Pneumonia in the Elderly: A Review of Severity Assessment, Prognosis, Mortality, Prevention, and Treatment

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Abstract: Pneumonia is an increasingly common disease in the elderly due to an aging population. This is a comprehensive literature review outlining the severity assessment, morbidity, mortality, prevention and treatment options. Several models have been postulated to predict severity assessment and prognosis in older patients. Mortality increases with age and functional status is also an independent predictor for short- and long-term mortality. The effectiveness of the pneumococcal vaccine is controversial, whereas the influenza vaccine is universally recommended. Treatment involves antibiotics with the type and method depending on the severity of the pneumonia. However, treatment of nursing home patients is challenging and there are no validated guidelines at present to determine when transfer to the hospital is necessary.

Key Words: elderly, mortality, pneumonia, prognosis, severity assessment

Pneumonia in older patients is associated with significant morbidity and mortality compared to younger adults. Undertaking a severity assessment can give prognostic information in this group and help guide appropriate treatment. Prevention by means of vaccination is an important aspect that should also be given attention.

In general, there are three types of pneumonia in the elderly: community-acquired, nursing home-acquired, and nosocomial pneumonia. Community-acquired pneumonia refers to patients who live in their home; these patients present more commonly than nursing home-acquired patients because most elderly live in their own homes. However, nursing home patients are a population deserving of special review as they have different characteristics and tend to be sicker than community patients.[1] Also, this population has a higher incidence of aspiration pneumonia compared to the community-acquired population.[2]

Recent developments in nomenclature include the term healthcare-associated pneumonia (HCAP), which was incorporated in the 2005 American Thoracic Society guidelines. HCAP refers to any patient who develops pneumonia in the hospital, resides in a nursing home or residential care facility, receives home wound care, undergoes chronic dialysis, or is exposed to a family member with a multidrug resistant pathogen.[3]

This review will focus on severity assessment, morbidity, mortality, prevention, and treatment of pneumonia in the elderly. For the purposes of this review, "elderly" is defined as patients 65 years or older, as most published studies use this definition.

Severity Assessment and Prognosis

It is important to assess the severity of pneumonia, particularly on presentation as this can be used to guide treatment and level of care, as well as allow predictions about prognosis. In the elderly, decisions regarding the extent of investigations, treatment (ie, intravenous versus oral antibiotics), and whether intensive care management is appropriate, needs to be considered from the outset. A discussion with the patient and their family is essential to determine their wishes

Key Points

- Severity assessment, including models such as the Pneumonia Severity Index, is important for predicting prognosis.
- Mortality increases in patients with age, comorbidities, and nursing home placement.
- The effectiveness of the pneumococcal vaccine in the elderly is controversial, whereas the influenza vaccine is universally recommended.
- Treatment of nursing home patients is challenging, and there are no validated guidelines at present to determine when transfer to the hospital is necessary.

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in regards to treatment, particularly for patients where treatment of pneumonia might actually cause more morbidity. For patients where treatment is pursued, the environment where they are treated needs to be considered. If patients are assessed as being at low risk for complications, they may be suitable for outpatient management, which reduces hospital admissions and cost as well as the adverse functional consequences of hospitalization in the frail elderly. On the contrary, if patients are identified early as being at high risk for complications, then they can receive appropriate treatment in a timely manner, such as antibiotic therapy and ventilatory support if necessary. This also highlights the important issue of the extent of treatment in the very elderly, especially if there are multiple comorbidities and estimates of long-term survival are guarded. Limitations in treatment may be entirely appropriate, for example, avoiding mechanical ventilation, especially if the patient's preference is for noninvasive treatment.

