Assessment of Outpatient Pneumonia Therapy with Return and Admission Rates from the Emergency Department

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Abstract

Objectives: Community acquired pneumonia (CAP) is a common reason for emergency department (ED) visits and is associated with high return rates and mortality. Physicians and pharmacists in the ED are responsible for primary diagnosis and therapy initiation. The purpose of this study is to identify adherence to guideline-recommended empiric antibiotic therapy for CAP, assess reasons for nonadherence, and evaluate the impact of incorrect empiric therapy on admission rates.

Methods: This study was performed as a single-center, retrospective, observational chart review and included ED patients with pneumonia. Each patient was reviewed for inclusion and exclusion criteria, appropriateness of therapy according to the 2019 CAP guidelines, and repeat ED visits or admission within 30 days.

Results: Inclusion criteria was met by 110 patients. There were 12 (10.9%) patients that received correct empiric therapy; the remaining 98 patients (89.1%) classified as incorrect were most often found to have prescription durations longer than recommended (64.3%) or needed additional empiric coverage due to comorbidities (41.8%). Of the 27 patients that returned to the ED, 11 returned for worsening pneumonia, with 6 admitted. Of the patients admitted for worsening pneumonia, none received appropriate therapy. No statistical significance was found for this data.

Conclusion: Although most empiric treatment regimens were incorrect per the guidelines, there were no differences seen for rates of return ED visits or admissions for any cause or for worsening pneumonia. Though education may be beneficial, higher-powered studies would be needed to determine this impact on patient-centered outcomes of return ED visits and admissions for suboptimal empiric antibiotics for CAP.

1. Introduction

Community acquired pneumonia (CAP) is a common reason for emergency department (ED) visits and is associated with high mortality and admission rates. According to the National Hospital Ambulatory Survey, from 2016 to 2018, the ED visit rate for pneumonia was 7.9 per 1000 persons, which was higher than the ED visit rate for influenza at the time. This ED visit rate was also shown to increase with age[1]. In 2019, pneumonia and influenza combined were the ninth leading cause of death in patients aged 25-44 years old and in those age 65 years and older[2].

CAP may be a leading cause of death due to the risks of worsening pneumonia or exacerbation of comorbidities. Because of this, in 2012, the Center for Medicare and Medicaid Services (CMS) implemented the Hospital Readmissions Reduction Program (HRRP) "value-based programs" for reimbursements in an effort to increase the quality of care and reduce hospital readmissions[3]. In a previous study from 2011, using national Medicare data for each hospital referral region, the readmission rate for pneumonia ranged from 8-27%[4]. A study from 2014 found that a 30-day hospital readmission rate was statistically greater among patients who initially received inappropriate treatment and had risk factors such as antibiotic exposure in the previous 30 days or comorbidities such as peripheral vascular disease and increasing CURB-65 scores[5]. By reducing readmissions, hospitals will reduce adverse outcomes and financial burdens to patients[3] .

Researchers have suggested targeting avoidable causes of CAP readmission to minimize these costs and complications. One study evaluated avoidable causes of readmission and found the highest percentage of readmission occurred in patients discharged with either missing or incorrect diagnosis or therapy (31.7%)[6]. A 2011 study emphasized failure to follow evidence-based guidelines as a preventable cause of readmission, highlighting that adherence to pneumonia guidelines had a positive impact on readmission[7]. ED physicians and pharmacists are in a unique position to impact these factors, as they are often responsible for initial diagnosis and initiation of empiric therapy.

