

ORIGINAL RESEARCH

Diagnosis and management of pneumonia and bronchitis in outpatient primary care practices

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Abstract**Aims:** To understand which clinical criteria physicians use to diagnose pneumonia compared to bronchitis and upper respiratory tract infection (URTI).**Methods:** Retrospective chart review of adults diagnosed with pneumonia, bronchitis, or URTI.**Results:** Logistic regression analysis identified rales, a temperature $\geq 100^{\circ}\text{F}$ (37.8°C), chest pain, dyspnoea, rhonchi, heart rate, respiratory rate, and rhinorrhoea, as the best explanation for the variation in diagnosis of pneumonia compared to either of the alternative diagnoses ($R^2 = 59.3$), with rales and a temperature $\geq 100^{\circ}\text{F}$ explaining 30% of the variation. Rales, chest pain, and a temperature $\geq 100^{\circ}\text{F}$ best predicted the ordering of a chest x-ray ($R^2 = 20.0$). However, 35% (59/175) of patients diagnosed with pneumonia had a negative chest x-ray. Abnormal breath sounds were the best predictors for prescribing antibiotics ($R^2 = 38\%$). A significant number of patients with acute bronchitis (93% excluding sinusitis) and URTI (42%) were given antibiotics.**Conclusions:** The presence of abnormal breath sounds and a temperature $\geq 100^{\circ}\text{F}$ were the best predictors of a diagnosis of pneumonia.

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Introduction

Since the early 1990s, a number of different organisations have developed guidelines for the management of patients with community-acquired pneumonia.¹ These guidelines are similar, yet each has unique features with respect to its focus and recommendations.

Several investigators have attempted to design criteria to improve the detection of pneumonia in ambulatory patients as well as those presenting to emergency departments.²⁻¹² According to clinical guidelines, the gold standard for diagnosing pneumonia is the presence of lung infiltrates indicated by chest radiography.^{1,2} A diagnostic study of pneumonia in adults in general practice found inconsistency in the radiologists' interpretation of the same chest radiograph, yet chest radiography is considered the best way

to distinguish pneumonia from other respiratory tract infections.^{13,14} Due to its unavailability and cost restrictions, patients seen in primary care clinics for possible pneumonia may not get a chest x-ray. As a result, untreated patients with unresolved chest infections may be labeled as having pneumonia in order to justify antibiotic prescriptions, despite guidance which advises against routine antibiotic use in patients with upper respiratory tract infection (URTI).¹⁴

According to guidelines, chest infection is divided into acute bronchitis (for which antibiotics are not recommended) and pneumonia (for which antibiotics are recommended).¹⁴ The effectiveness of antibiotic treatment in reducing the risk of complications of pneumonia has already been validated in several studies, but the use of antibiotics to reduce the risk of serious complications for acute bronchitis or URTI is generally not justified.¹⁴⁻²² Given the emergence of antibiotic-resistant strains of bacteria such as *Streptococcus pneumoniae* and *Haemophilus*

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influenza type B (H1B), it is extremely important to diagnose and treat pneumonia accurately.¹⁵ Recommendations not to prescribe are based on concerns about the development of antimicrobial resistance.¹⁶

Detecting pneumonia in outpatient settings has been a challenge for physicians, since chest radiographs are not readily available and also because the associated signs and symptoms used for clinical diagnosis are mainly based on studies of inpatients.²¹ Gennis², Heckerling³, Diehr⁸, and Singal⁹ are some of the widely used pneumonia prediction criteria models. Studies conducted show that the specificity of the Gennis, Heckerling, and Diehr rules are each greater than that of physician judgment, and are more accurate in selecting patients with

respiratory infection for chest radiography.²¹ However, much research is required to determine whether the use of decision aids enhance the physician's ability to diagnose pneumonia.

The aims of this study were to evaluate the diagnostic criteria used by primary care physicians to diagnose pneumonia empirically – as opposed to acute bronchitis and URTI – in an outpatient setting.