There are a variety of assessment tools that can assist in determining the severity of pneumonia. We describe three well-known models; Pneumonia Severity Index (PSI), CURB-65, and the modified American Thoracic Society (ATS) guidelines (Table). PSI is a scoring system used to categorize the severity of pneumonia on presentation. It is aimed at identifying patients at low risk of mortality so that they can be treated in the community or at home.[4] CURB-65 is a modification of the original British Thoracic Society (BTS) rule and is designed to predict mortality in hospitalized patients. The modified ATS guidelines were developed to predict which patients should be treated in the intensive care unit. Thus, these three scoring systems were developed for different reasons and other authors have looked at the predictive power in predicting mortality, intensive care unit (ICU) admission, and outcomes. The PSI was not specifically designed for the elderly population, but it does give useful prognostic information. It was developed in a large cohort of patients (14,199 inpatients) and has been well validated in 38,039 inpatients and 2287 inpatients and outpatients enrolled in the pneumonia PORT cohort study.[4] Patients are stratified into five risk groups with the lowest mortality being for classes I to III (0.1–2.8%), intermediate risk for class IV (8.2–9.3%) and highest risk for class V (27%–31.1%). Class I (age <50, no coexisting illness, and no adverse clinical findings) and II (PSI <70) are considered for outpatient treatment, class IV (PSI 91–130) and V (PSI score >130) for inpatient management, and class III may be managed either as an inpatient or outpatient.[4] However, the index has not been prospectively tested for the purpose of defining the need for hospitalization. Also, the index heavily weights age, assigning men over the age of 70 and women over 80 into risk class III even if there are no other risk factors. It also

Table. Pneumonia assessment tools

Pneumonia severity index scoring system[4]

Characteristic	Points
Age	
Men	Age (yr)
Women	Age (yr-10)
Nursing home resident	10
Coexisting illness	
Neoplastic disease	30
Liver disease	20
Congestive heart failure	10
Cerebrovascular disease	10
Renal disease	10
Physical examination findings	
Altered mental status	20
Respiratory rate >30 min	20
Systolic blood pressure <90 mm Hg	20
Temperature <35 or >40°C	15
Pulse >125/min	10
Laboratory and radiographic findings	
Arterial pH <7.35	30
Blood urea nitrogen >30 mg/dL	20
Serum sodium <130 mmol/L	20
Serum glucose >250 mg/dL	10
Hematocrit <30%	10
Partial pressure of oxygen <60 mm Hg	10
Pleural effusion	10

Modified British Thoracic Society guidelines (CURB-65)[5]

Confusion (defined as Mental Test Score of 8 or less, or new disorientation in person, place or time)
Urea >7 mmol/L
Respiratory rate ≥30/min
Blood pressure (systolic <90 mm Hg or diastolic ≤60 mm Hg
Age ≥65 yr

American Thoracic Society guidelines[6]

Criteria for severe community-acquired pneumonia
Presence of 1 major or 2 minor criteria
Major
- Septic shock
- Need for ventilation

Minor
- Multilobar disease (>2 lobes)
- Systolic BP <90, diastolic BP <60
- PaO_2/FiO_2 ratio <250

SOAR prediction rule for elderly patients[7]

One point for each of the following:
- Systolic blood pressure <90 mm Hg
- Oxygentation (PaO2: FiO2 <250)
- Age ≥65 yr
- Respiratory rate ≥30 breaths/min

yr, year; BP, blood pressure.

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neglects other areas such as social circumstances which are important in deciding whether or not to admit elderly patients.

CURB-65 is a modification of the British Thoracic Society guidelines and incorporates age greater than 65 as a risk factor.[5] CURB-65 is said to be more "user friendly" than the PSI and only focuses on a limited number of factors that most highly correlate with poor outcome. CURB-65 was developed by Lim et al[5] who analyzed 1068 patients and their 30-day mortality to identify those with severe pneumonia. The sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) for severe pneumonia (score $\geq$3) was 75%, 75%, 23%, and 97% in the derivation set and 68%, 75%, 22%, and 96% in the validation set. The high negative predictive values are a useful guide to predicting mortality. The authors suggest that the CURB-65 score can stratify patients into 3 different management options: group 1 (score 0 or 1) was found to have a low mortality of 1.5% (n = 324, 5 died) and can be considered for outpatient management; group 2 (score of 2, mortality intermediate 9.2%, n = 184, 17 died) can be considered for hospital-supervised treatment; and group 3 (score 3 or more, mortality high at 22%, 47 died) should be considered for intensive care management if appropriate. Although CURB-65 was primarily designed to determine mortality, it compares favorably with the PSI in determining which patients could be safely managed out of the hospital (ie, lower risk patients) in Lim et al's study. The PSI is more tedious to calculate and may be more difficult to apply in a busy clinical setting. Another well-known assessment tool is the modified ATS guidelines, which can identify those with severe community-acquired pneumonia. It is designed for use in all age groups, and is not specific to the elderly population.[6,8] Ewig et al[9] found that using the modified ATS to predict ICU admission had a sensitivity of 69%, specificity of 98%, PPV of 87%, and NPV of 94%. The modified ATS was favorable in predicting the severity of pneumonia and mortality as well.