The American Thoracic Society (ATS) and Infectious Diseases Society of America (IDSA) approved an updated version of the CAP guidelines in 2019. These guidelines made several notable updates regarding empiric antibiotic therapy. In patients with no comorbidities or risk factors for multi-drug-resistant organisms, amoxicillin, doxycycline, or a macrolide such as azithromycin is appropriate when local pneumococcal resistance to macrolide therapy is less than 25%. Patients with chronic disease, diabetes mellitus, alcoholism, malignancy, asplenia, recent hospitalization with intravenous antibiotics within 90 days, or prior isolation of methicillin resistant *Staphylococcus aureus* (MRSA) or *Pseudomonas aeruginosa should receive* standard empiric therapy which is a combination of amoxicillin/clavulanate or cephalosporin (cefpodoxime, or cefuroxime) with a macrolide or doxycycline. Another option for this at-risk group is monotherapy with respiratory fluoroquinolone, (levofloxacin, moxifloxacin, or gemifloxacin). The guidelines also recommend a 5 to 7 day duration of antibiotics for patients diagnosed with CAP[8]. Though azithromycin monotherapy is a guideline-listed option if resistance rates are lower than 25%, recent data suggests very few, if any, areas within the

United States have less than 25% resistance to macrolides, making azithromycin monotherapy a suboptimal and inappropriate monotherapy option for CAP[9].

To date, no study has evaluated outpatient antibiotic prescription guideline adherence in patients diagnosed with CAP in the ED, the reason(s) for guideline nonadherence, and how these factors relate to return ED visits and admission rates[8]. The purpose of this study is to identify adherence to guideline-recommended empiric outpatient antibiotic therapy for CAP according to the 2019 guidelines, assess reasons for nonadherence to guideline recommendations, and evaluate the impact incorrect therapy has on return ED visits and admission rates.

2. Methods

2.1 Patient Selection

This study was performed at a 195-bed, urban academic medical center. The ED is a level three trauma center with an annual patient volume of 42000.

In partnership with the information technology department at our facility, a report was generated to identify patients through our electronic medical record (EMR) that had a one-day length-of-stay in the ED and an ICD-10 diagnosis code of J18.9 (Pneumonia, unspecified organism) during the specified period. Patients were reviewed for inclusion and exclusion criteria by two independent investigators to develop the study population.

Patients qualified for study inclusion if they were discharged from the ED between July 1, 2021, and June 30, 2022 (capturing one full residency training year), received an ICD-10 diagnosis code for pneumonia (J18.9), and were at least 18 years of age. Patients were excluded from the study if they were admitted to the hospital by the ED, were less than 18 years of age, or exhibited risk factors for multi-drug resistant organisms as defined by the 2019 CAP guidelines, identified as: (1) prior respiratory isolation of methicillin-resistant *Staphylococcus aureus* (MRSA) or *Pseudomonas aeruginosa* or (2) recent hospitalization and receipt of parenteral antibiotics within the last 90 days.

This study was determined by the institutional review board to be quality improvement and therefore non-human-subjects research. This study was conducted in accordance with the SQUIRE 2.0 guidelines. [11]

2.2 Assessments and Measures

This was a single-center, observational, retrospective chart review. Data points collected were patient sex, age, weight, height, past medical history, comorbid disease states (including chronic heart, lung, liver, or renal disease, diabetes mellitus, alcoholism, malignancy, or asplenia), drug allergies, repeat ED visits within 30 days with or without admission, reason for ED visit or admission, all antibiotics administered in the ED (drug, dose, route of administration, and number of doses), and antibiotics prescribed for outpatient use (drug, dose, frequency, and duration of therapy). Outpatient prescriptions were reviewed for appropriateness according to the 2019 ATS/IDSA CAP guidelines. Reason for repeat ED visit or admission was determined by

the provider's documentation during the encounter. Four investigators participated in chart review after being trained on the EMR and assessment of regimen appropriateness, and each investigator reviewed approximately 84 charts resulting in each patient being independently reviewed by two investigators. A third investigator was available for final decision making if needed in situations where consensus was lacking, and the final data set evaluated was compiled based on the majority's decision.

2.3 Outcomes

The primary outcome was adherence to current 2019 ATS/IDSA CAP guideline recommendations for outpatient empiric therapy. Secondary outcomes were (1) reason therapy was deemed inappropriate, (2) return ED visits within 30 days resulting in discharge, and (3) return ED visits within 30 days resulting in hospitalization. We evaluated further if the reason for the return ED visit was for any reason including pneumonia or for pneumonia specifically.

