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

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ABSTRACT

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.

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 over-prescribing 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 $\geq$ 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 $P < .05$.

Table 1
Coding of 226 Representative Chest X-Ray Interpretations From 31 Nursing Homes and the Proportion of Reports Assigned to Each Category

Name of Code	Definition/Description	Degree of Certainty of Pneumonia	N (%) of X-Ray Reports
No mention of infiltrate or pneumonia	**Clearly identifies absence of pneumonia:** terms included lungs are clear without pneumonia, "no active infiltrates", "no radiographic evidence of acute pulmonary disease", "no acute cardiopulmonary disease seen", "no active disease", "no focal pneumonia", "no acute parenchymal process", "lungs are clear and fully expanded"	Low	96 (42)
Atelectasis without pneumonia	**Identifies atelectasis without mention of possibility of pneumonia:** terms included linear opacities, streaky opacities, right lower lobe atelectasis, atelectasis at lung bases, possible atelectasis, likely atelectasis	Low	22 (10)
Cannot exclude pneumonia	**Pneumonia is not likely but cannot be excluded:** terms included pneumonia could be missed, pneumonia not excludable, pneumonia would be considered, may reflect pneumonia, suggesting pneumonia, infiltrate may not be seen, possible infiltrate	Intermediate	15 (5)
Atelectasis or pneumonia	**Reports both pneumonia/infiltrate and atelectasis as possibilities:** terms included patchy atelectasis or pneumonitis, patchy atelectasis or interstitial pneumonitis, may reflect atelectasis or pneumonia, pneumonia vs. atelectasis, infiltrate vs. atelectasis, consistent with atelectasis or developing acute infiltrate, underlying atelectasis or infiltrate cannot be excluded, right lower lobe atelectasis or infiltrate	Intermediate	26 (12)
Infiltrate without pneumonia	**Infiltrate is identified without use of the word pneumonia:** terms included possible infiltrate suggested, right lower lung infiltrate, right base infiltrate, minimal infiltrate persists, infiltrate and linear atelectasis in both, bilateral lower lobe infiltrates with linear atelectasis	High	34 (16)
Probable pneumonia	**Report strongly suggests pneumonia may be present but does not definitively provide diagnosis:** terms included suspicious for pneumonia, could represent some developing pneumonia, consistent with pneumonia, compatible with pneumonia, relates to pneumonia, concerning for pneumonia	High	11 (5)
Pneumonia clearly diagnosed	**Clearly states diagnosis of pneumonia:** terms included bilateral lower lobe pneumonia, basilar pneumonia, patchy pneumonitis, bilateral perihilar pneumonia, developing right basilar pneumonia, bilateral lower lung pneumonia, atelectasis with pneumonia, infiltrate with pneumonia	High	22 (10)

Results

Results of coding the 226 chest x-ray interpretations into seven categories are presented in Table 1. "No mention of infiltrate or pneumonia" was assigned to 42% of cases, and "definite pneumonia" was assigned to only 10%. When the codes were aggregated into three groups by likelihood of pneumonia, 52% were categorized as low probability, 18% as ambiguous/intermediate probability, and 30% as high probability. Antibiotics were prescribed to 40 of the 118 patients (34%) who had x-ray reports indicating a low probability of pneumonia, 29 of the 41 patients (71%) with reports indicating an ambiguous/intermediate probability of pneumonia, and 52 of the 67 patients (78%) with reports indicating a high probability of pneumonia (Table 2). Prescribing was significantly more likely for patients with an intermediate or high probability of pneumonia compared to those with a low probability ($P < .001$). Thirty percent (68 patients) met modified Loeb criteria for pneumonia, nearly 82% of which were treated with antibiotics; however, 41% of the 158 residents who did not meet these criteria were also treated with antibiotics. Even fewer residents met the IDSA or modified McGeer criteria (35 residents and 15 residents, respectively).

