and $3520 in the low-, moderate-, and high-risk categories, respectively. The average time required to return to these baseline cost levels were 247, 562, and 574 days in the low-, moderate-, and high-risk strata, respectively, as shown in **Table 2**. The pre-episode costs were not substantially different for CAP patients older than 50 years. The average pre-episode monthly costs were $527, $1263, and $3411, in the low-, moderate-, and high-risk categories, respectively. The average time to revert to baseline expenditures among low-risk patients in the older than 50 years category was remarkably similar (252 days) to patients in the younger 18 to 49 years group (247 days). The numbers of days to revert to pre-diagnosis costs in the moderate and high-risk strata, however, were substantially longer in the moderate-risk group (678 days), the longest among all the groups, and in the high-risk group (610 days) than among the younger 18 to 49 years old patient segment (562 and 574 days, respectively). Table 2 presents the data for mean (± SD) pre-episode costs and the days needed to return to pre-episode costs for the patients 50 years and over. **Figure 2** displays the baseline (which are the month-to-month costs during the pre-episode period), as well as

Table 2. Mean Baseline (Pre-episode) Monthly Costs and Days Needed Post-episode to Return to Baseline Costs for CAP Patients by Age and Risk[a]

	Low Risk			Moderate Risk			High Risk		
Age	Mean	SD	Days to Return to Baseline	Mean	SD	Days to Return to Baseline	Mean	SD	Days to Return to Baseline
18-49	$423	$46	247	$1173	$44	562	$3520	$202	574
50+	$527	$42	252	$1263	$70	678	$3411	$228	610

CAP indicates community-acquired pneumonia; SD, standard deviation.
[a]Does not include the 90 days allowed for the episode of CAP
Low risk: immunocompetent without chronic medical condition; Moderate risk: immunocompetent but with chronic medical condition; High risk: immunocompromising conditions.

the monthly costs during the episode and the 6-month post-episode costs by risk stratification level for patients aged 50 years and over.

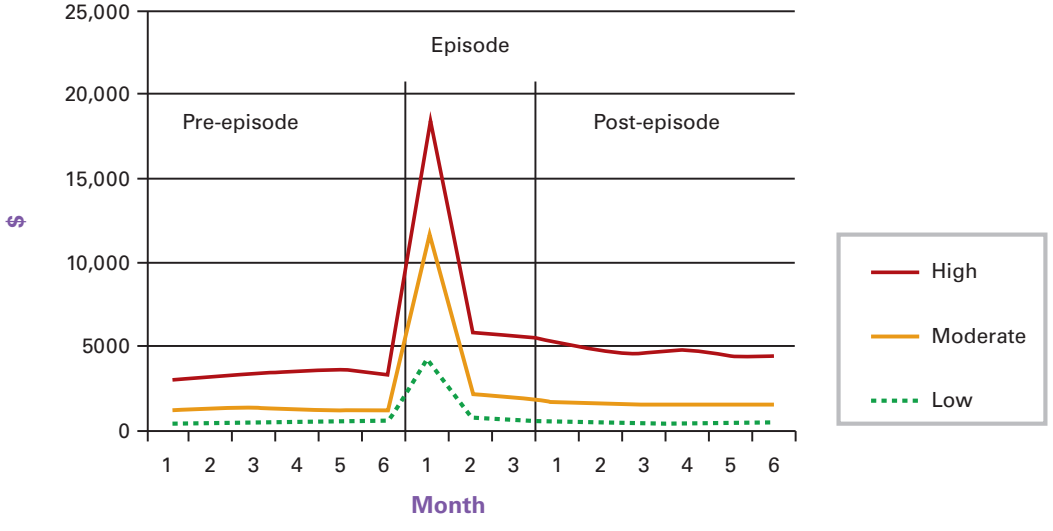
DISCUSSION

This study assessed the length of time that elapsed before CAP patients in 2 broad age categories (18-49 and ≥50 years) were able to curtail spending on healthcare resources and revert to baseline (pre-CAP episode) level expenditures. The return to pre-diagnosis cost levels was evaluated in light of published reports on the time needed for symptomatic recovery from CAP. No earlier study appeared to have employed such a risk stratification scheme, and none estimated the burden of CAP by calculating the cost impact beyond the CAP episode. As a result, this study was able to report not only the cost of the episode, but both the duration of time to return to normal costs and the actual episode and post-episode costs.