2.4 Statistical Analysis

Descriptive statistics were utilized for patient demographics and dichotomous data such as therapy appropriateness and reason therapy was deemed inappropriate. Additional outcome analysis was performed using Pearson chi-square analysis and Statistical Package for Social Sciences (SPSS) Data Analysis Software. An alpha of 0.05 was used to determine statistical significance, and a post-hoc power analysis determined a sample size of 122 was required to meet a power of 80%.

Results

In this study, 157 charts were identified for assessment, with 47 excluded (Figure 1). Of the 110 patients that met inclusion criteria, 12 (10.9%) received correct empiric therapy per the 2019 CAP guidelines, while 98 patients (89.1%) received incorrect empiric therapy (Figure 2). Baseline demographics and rates of comorbidities were similar between correct and incorrect therapy groups (Table 1).

347 **Figure1: Patient Inclusion and Exclusion**

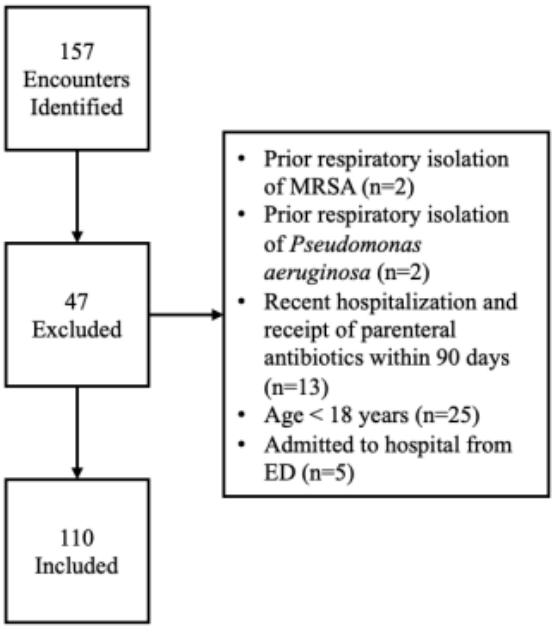
157 Encounters Identified
47 Excluded
110 Included
• Prior respiratory isolation of MRSA (n=2)
• Prior respiratory isolation of *Pseudomonas aeruginosa* (n=2)
• Recent hospitalization and receipt of parenteral antibiotics within 90 days (n=13)
• Age < 18 years (n=25)
• Admitted to hospital from ED (n=5)

Table 1. Patient Baseline Characteristics, Divided by Guideline Adherence for Empiric Treatment

	All Patients	Correct Empiric Treatment	Incorrect Empiric Treatment	p value
Total, *n (%)*	110 (100%)	12 (10.9%)	98 (89.1%)	---
Male, *n (%)*	61 (55%)	8 (13.1%)	53 (86.9%)	0.60
Female, *n (%)*	49 (45%)	4 (8.2%)	45 (91.8%)	0.60
Age (years), *m (SD)*	50.22 (±14.54)	55.17 (±13.62)	49.73 (±14.64)	0.31
Weight (kg), *m (SD)*	90.78 (±30.18)	84.06 (±18.26)	91.61 (±31.29)	0.41
Height (cm), *m (SD)*	171.35 (±9.90)	170.18 (±9.57)	171.49 (±9.98)	0.67
Comorbidities, n (%)	77 (70%)	8 (10.4%)	69 (89.6%)	0.61
Chronic heart disease	24 (22%)	0 (0%)	24 (100%)	0.07
Chronic lung disease	28 (25%)	1 (3.6%)	27 (96.4%)	0.29
Chronic liver disease	6 (5%)	0 (0%)	6 (100%)	0.84
Chronic kidney disease	5 (5%)	0 (0%)	5 (100%)	0.94
Diabetes	24 (22%)	2 (8.3%)	22 (91.7%)	0.93
Alcoholism	2 (2%)	1 (50%)	1 (50%)	0.21
Malignancy	7 (6%)	1 (14.3%)	6 (85.7%)	0.57
Asplenia	0 (0%)	0 (0%)	0 (0%)	---

