Original Study

Evaluation and Management of the Nursing Home Resident With Respiratory Symptoms and an Equivocal Chest X-Ray Report

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A B S T R A C T

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Objectives: Pneumonia is a leading cause of morbidity and mortality in nursing home (NH) residents. Chest x-ray evidence is considered a key diagnostic criterion for pneumonia by the Infectious Disease Society of America (IDSA) diagnostic guidelines, the modified McGeer diagnostic criteria, and the Loeb criteria for initiating antibiotics; however, x-ray interpretation is often equivocal. We conducted chart audits of patients in NHs who had chest x-rays for new respiratory symptoms to determine the degree of ambiguity in the radiology reports and their relationship to antibiotic prescription decisions.
Design: Cross-sectional study.
Setting: Thirty-one NHs in North Carolina.
Participants: Two hundred twenty-six NH residents who had a chest x-ray.
Methods: Medical charts were abstracted to record (1) the patient's clinical presentation when a chest x-ray was ordered, (2) the verbatim report of the chest x-ray, and (3) the patient's course during the subsequent 7 days. To standardize the radiologist reports, a seven-category coding system was developed, which was further aggregated into three groups based on the radiologist's description of the likelihood of pneumonia.
Results: Of the 226 chest x-rays, 118 (52%) identified a very low likelihood of pneumonia, 67 (30%) indicated that pneumonia was present or highly likely, and the remaining 41 (18%) used a variety of terms to describe uncertainty regarding the presence of pneumonia. NH medical providers tended to treat ambiguous chest x-ray reports similarly to positive x-ray reports, prescribing antibiotic therapy to 71% of patients with ambiguous reports and 78% of positive reports. Also notable is that 40 (34%) of the 118 patients with a very low likelihood of pneumonia based on chest x-ray results were prescribed antibiotics, the majority of whom failed to meet criteria for a clinical diagnosis of pneumonia or chronic obstructive pulmonary disease exacerbation.
Conclusion: The moderate rate of ambiguous x-ray interpretations in NH residents is likely a combination of the poor quality of portable x-rays, a high prevalence of chronic lung conditions, and conservative (ie, cautious) decision making by radiologists whose interpretation is based on little clinical information and a suboptimal quality film. As a result, data suggest that chest x-rays obtained in NHs may unnecessarily encourage antibiotic prescribing because a majority of readings are ambiguous or show a low likelihood of pneumonia, yet more than half of the patients are still treated. From an antibiotic stewardship standpoint, the apparent solution is to more closely rely on clinical signs and symptoms for diagnosis of pneumonia and to place less emphasis on the role of the chest x-ray given the high number of unclear readings.

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Antibiotic resistance among common bacterial pathogens is a growing concern in nursing homes (NHs). According to the U.S. Centers for Disease Control and Prevention (CDC), up to 75% of the antibiotics given in NHs do not meet prescribing criteria and are therefore unnecessary and potentially harmful.[1] Respiratory disease is the second most common reason for antibiotic use in NHs, accounting for more than one-third of all antibiotic prescriptions.[2] Antibiotics for respiratory infections are a leading source of antibiotic overprescribing in adults not residing in nursing homes and therefore should be scrutinized carefully as part of any NH antibiotic stewardship program.[3]

Pneumonia is the leading infectious cause of morbidity and mortality in NH residents and a common reason for transfer to acute care facilities.[4,5] From the standpoint of antibiotic stewardship, the challenge is differentiating bacterial pneumonia from other respiratory illnesses. In NH residents, pneumonia frequently presents without typical symptoms such as fever, cough, or dyspnea.[6] Several guidelines have been promulgated to help improve the precision of clinical diagnoses of pneumonia, most of which include results of a chest radiograph as a cornerstone of diagnosis.[7] The 2005 American Thoracic Society/Infectious Diseases Society of America (ATS/IDSA) guideline recommends that the clinical diagnosis of health care-associated pneumonia, including NH-acquired pneumonia, be based on "a new or progressive infiltrate" and two or more of the following: fever > 38°C (100.4°F), leukocytosis or leukopenia, or purulent secretions.[8] The modified McGeer criteria for NH infection surveillance (2012) recommend diagnosis of pneumonia based on three parameters: "pneumonia or the presence of a new infiltrate" on x-ray and at least one of the following: new or increased cough, new or increased sputum production, O_2 saturation < 94% on room air or a reduction in O_2 saturation >3% from baseline, new or changed lung examination abnormalities, pleuritic chest pain, or a respiratory rate ≥ 25 breaths/min and one or more "constitutional signs" (fever, leukocytosis, acute change in mental status, or acute functional decline).[9] Although not strictly diagnostic criteria, Loeb and colleagues developed widely used "minimum criteria" for the initiation of antibiotics in NH patients. In these criteria, if a chest x-ray shows a new infiltrate, any of the following would justify starting antibiotics: a respiratory rate >25 breaths/min, a productive cough, or fever (temperature > 37.9°C [100°F]). In the absence of an infiltrate on x-ray, initiation of antibiotics depends on a combination of clinical findings involving an elevated temperature, history of chronic obstructive pulmonary disease (COPD), cough, purulent sputum, respiratory rate, and cognitive status.[10]