Myint et al[7] evaluated the usefulness of the BTS guidelines in predicting mortality and looked for alternatives. One hundred and ninety-five patients with a median age of 77 years were recruited with the main outcome studied being mortality at 6 weeks. Their sensitivity and specificity were comparable to Lim et al's study, confirming the usefulness of CURB-65 in predicting mortality. However, they came up with a new set of criteria called SOAR (Table). They found that oxygenation was the best predictor of outcome in the elderly. They note that in an elderly cohort, confusion and elevated urea are common and add little to predictive models. They proposed SOAR as an alterative predictive model for these older patients, although it did not improve the identification of death compared to the other models and is not as well validated yet.

These models do not take into account all the patients' comorbidites which may impact greatly on outcome, especially in the elderly and nursing home patients. Niederman and Brito[3] commented that the PSI and BTS can be viewed in a complimentary fashion: the PSI is best validated for identifying patients at a low risk of mortality, whereas the BTS picks up patients at a higher risk of mortality. The authors note that variable clinical presentations in the elderly make it difficult to apply prognostic scoring systems. Therefore, we conclude that mortality prediction rules do not replace comprehensive medical assessments, but can aid in determining the severity of illness. Admission to the hospital also depends on patient factors, such as social situations. Even a patient at low risk of mortality may require inpatient instead of outpatient treatment due to important psychosocial factors. On the other hand, patients at high risk of dying might not necessarily require admission; for example, nursing home residents may not want to transfer to the hospital if the goal of management is symptom relief, such as palliative measures, and not cure.

In general, all the models described can help in estimating prognosis. Higher scores are worse than lower scores in all of the models described earlier, indicating a higher risk of mortality. Zalacain noted that there have been other studies in the literature offering different prognostic rules for elderly patients with community-acquired pneumonia[1,10,11]; however, these small studies, though useful, have not been as well validated as the models discussed previously. Naughton performed a retrospective review of 378 patients from a nursing home and looked at predictors of 30-day mortality.[12] Variables included tachypnea (respiratory rate >30), tachycardia (heart rate >125), altered mental state, and history of dementia. It was found that the mortality rate for patients with two or more variables at diagnosis was higher than 30%. This prognostic model has been used to develop guidelines in treating nursing home-acquired pneumonia.

Mortality and Morbidity

Kaplan's study[13] of 623,718 hospital admissions for community-acquired pneumonia included 26,476 (4.3%) who were from nursing homes. Overall, 66,045 (10.6%) died. Mortality doubled with age from 7.8% in those aged 65–69 years to 15.4% in those aged 90 and older. Nursing home residents had a mortality of 17.6%. Mortality was also higher in those with an underlying illness defined by the Charlson-Deyo comorbidity index (11.9% versus 7.6%, $P < 0.006$) and was higher in men than in women (11.6% versus 9.8%, $P < 0.001$) using a univariate analysis. The adjusted odds ratio for death in men was 1.15 (95% CI 1.13–1.17) after adjusting for age, residence, comorbidity, and etiology. The authors note that this effect was small. Increasing age, residing in a nursing home, and comorbidity were shown to be significant predictors of death. They also found that patients with a complex course of pneumonia, defined as one requiring mechanical ventilation or ICU admission, not surprisingly had a higher