Out of the 98 patients who received therapy deemed incorrect, the most common reasons included duration beyond the recommended 5-7 days (64.3%), incomplete regimen based on patient needing additional drug therapy because of comorbidities (41.8%), or a combination of both (24.4%). Other reasons for guideline-discordant therapy included incorrect azithromycin monotherapy (4.1%), incorrect beta-lactam chosen (5.1%), and receipt of combination therapy when single-drug therapy was appropriate (8.1%). (Table 2)

Table 2: Reason for Guideline Discordance and Pneumonia Related Outcomes

Outcome	Incidence n, (%)	p-value
Extended Duration*	**63 (64.3)**	
Return ED visit within 30 days	16/63 (25.4)	0.810
Worsening PNA	9/16 (56.3)	0.083
Incorrect drug regimen due to comorbidities**	**41 (41.8)**	
Return ED visit within 30 days	12/41 (29.3)	0.375
Worsening PNA	3/12 (25.0)	0.470
Both extended duration and incorrect regimen	**24 (24.4)**	
Return ED visit within 30 days	7/24 (29.2)	0.55
Worsening PNA	2/7 (28.6)	0.75
Other***	**18 (18.4)**	

PNA=Pneumonia; ED=Emergency Department

*Extended duration is a combination of both "extended duration" plus "both extended duration and incorrect regimen" data points.

**Incorrect drug regimen due to comorbidities is a combination of both "incorrect drug regimen" plus "both extended duration and incorrect regimen" data points.

***Other reasons include: azithromycin monotherapy not appropriate (n=4), incorrect beta-lactam selection, dose, or frequency (n=5), monotherapy recommended over dual antibiotics (n=8), incorrect fluoroquinolone (n=1)

A total of 83 patients evaluated did not return to the ED within 30 days of pneumonia diagnosis. Out of the 27 patients who did return within 30 days (24.5%), eleven returned specifically for worsening pneumonia (40.7%) and six were admitted for their condition (22.0%). None of the eleven patients who returned for worsening pneumonia received correct empiric treatment (Table 3).

Table 3 Return ED Visits

	Total Patients (n=110)	Correct Empiric Treatment (n=12)	Incorrect Empiric Treatment (n=98)	p-value
No return ED visit within 30 days	83 (75.5%)	8 (9.6%)	75 (90.4%)	--
Return ED visit within 30 days	27 (24.5%)	4 (14.8%)	23 (85.2%)	0.45
Worsening PNA	11 (40.7%)	0 (0%)	11 (100%)	0.22
PNA and Hospitalization	6 (22.2%)	0 (0%)	6 (100%)	0.84

When assessing reasons for incorrect therapy for patients with return ED visits for worsening pneumonia, the most common reason was receiving an antibiotic with a duration longer than necessary (7 out of 11). Other reasons included wrong beta-lactam (1 out of 11), incorrect drug regimen due to comorbidities (1 out of 11), and a combination of duration length and incorrect regimen due to comorbidities (2 out of 11). Further delineating those who were admitted from this group, three had extended durations, one had incorrect therapy due to comorbidities, and two had a combination of both problems with their antibiotics. No difference was found between the reason for incorrect therapy and return ED visit for worsening pneumonia (p=0.30).

When comparing the proportion of patients studied who had incorrect empiric therapy at study inclusion (89.1%), the rates for patients who did (23 out of 27, or 85.2%) and did not return to the ED within 30 days for any reason (75 out of 83, or 90.4%) were numerically alike. There was no statistical significance when comparing correct and incorrect empiric treatment on return ED visits for any cause (p=0.45). Furthermore, there was no difference in incorrect empiric treatment and whether a patient returned to the ED for worsening pneumonia (p=0.22) or got admitted for worsening pneumonia within 30 days (p=0.84). (Table 3)

3. Discussion

Overall, empiric therapy from the ED for CAP was not adherent to current guidelines. Most patients with guideline-discordant therapy had issues with either extended duration of therapy, too narrow of empiric treatment due to comorbidities, or a combination of these two errors. However, patients prescribed CAP treatment that deviated from guideline recommendations were not statistically more likely to have a return ED visit for any reason, for worsening pneumonia, or be admitted for worsening pneumonia (Table 3).