Methods

A retrospective electronic chart review from outpatient clinics in a large, integrated health care system serving urban and rural eastern Wisconsin was conducted. Just over 55,000 patients (pneumonia= 4907; bronchitis= 32,760; URTI= 20,037) aged 18-

Table 1. Predictors of pneumonia diagnosis compared with both alternative diagnoses.

	Pneumonia (%)	Bronchitis (%)	URI (%)	P [^]
N	200	205	199	
Mean Age	45.9 +/-13.4	40.4 +/- 12.2	40.4 +/- 12.6	< 0.001*
Sex				0.066
Males	48.0	37.6	38.4	
Females	52.0	62.4	61.6	
Race				< 0.001*
Caucasians	84.5	67.3	64.9	
African American	2.0	8.3	5.5	
Others/Unknown	14.5	23.5	25.7	
Current smokers	36.5	34.3	28.7	0.338
COPD	10.0	1.5	0.5	< 0.001*
Asthma	19.5	21.0	7.9	0.001*
Chest X-ray ordered	87.5	11.2	1.5	0.001*
Chest X-ray results (positive)	55.5	8.3	8.3	0.001*
Antibiotics prescribed	98.5	95.0	42.4	0.000*
Sinusitis removed	-	93.0	-	< 0.001*
Symptoms				
Fever	59.0	27.3	17.2	< 0.001*
Cough	90.0	92.7	70.4	0.014*
Chest Pain	15.0	7.3	1.0	< 0.001*
Chills	27.0	17.6	7.9	< 0.001*
Sore Throat	14.0	29.3	42.4	< 0.001*
Dyspnea	34.5	20.5	3.5	< 0.001*
Green Sputum	40.0	52.2	21.2	0.590
Malaise	20.0	13.2	14.8	0.070
Sinus Pain	4.5	15.1	8.9	0.006*
Head Congestion	9.0	21.5	40.0	< 0.001*
Chest Congestion	8.0	9.8	6.9	0.010*
Signs				
Rales	39.0	4.9	1.0	< 0.001*
Rhonchi	28.0	29.3	2.5	0.001*
Rhinorrhea	8.5	28.8	46.8	< 0.001*
Wheezes	31.0	25.4	6.0	< 0.001*
Heart rate (mean)	89.6	80.5	80.0	< 0.001*
Temp ≥ 100°F (37.8°C)	40.3	9.9	5.3	< 0.001*
Temp ≥ 101°F (38.4°C)	26.9	5.5	4.1	< 0.001*
Respiratory rate(mean)	19.2	18.0	17.4	< 0.001*
Decreased breath sounds	22.5	9.3	0.0	< 0.001*

[^] p-value of pneumonia compared to no pneumonia (both alternative diagnoses) * p-value ≤ 0.05 significant

80, diagnosed with pneumonia, bronchitis and upper respiratory infection from all outpatient facilities from January 2005 to December 2006, were identified. Medical records of 604 consecutive, randomly selected patients based on clinical ICD-9 codes were compared: 200 with clinically diagnosed pneumonia (ICD-9-486.0); 205 with acute bronchitis (466.0); and 199 with URTI (460.0-465.9). Subjects diagnosed with cancer, bronchiectasis, blood disorder, tuberculosis, HIV/AIDS and pregnant women were excluded from this study. Patients with acute exacerbations of chronic bronchitis were omitted from the acute bronchitis group after univariate analysis.

Following approval by the Aurora Health Care Institutional Review Board, a random list of potential subjects from the year 2005-2006 was generated. Data collected for the study included demographic variables (race, age, gender), type of physician making the diagnosis, smoking status, and medical history. In addition, signs and symptoms including rales, wheezes and rhonchi, temperature (in degrees Fahrenheit, °F), x-ray orders/results, lab orders/results, antibiotics prescribed and disease outcomes, were extracted from the electronic medical record.