We examined data of residents who failed to receive antibiotics when their radiographs clearly indicated pneumonia (N = 15, 22%) and also of residents who received antibiotics when their radiographs clearly indicated the absence of pneumonia (N = 40, 34%), to look for case-specific factors that might explain the clinicians' decisions. In all instances when x-ray results indicated a high likelihood of pneumonia, but antibiotics were not prescribed, the patient did not have fever, cough, or any other specific finding that would support treatment based on the Loeb criteria, McGeer criteria, or IDSA guidelines. Of those with x-ray results indicating a low likelihood of pneumonia who were treated with antibiotics, five (13%) met Loeb's criteria for treating a COPD exacerbation, and most of the others had one or two symptoms that did not meet established criteria for antibiotic use, such as cough alone, cough with rhonchi, decreased oxygen saturation, or sputum production with rhonchi.

Next, resident characteristics and clinical features were examined analytically to determine which were associated with antibiotic treatment (Table 2). In bivariate analyses, female resident gender, documentation of a body temperature (regardless of whether fever was present), new or increased cough, new or increased sputum production, new rales/crackles, and new rhonchi or wheezes were all significantly associated with antibiotic treatment at the level $P < .10$.

In a multivariable regression, the following variables remained significantly associated with antibiotic prescribing ($P < .05$)[1]: documentation of a temperature (regardless of whether fever was present) (odds ratio [OR], 2.5; relative risk [RR], 1.5); new or increased cough (OR, 2.9; RR, 1.6); new or increased sputum production (OR, 5.1; RR, 2.1); intermediate (compared with low) likelihood of pneumonia on x-ray (OR, 7.0; RR, 2.3); and a high likelihood of pneumonia (compared with low) on x-ray (OR, 10.3; RR, 2.6).

Discussion

Guidelines for diagnosing and treating pneumonia repeatedly cite chest x-ray results as an integral component of the diagnosis. However, one-fifth of the 226 x-ray reports in this study of 31 NHs were ambiguous in communicating the probability of pneumonia, creating an interpretation dilemma for the NH clinicians. In terms of antibiotic treatment, clinicians regarded an ambiguous x-ray report almost identically to one that is reported as definitive for pneumonia, as prescribing rates for both were very similar, at 71% and 78%, respectively. In addition, one-third of patients with a low likelihood of pneumonia on x-ray were also treated with antibiotics, suggesting that ruling out an infiltrate does not necessarily rule out the use of antibiotics. One explanation for the high proportion of ambiguous x-ray reports is the high prevalence of chronic illness and disability in the NH population. Frailty, contractures, arthritis, osteoporotic kyphosis, pain, and cognitive impairment may all lead to difficulty positioning a patient for an x-ray. Physiologic changes, such as calcifications of the costal cartilages, scarring from previous illnesses, changes from recurrent aspiration, and anatomic changes due to COPD may also create challenges interpreting a film. Perhaps even more important is the fact that NHs use mobile x-ray companies, which typically generate single anterior-posterior images of poorer quality compared to those taken in hospitals.[13] Portable chest x-rays also have several technical limitations, including difficulty controlling scattered radiation, nonstandard distance to shoot the film, and more limited ability to control film exposure among patients of different sizes.[14]