A patient with CAP and history of comorbidities such as heart disease, lung disease, or diabetes should be prescribed a combination of drugs to cover both *Streptococcus pneumoniae* and atypical bacteria (e.g., amoxicillin/clavulanate plus azithromycin) based on currently available guideline recommendations[8]. An appreciable portion of incorrect therapy in this study was due to

incorrect or incomplete drug selection based on a patient's identified comorbidities, where the group should have been prescribed broader empiric antibiotic coverage. Of the patients with comorbidities, nearly 90% were given incorrect empiric treatment, mostly with doxycycline monotherapy instead of either doxycycline plus a beta-lactam or fluoroquinolone monotherapy. This guideline discordance did not demonstrate a statistically significant effect on repeat ED visits or admissions, though the p-value approached significance. Exploring this data trend warrants an additional adequately powered study, due to patients with comorbidities being at an increased risk of all-cause admission. [5]

The most common reason for inappropriate therapy was duration beyond the guideline-recommended 5-7 days, with over 60% of the study population meeting criteria for this error. However, extended duration did not demonstrate a statistically significant effect on repeat visits or admissions for any cause or for worsening pneumonia (Table 2). One may anticipate that patients who receive correct but longer-than-necessary antibiotics might present to the ED, not for worsening pneumonia, but for consequences of excess antibiotic therapy, however this was not the case, and no statistical difference was seen between those who received extended duration of treatment and those who did not. Regardless of the true effect the extended duration of therapy had on admission rates, receiving more antibiotic therapy than necessary resulted in avoidable adverse effects. Outside of practicing good antimicrobial stewardship, other reasons to limit patients' antibiotic exposure are potential for adverse drug reactions, high cost to the patient, and risk of secondary infections. Even if extended duration of therapy is not affecting admission for worsening pneumonia, it will still be an important part of future education to watch for untoward adverse effects.

All-cause return ED visits within 30 days (24.5%) was similar to the pneumonia readmission rates previously identified in existing literature[4]. Though these variables are not synonymous, one may hypothesize if return ED visits are reduced with proper empiric antibiotic selection upon initial presentation then patients may avoid the initial admission with early and accurate antibiotic therapy. Since a high Charlson comorbidity index and multi-drug-resistant infection serves as predictors of all cause-admission, recognizing patients with comorbidities and treating appropriately may impact outcomes if a study sample size is powered to detect this difference.[10] This study can serve to inform future educational endeavors in the ED, with changes in prescribing patterns studied in a post-educational comparison review.

4. Limitations

This study was performed as a retrospective chart review study, making it difficult to control for confounders, such as patient compliance for their previously prescribed antibiotics. Additionally, the study population was small and inadequately powered to identify statistically significant relationships between variables. In the future, larger, adequately powered studies are needed to further investigate the study objectives and secondary outcomes. With chart reviews, an element of human error in data collection cannot be excluded even with methods to account for interrater reliability differences and training before data collection begins. Nevertheless, increasing sample size will in turn increase power and a regression to the mean.

5. Conclusion

Empiric outpatient CAP therapy prescribed from the ED was not adherent to current guidelines. Therapy was inappropriate most commonly due to extended duration, incorrect drug choices based on comorbid conditions, or a combination of both factors. Incorrect therapy did not have a statistically significant effect on repeat ED visits or admission rates; however, larger, higher-powered studies would be necessary to further investigate the relationship with admission rates. Even with the study's limitations, useful data was gathered that will assist in improving current practice and further education of ED physicians, residents, and pharmacists.

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