Univariate analysis was performed using the Chi-square test for dichotomous variables and Kruskal-Wallis test for non-normally distributed continuous variables. Odds ratios were calculated for pneumonia diagnosis. For multivariate analysis, binary logistic regression as well as nominal logistic regression and stepwise backward and forward regression was performed to determine which variables were associated with the empirical diagnosis of pneumonia, ordering of chest x-ray, and antibiotic prescribing. MINITAB software (Minitab, State College, PA) was used for the analysis. A p-value of less than or equal to 0.05 was considered statistically significant.

Results

The age, sex, and race distribution for patients presenting with

pneumonia, bronchitis, and URTI are listed in Table 1. Overall, age, race, and COPD were significant predictors of a diagnosis of pneumonia. Females (52%) and Caucasians were disproportionately diagnosed with pneumonia. A prior diagnosis of asthma was a significant predictor of a pneumonia diagnosis only when compared with the URTI diagnosis group. Diabetes and smoking status were not significant for all three diagnoses. Chest x-rays were obtained in 87% of patients diagnosed with pneumonia, of which 35% were negative.

Dyspnoea, cough, chills, chest pain, fever, decreased breath sounds, rales, rhonchi, wheezes, a temperature $\geq 100^{\circ}\text{F}$ (37.8°C), a temperature $\geq 101^{\circ}\text{F}$ (38.4°C), heart rate and respiratory rate, were all significant individual predictors of a pneumonia diagnosis when compared to both bronchitis and URTI. Rales and a temperature $\geq 100^{\circ}\text{F}$ (37.8°C) explained 30% of the variations of the clinical diagnosis of pneumonia.

Table 2 provides a forest plot for the best logistic regression model of predictors of a diagnosis of pneumonia when compared to both alternative diagnoses.

The significant negative individual predictors of a diagnosis of pneumonia when compared to both bronchitis and URTI included sinus pain, sore throat, head congestion, chest congestion, and rhinorrhoea. Green sputum was significant in both alternative diagnoses but not pneumonia. A significant number of patients diagnosed with bronchitis (95%) were prescribed antibiotics ($p \leq 0.001$) as compared to those with URTI. When removing those with concurrent sinusitis (53/205), 93% of patients had been prescribed antibiotics. Rales or rhonchi, heart rate, dyspnoea and green sputum, were significant predictors for prescribing antibiotics and remained significant when removing patients with concurrent sinusitis ($R^2 = 27.6$). The best predictors of prescribing antibiotics were abnormal breath sounds (rhonchi and rales), which explained 38% of the variation.

Table 2. Predictors of a diagnosis of pneumonia.^

Predictors	Statistic			p-Value	Odds ratio and 95% CI
	Odds ratio	CI	CI		
Temp $\geq 100^*$	5.1	2.2	11.8	<0.00	
Dyspnoea	3.6	1.7	7.9	<0.00	
Rhonchi	2.7	1.3	5.8	0.0	
Rales	26.0	8.7	77.4	<0.00	
Chest Pain	4.6	1.4	14.5	<0.00	
Rhinorrhea	0.2	0.1	0.6	0.00	
Resp. Rate	0.9	0.8	1.0	0.47	
Heart Rate	0.9	0.9	0.9	0.00	
R² = 59.3					

^ compared to two alternative diagnoses *°F (37.8°C)

Rales, dyspnoea, chest pain, heart rate, and a temperature $\geq 100^\circ\text{F}$ (37.8°C) were the best predictors of ordering a chest x-ray ($R^2 = 42.6$). Rales, chest pain, and a temperature $\geq 100^\circ\text{F}$ (37.8°C) explained 20% of the variation.

Discussion

There was no single constellation of signs and symptoms that was highly predictive of the clinical diagnosis of pneumonia, the ordering of a chest x-ray, or the prescribing of antibiotics. Overall, the most highly predictive symptoms for a diagnosis of clinical pneumonia, the ordering of a chest x-ray and the prescribing of antibiotics were abnormal breath sounds (rales or rhonchi) and a temperature $\geq 100^\circ\text{F}$ (37.8°C), although these signs and symptoms only explain part of the prediction criteria. Chest pain was also a predictor of ordering a chest x-ray.