	N	N (%) Prescribed Antibiotics	Bivariate Result OR	P Value	Multivariate Result OR	P Value
X-ray result						
Probability of pneumonia				<.001		<.001*
Low	118	40 (34)	—	—	—	—
Intermediate	41	29 (71)	4.7	<.001	5.8	<.001†
High	67	52 (78)	6.9	<.001	9.6	<.001
Degree to which case meets criteria						
Meets modified Loeb criteria for diagnosis‡						
No	158	65 (41)	6.6	<.001	1.12	.80
Yes	68	56 (82)				
Meets McGeer criteria for diagnosis						
No	211	108 (51)	6.2	.008	2.4	.36
Yes	15	13 (87)				
Meets McGeer criteria for diagnosis (fever defined by > 99.0°F)						
No	198	97 (49)	6.1	<.001	1.6	.51
Yes	28	24 (86)				
Meets IDSA guidelines for diagnosis						
No	191	95 (50)	2.9	.007	0.4	.12
Yes	35	26 (74)				
Resident Characteristics						
Resident gender						
Male	72	33 (46)	1.6	.10		
Female	146	84 (58)				
Residents with COPD						
No	135	75 (56)	0.9	.66		
Yes	79	42 (53)				
Residents on continuous oxygen therapy the week of x-ray						
No	133	70 (52)	1.4	.32		
Yes	72	43 (60)				
Residents receiving hospice care						
No	207	113 (55)	0.6	.39		
Yes	10	4 (40)				
Residents with do not give antibiotics directive in chart						
No	107	57 (53)	—	—		
Yes	0	—				
Resident Signs and Symptoms						
Temperature >38.9°C (102°F)						
No	222	118 (53)	2.7	.84		
Yes	4	3 (75)				
Temperature >37.9°C (100°F)						
No	207	112 (54)	1.0	.93		
Yes	19	10 (53)				
Temperature >37.2°C (99°F)						
No	174	91 (52)	1.2	.55		
Yes	52	30 (58)				
Temperature documented						
No	36	14 (39)	2.0	.06	2.5	.039
Yes	190	107 (56)				
Respiratory rate > 25 breaths/min						
No	220	119 (54)	0.4	.32		
Yes	6	2 (33)				
Oxygen saturation <94% or >3% less than baseline						
No	184	96 (52)	1.3	.42		
Yes	42	25 (60)				
New or increased cough						
No	129	55 (43)	2.9	<.001	2.9	.002
Yes	97	66 (68)				
New or increased sputum production						
No	205	104 (51)	4.1	.010	5.2	.013
Yes	21	17 (81)				
New rales/crackles on physical exam						
No	207	107 (52)	2.8	.06	1.7	.45
Yes	19	14 (74)				
New rhonchi/wheezes on physical exam						
No	168	81 (48)	2.4	.010	1.6	.25
Yes	58	40 (69)				
Diminished breath sounds						
No	214	115 (54)	0.8	.77		
Yes	12	6 (50)				
Altered mental status						

Table 2 (*continued*)

	N	N (%) Prescribed Antibiotics	Bivariate Result OR	P Value	Multivariate Result OR	P Value
No	196	106 (54)	0.8	.67		
Yes	30	15 (50)				
Acute functional decline						
No	212	111 (52)	2.2	.20		
Yes	14	10 (71)				

*Two-degree of freedom test of overall effect.
†Difference in odds ratios between intermediate and high is not statistically significant in bivariate analysis (*P* = .43) or multivariate model (*P* = .31).
‡Loeb criteria have been modified for this report due to absence of data collection on pulse or rigors.

In other work, academic radiologists disagreed on the presence or absence of an infiltrate in 15% of nonportable, two-view chest x-rays[15]; so, in light of the NH population and the use of portable single-view films, the high prevalence of ambiguous readings that we observed is understandable. In a 2006 NH study, Loeb et al concluded that interrater reliability between radiologists' interpretation of portable films was fair at best. Because of this challenge, the authors recommended that clinical findings be weighted especially highly in determining treatment.[11] In another study, radiologists stated that 40% of the 40 portable films they interpreted were of fair or poor quality. In that study, four radiologists agreed on only 57% of the interpretations.[16] Given the fact that the reliability of the chest radiograph in the NH setting is suboptimal, treatment decisions about lower respiratory tract infections should be based on clinical findings and not on radiographic findings alone.

Interestingly, a radiograph highly likely for pneumonia did not always lead to antibiotic prescribing in this sample, as seven of the 33 patients with pneumonia on the radiology report were not treated. On further review of each of these cases, this decision appeared appropriate based on the lack of clinical findings. Thus, at least some NH clinicians are also taking into account clinical factors, a practice we strongly recommend in light of concerns regarding antibiotic overuse.

A report indicating a low likelihood of pneumonia did not necessarily rule out antibiotic prescribing in this sample, as one-third of patients with radiology reports interpreted as low likelihood for pneumonia were also treated with antibiotics. Unexpectedly, a diagnosis of COPD was not associated with a decision to initiate antibiotics in this sample; thus, many of these prescriptions were likely for patients with acute bronchitis—a diagnosis that is a major cause of antibiotic overprescribing in adults and which has been shown to be reduced by antibiotic stewardship programs in ambulatory care.[17,18] Because clinical manifestations of acute bronchitis may be similar to those of pneumonia, distinguishing between these conditions by chest x-ray is paramount to optimizing therapy.[19] If an x-ray shows a negative result, both the American College of Physicians[20] and the American College of Chest Physicians[21] have concluded that bronchitis is the likely diagnosis and that antibiotics are usually not indicated. Of course, the decision to refrain from antibiotic use should not preclude close monitoring and symptomatic support for dyspnea, fever, or other signs and symptoms.