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mortality (22.5% versus 7.1% for a simple course, $P < 0.001$) as did patients with organ dysfunction (23.2% versus 9.9%, $P < 0.001$), which would reflect increasing severity of illness. Patients receiving mechanical ventilation had a high mortality of 55.4%. The study also found that most deaths occurred within 48 hours of admission, the most common day of death being day one, both overall (17.9%) and for subgroups managed aggressively (12.8% for complex cases and 10.8% for cases on mechanical ventilation). Approximately one-quarter of deaths occurred within 48 hours of admission, and those dying early were older (79.6 years versus 78.3, $P < 0.001$) and were more likely to be from nursing homes (8.2% versus 6.7%, $P < 0.001$). The authors commented on the large number of deaths that occurred on day one and suggested that the elements of care (eg, intravenous antibiotics, life support, and certain diagnostic tests) were not expected to reverse a patient's course in one day. They speculated that some deaths may have been averted if the patient had been hospitalized sooner. In other instances, death may have been considered inevitable and palliative treatment was instituted, which raises the issue as to whether hospital admission was appropriate in the first place (particularly with residents from nursing homes). They stated that the current focus is on improving hospital decision-making in decreasing hospital admissions for low-risk patients by treating them as outpatients, and suggested focusing on earlier admissions of high-risk patients and exploring better options for those better suited for end-of-life care.

There are a number of studies looking at risk factors for death in the older population. Fernandez-Sabe found that acute respiratory failure, shock, and multiorgan failure accounted for most early mortality in both young and older patients.[14] Beyond 48 hours, worsening of underlying diseases (eg chronic obstructive pulmonary disease [4% in younger versus 17% in very elderly patients]) was more likely to cause death in the very elderly compared to younger patients. In the multivariate analysis, the only variables independently associated with increased mortality were altered mental status, shock, respiratory failure, renal failure, and Gram-negative pneumonia.

In nursing home patients, Muder found in his review that the most important determinant of pneumonia outcome was a patient's functional status.[15] This has also been the conclusion in several other studies.[16–18] Neither age nor underlying medical illness appeared to have a significant effect after adjusting for level of dependency. Long-term survival is also intimately linked to functional status. Approximately 60% of patients with multiple dependencies will die within 12 months of an episode of pneumonia, and fewer than one quarter will be alive at 2 years.[18] During that time, recurrent pneumonia is common, as is transfer to a hospital for other acute illness. The author comments that it is not clear whether the initial episode of pneumonia contributes to a patient's subsequent decline and demise, or whether it serves as a marker for debility that is incompatible with long-term survival.

Additionally, a recent study by Torres et al[19] looked at the importance of functional assessment in determining outcome. Although this was a small study of 99 patients aged 65 or older who had community-acquired pneumonia, it showed that functional status (using the Barthel index) was an independent predictor for short- and long-term mortality. This study found that neither age nor comorbidity predicted mortality. The pneumonia severity index (PSI) was not an independent predictor of mortality either, demonstrating that the PSI may be less accurate when applied to elderly patients. The PSI was, however, an independent predictor for functional decline. More data is needed to determine the longer term effects of an episode of pneumonia on an older person's functional and cognitive status, as trials are lacking in this area.

Prevention by Vaccination

Streptococcus pneumoniae is responsible for a substantial amount of cases of pneumonia, and vaccines have been developed to try to prevent disease and death. The pneumococcal vaccine is an attractive option as antibiotic resistance among pneumococcal strains is increasing worldwide.[20] The first 14-serotype pneumococcal polysaccharide vaccine has existed since 1981, and since 1983, the 23-serotype vaccine has been in use, containing roughly 90% of the serotypes of *Streptococcus pneumoniae*. However, the effectiveness of the pneumococcal vaccine is still controversial and has been the subject of several randomized controlled trials and meta-analyses.

Cornu et al[20] studied 14 trials in 2001 with 48,837 patients in total (level I evidence). They found that the pneumococcal vaccine was highly efficacious in preventing definite pneumococcal (bacteremic) pneumonia by 71%, presumptive pneumococcal pneumonia by 40%, and mortality due to pneumonia by 32%, but not all-cause pneumonia or death, which was similar to a previous meta-analysis.[21] The analysis was unable to show any preventative efficacy against all-cause pneumonia and it was suggested that this was because of the heterogeneity between studies and reduced statistical power. The subgroup analysis of elderly patients also did not show any positive result for any of the endpoints, mainly due to low statistical power.