Although the chest x-ray is a cornerstone of pneumonia diagnosis, radiographic interpretation is often equivocal. The limited studies that exist indicate considerable variation in interobserver reliability among radiologists, depending on the type of imaging and the reader's experience level. In addition, mobile chest x-rays, which are almost universally used in NHs, are often of suboptimal quality.[11] Because of these factors, chest x-rays may be less useful in diagnosing pneumonia in NH clinical practice than is suggested by clinical guidelines, and if so, the guidelines themselves may be of limited usefulness in informing antibiotic stewardship.

To better understand the role of chest x-rays in the diagnosis of pneumonia in actual NH practice, we evaluated 226 cases from 31 community NHs in which a chest x-ray had been obtained. We conducted medical record audits and examined the signs, symptoms, and patient characteristics associated with each x-ray. We studied the radiologists' interpretations and re-coded them to systematically classify the degree to which they identified pneumonia and to study the relationship between the x-ray report and physician prescribing. Our goal was to determine current practice around treatment when concern for pneumonia exists and to compare practice with published guidelines.

Methods

Thirty-one community-based NHs in North Carolina were enrolled in an antibiotic stewardship study. All NHs were either affiliated with a specific for-profit regional NH chain or had as their medical director a regional long-term care medical group practice. Overall, 81% of the homes were for-profit: the mean bed size was 113, and the mean quality rating on Nursing Home Compare was 3.3[12]; none of these characteristics was statistically different from all NHs nationally. The University of North Carolina Institutional Review Board approved this study.

Baseline data were collected by medical record audits conducted between November 2014 and March 2015. Within each home, we audited a random selection of up to 10 cases from the previous month in which chest x-rays had been ordered, yielding a total of 226 cases. Inclusion criteria required only that a chest x-ray was ordered. Medical and nursing records for each case were systematically audited to identify signs and symptoms contained in the IDSA, Loeb, and McGeer criteria on the day of or the day before the chest x-ray was obtained. These signs and symptoms included temperature, respiratory rate, oxygen saturation, new or increased cough, new or increased sputum production, new rales or crackles on exam, new rhonchi or wheezes on exam, diminished breath sounds, altered mental status, and acute functional decline. Other components of the guidelines, including serum white blood count (because results typically were reported after antibiotic prescribing was done) and whether the patient was delirious (due to the difficulty of identifying delirium from NH records) were not obtained. The audit also recorded the verbatim chest x-ray reading and impression and gathered data on the patient's clinical course, including the same infectious signs and symptoms as recorded on the day of or before the chest x-ray, for the 7 days after the chest x-ray was performed.

To help standardize the qualitative radiographic reports, a coding system was developed to describe the degree to which the radiologist reading suggested the presence of pneumonia. For this analysis, the "reading" and "interpretation" (which are reported in separate sections by radiologists) were merged into a single qualitative analytic file, owing to a lack of consistency in the content reported in each section. The coding system that was developed included seven categories based on the likelihood of pneumonia and the prevalence of specific findings or terms in the report; they ranged from "no mention of infiltrate or pneumonia" to "pneumonia clearly diagnosed." Descriptions of each category are presented in Table 1. Once the codes and definitions had been agreed upon by the team (two research assistants and two geriatricians), all 226 chest x-rays were independently coded by two research assistants; all but 24 were coded identically, yielding an 89% agreement and a weighted kappa of 0.75. The 24 discordant codes were reviewed by the research assistants and geriatricians, and for each, a consensus categorization was determined.

For analysis, the seven categories were combined into three groups in terms of likelihood of pneumonia based on the x-ray report: a low-likelihood category, represented by the codes "no mention of infiltrate or pneumonia" and "atelectasis without pneumonia"; an ambiguous-likelihood category, represented by the codes "cannot exclude pneumonia," "atelectasis or pneumonia,"; and a high-likelihood category, composed of the codes "probable pneumonia" and "pneumonia clearly diagnosed."

Lastly, the association of characteristics of the cases with antibiotic treatment was examined, using generalized linear mixed models with logit link functions and random intercepts to adjust for clustering of cases within NHs while estimating odds ratios and P values. Characteristics with P values less than .10 in bivariate models were included in a multivariate model where statistical significance was defined as $P < .05$.