Primary care clinicians in this region appear to have no set algorithm to diagnose pneumonia, order a chest x-ray, or prescribe antibiotics. Our findings are similar to those described in the clinical decision rules by Heckerling³ and Gennis² but it appears that physicians are not using these prediction rules consistently in practice. In fact, only eight of the 200 patients in our study diagnosed with pneumonia fit Heckerling's criteria (none in the bronchitis and URTI groups) and of the 201 patients who received chest x-rays 16 fit Gennis' criteria and all were diagnosed with pneumonia.

Surprisingly, 93% of patients diagnosed with acute bronchitis alone were prescribed antibiotics in this population. This is much higher than the 65–80% previously reported.^{20,21,23} Both the American College of Physicians²⁴ and the American College of Chest Physicians²⁵ recommend against the use of antibiotics for the treatment of uncomplicated acute bronchitis. Systematic analyses of clinical trials have suggested that antibiotics may reduce the duration of symptoms, but at best modestly.^{17–19} In fact, antibiotic use has been shown to decrease symptoms by only one-half day in normally healthy individuals.¹⁷ Researchers suggest that the minimal decrease in symptoms does not outweigh the increased costs and possible increased risk of antibiotic resistance.^{17–19}

Studies have tried to understand clinicians' reasoning for prescribing antibiotics to patients diagnosed with acute bronchitis when the literature clearly recommends against their use. Patient expectations,^{26–30} clinical error,^{31,32} office location,³³ workload,^{34–36} and legal considerations,^{27,35} are often cited as reasons for inappropriate antibiotic prescribing. Increased academic detailing has been shown to lower antibiotic prescribing rates effectively and may be an important intervention within this system.^{36,37} In addition to educating physicians on the appropriateness of antibiotic prescribing these data could also be used to make improvements in the empirical diagnosis of pneumonia. It is important to educate clinical providers on the best predictive symptoms of a

- a) One of the difficulties of this study was the retrospective design, which required an extensive and time consuming chart review to extract study data.
- b) A double blinded randomised control trial where all patients receive confirmatory chest x-rays would have been the ideal study design to answer this question.
- c) A new question that arose from this study was whether chest x-rays are really needed in order to confirm a diagnosis of pneumonia. Also, better prediction rules are needed for diagnosing pneumonia in the outpatient setting.
- d) One lesson for clinical application from this study was that patients diagnosed with bronchitis they are still being prescribed antibiotics for a primarily viral disease. Academic detailing is essential in this health care system to discourage antibiotic prescribing for viral disease.

pneumonia diagnosis as compared to bronchitis and URTI in order to ensure the most appropriate and best treatment. Further prospective studies using chest x-rays as the "gold standard" need to be completed to confirm these results.

The limitations of this study include the retrospective nature and use of a single regional healthcare system. This was a study of the clinical diagnosis as represented in the electronic medical record according to ICD-9 codes without confirming the certainty of the diagnosis using x-ray or laboratory testing. It is important to note that our study design enabled us to look retrospectively at diagnoses and antibiotic prescribing without introducing the Hawthorne effect.³⁸

In this community healthcare system we did not identify a consistent set of diagnostic criteria that distinguished a pneumonia diagnosis, the ordering of a chest x-ray, or the prescribing of antibiotics, from that of bronchitis and URTI – although decreased breath sounds and a temperature $\geq 100^\circ\text{F}$ (37.8°C) could be a good indication that further tests are needed to justify a pneumonia diagnosis, chest x-ray or antibiotics. In this region antibiotics are still being prescribed at high rates for bronchitis and URTI, which are predominantly viral illnesses. Academic detailing or physician incentives may be an important mechanism to decrease prescribing rates.

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Conflict of interest declaration

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