The number of days to revert to baseline cost levels in the moderate-risk stratum was substantially shorter (562 days) among the younger patients versus 678 days among those older than 50 years. The gap reduced somewhat for the high-risk patients, with an average of 574 days elapsing before recovery among the younger patients, and 610 days for patients in the older age group. While earlier studies on CAP symptomatology did not evaluate recovery by risk strata, our results were consistent with one of their central findings, ie, CAP symptoms did not necessarily resolve following the completion of a course of antibiotic therapy.[14-19] In fact, our data indicated that cost was probably the last parameter to return back to the pre-CAP baseline value.

Several prior studies relied on clinical outcome measures including mortality, disease recurrence rates, and adverse events, while others assessed outcomes from a patient's perspective via health related quality-of-life (HRQL) measures. One clinical study that evaluated 102

Figure 2. Baseline (Pre-episode), Episode, and Post-episode Costs by Risk Stratification Level for CAP Patients Aged ≥50 years



CAP indicates community-acquired pneumonia.

CAP patients reported that respiratory symptoms were resolved within 14 days, while conditions that were associated with patient well-being took a longer time.[2] Furthermore, the authors argued that once the pre-pneumonia status of patients was factored in, patients were observed to recover fully after 6 months. They noted that the persistence of symptoms for more than 28 days and accompanying HRQL impairment were more reflective of age and comorbidity status rather than the lingering effects of the CAP infection itself.[2] Our results correlate well with this important finding in that other associated costs of the episode due to other illnesses and comorbidities extend well beyond the actual respiratory symptoms encountered with the CAP episode. This study demonstrates that the risk factors are directly related to the increased recovery time of the higher-risk strata, and are associated with higher cost regardless of age group.

Because our study relied on an economic measure (reversion to baseline costs) as a surrogate for recovery, we were not positioned to address questions associated with patients' perceptions of their quality of life or the impact of their symptoms over time. Consistent with existing literature, however, we found that even though there may be clinical recovery from an acute episode of CAP over a relatively short period of time, well within 3 months, there are lingering CAP symptoms that still require medical care that extend beyond 3 months. Furthermore, the longer-term effects of the CAP event may prevent costs from returning to normal pre-episode levels for up to 9 months post-diagnosis or longer. Our findings suggested that the long-term cost consequences linked to CAP are independent of patients' age and their risk profile.

In the treatment of CAP, one of the principal objectives in any circumstance is to relieve patient symptoms in the interim while ultimately eliminating the causative pathogens over a reasonable period of time. In most scenarios, the shortest time to full symptom resolution is the most desirable outcome, and because of the economic burdens associated with prolonged periods to full recovery, the elapsed time is of particular interest to payer organizations. This research suggests that the cost to return to normal costs extends to 9 months post-diagnosis or about 6 months after the CAP episode has been clinically concluded.

Limitations and Benefits of This Research

While comorbidity levels and DCI values were measured for the patient groups in this study, patient comorbidities were not linked to the time that elapsed before patients reverted to baseline costs. Furthermore, this study did not assess the medications or dosing information and treatment strategies utilized during this study. It has been demonstrated that dosing regimen and treatment strategies for infectious diseases have important implications for patient outcomes, and typically impact the major cost areas.[26] This study only included those data on patients that survived their CAP episode and survived not only the 90-day period allotted for the episode but also the full 9 months including the CAP episode. This is a limitation only to the extent that any costs of death due to CAP are not included. This is mitigated by the high survivability of the vast majority of CAP patients.

While the use of claims data for research purposes has several known limitations, their use in this study allowed us to examine a large sample of commercially insured patients with well-adjudicated and accurate records. Data on disease severity and concomitant conditions are included in the costs reported and likely reflect the total disease burden associated with CAP. Another challenge is that patients can present a wide range of pulmonary and extra-pulmonary symptoms that could be due to typical bacterial pathogens as well as atypical pathogens. To acknowledge this heterogeneity in CAP, this study utilized a wide variety of *ICD-9-CM* codes that could be reflective of CAP and also required x-ray claims to further refine the likelihood of CAP identification.

CONCLUSIONS

The cost of the CAP episode extends beyond the clinical symptom phase. Despite treatment advances, CAP patients who experience short-term clinical recovery may still face long-term clinical and economic consequences regardless of their age and risk stratum. Knowledge of such lingering impact is important in formulating efficacious treatment and prevention strategies. It is also of value to payers faced with covering healthcare costs for extended periods after the resolution of the initial acute condition.

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Authorship Information: Concept and design (TW, JY, JS, RS); acquisition of data (TW, JY); analysis and interpretation of data (TW, JY, RS); drafting of the manuscript (TW, JY, BT); critical revision of the manuscript for important intellectual content (TW, JY, RS); statistical

analysis (TW, JY); obtaining funding (RS); administrative, technical, or logistic support (TW); and supervision (TW, JS, RS).

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