Our team initially considered the category "infiltrate without pneumonia" as an intermediate reading, as the term *infiltrate* has more implications than pneumonia. Radiologists use the term *infiltrate* to represent any of at least 14 pathophysiologic conditions.[22] Additionally, we noted when coding the readings that 14 of the 34 (41%) "infiltrate without mention of pneumonia" readings used words such as "mild," "modest," "minimal," or "ill-defined" suggesting that some of the reports may have been over read. A few indicated a previous infiltrate; however, because NH documentation is incomplete, we could not tell whether the x-ray was ordered solely to follow

up or because of new symptoms. However, the term *infiltrate* is specifically utilized in the IDSA definition of pneumonia, and therefore, our final decision was to include the readings coded into this category as "high likelihood of pneumonia."

This study is the first to examine in such detail NH patient management concerning chest x-rays. Our data collection did have some limitations, however. First, our audits did not capture whether patients had white blood counts measured, a component included in both the IDSA guidelines and McGeer criteria; that said, because blood work typically takes 24 hours or more to be reported in NH patients, it is unlikely that this test had a profound effect on decision making in these cases. We also did not assess whether patients had experienced a temperature rise from their personal baseline; however, by including any temperature of 37.2°C (99°F) as an indicator—as recommended by one of our previous studies[23]—we helped account for the issue of lower normal temperatures in NH residents. Although delirium is one of the "constitutional criteria" in the modified McGeer criteria,[9] the standardized assessment recommended by McGeer is virtually never found in NH records; so that measure was not included in this study. It is possible that some antibiotics were prescribed before an x-ray report was available; however, we were unable to determine this because reports are typically returned on the same day and are not time stamped. However, the relatively rapid return of results in most NHs leads us to conclude that in most, if not all cases, the x-ray report contributed to decision making.

While aware of the limitations of our data, our overall conclusion from these analyses is that chest x-rays in NHs often leave clinicians uncertain of what to do next, because at least one-fifth of radiology readings are ambiguous, which may exacerbate the tendency for antibiotic overprescribing. This conclusion appears particularly applicable considering that, of our 226 study cases, only 19 had a temperature greater than 37.9°C (100.0°F), and only six had a respiratory rate greater than 25 breaths per minute, yet 121 received antibiotics. Thus, while expert guidelines indicate that chest x-rays should be used to narrow diagnoses and minimize antibiotic overuse, these results suggest that this is not the outcome in clinical practice.

Based on expert-based guidelines, antibiotic stewardship efforts should encourage clinicians to rely more on clinical signs and symptoms and to not rush to prescribe antibiotics in patients who lack clinical signs of pneumonia—regardless of the chest x-ray result. Specifically, antibiotic treatment should be reserved for patients who experience clinical signs and symptoms that are worrisome for bacterial infection. Evaluating the patient clinically for symptoms such as fever greater than 100.4°F, purulent sputum, increased respiratory rate (>25 beats/min), new or worsening cough, change in mental status, and vital sign instability is key to determining the need for antibiotics or for careful observation. We recognize that clinicians may well express appropriate concern that no combination of history and physical exam findings definitively confirm or rule out a diagnosis of pneumonia.[23–25] However, vital signs and physical exam have been shown to be 95% sensitive in diagnosing pneumonia, so in the setting of normal vitals and physical exam, neither an x-ray nor an antibiotic should be necessary if close follow-up is available.[26] In a similar vein, Mehr and colleagues suggested that the use of eight clinical variables (increased pulse, respiratory rate >30 beats/min, temperature >38°C, somnolence or decreased alertness, presence of acute confusion, lung crackles on auscultation, absence of wheezes, and increased white blood count) will identify NH patients with a high probability of having pneumonia without a chest x-ray.[27] Consequently, ordering a chest x-ray should be carefully considered, and the results must be treated with more circumspection than is currently done, using

established guidelines to decide if a positive or ambiguous chest x-ray result should result in therapy.[8–10].

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