Another study looked at the effectiveness of the pneumococcal vaccine in adults aged older than 65 (level III) evidence).[22] This was a retrospective cohort of 47,365 and showed that the vaccine was effective in reducing bacteremia, but did not alter the risk of outpatient or any case of community-acquired pneumonia or nonbacteremic pneumococcal pneumonia whether or not it required hospitalization. This was in agreement with Cornu's meta-analysis.

In elderly bedridden patients, the pneumococcal vaccination shortened the overall febrile days and reduced the rate of hospitalization but, again, did not alter the pneumonia or invasive pneumococcal disease-related mortality (level IV ev-

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idence).[23] In one case control study it was suggested that there was a decline in the vaccine efficacy after the age of 75 (level IV evidence).[24] Vaccines are given every 5 years, and even if the efficacy is lower, the higher risk of pneumonia in the elderly population makes the vaccine an attractive proposition.

The Cochrane Collaboration reviewed randomized studies from 1966 to June 2007 and found that the combined results of these studies again failed to show that the polysaccharide pneumococcal vaccine is effective in preventing either pneumonia (odds ratio = 0.71, confidence interval 0.52–0.97) or death (odds ratio = 0.87, confidence interval 0.69–1.10) (level I evidence).[25] They noted that the earlier trials had more positive findings, but pooling from trials after 1977 suggested there is no effect. This could be due to improvements in trial methodology or different trial settings to a real loss of efficacy over time. It was also noted that earlier trials were more often conducted in the higher-risk healthy populations where the expected benefit of the vaccine would be greater. Also, difficulty in diagnosis may be a reason why results of pooled randomized controlled trials of pneumococcal vaccine have not shown significant benefit.[26] Some studies isolated blood cultures, while others used sputum culture and serology.

Moreover, case control studies (level IV evidence) do show efficacy in preventing invasive pneumococcal disease (OR 0.48, confidence interval 0.37–0.61) which corresponds to an efficacy of 53%.[25] Thus, the evidence from nonrandomized studies suggests that the vaccine is effective in reducing invasive pneumococcal disease in adults. The authors estimate the incidence of pneumococcal infection to be 0.01%. An efficacy of 50% corresponds to a number needed to treat of 20,000 vaccinations per infection avoided, and perhaps 50,000 per death avoided. Overall, however, it seems that the vaccine is a cost effective option and can prevent invasive pneumococcal disease with few side effects.[21,27] The vaccination is recommended for all immunocompetent patients >65 years, and all younger persons with chronic illnesses such as cardiovascular disease, chronic pulmonary disease, diabetes mellitus, alcoholism, chronic liver disease, cerebrospinal fluid leak, and functional or anatomic asplenia.[28]

Less controversy surrounds the influenza vaccine. It is an attractive preventative option and is cost effective.[29] The current vaccines are trivalent and contain two type A and one type B viruses. A meta-analysis of 20 studies of patients older than 65 years with community-acquired pneumonia showed that the vaccine reduced the occurrence of pneumonia by 53%, the hospitalization rate by 50%, and mortality rate by 68% (level I evidence).[30] Although pulmonary infection is not the main presentation of influenza, it is strongly associated with mortality, either due to viral pneumonia or bacterial superinfection.[31] There is consensus in the literature that the influenza vaccine should be administered yearly to all elderly patients and is an important factor in the care of these patients from home or residential care. Also, other individuals at high risk or at risk of transmitting influenza, such as health care workers, should be vaccinated.[29] Interestingly, a recent review by Simonsen et al[32] questions the influenza vaccine's true efficacy after the age of 70 and in the frail elderly. The authors cite a lack of evidence in these populations and that cohort studies have bias, eg. selection bias by vaccinating the "well" elderly. It is suggested that vaccine effectiveness declines after the age of 70 years and that there are a lack of randomized controlled trials in this population. Nevertheless, the authors conclude that the vaccine should still be given to these elderly patients until more evidence to the contrary becomes available.

Apart from vaccines, other simple measures to prevent pneumonia should not be neglected. This includes good hand hygiene (particularly in hospitals to prevent the spread of bacteria and other microbiology), ensuring good oral hygiene (particularly in patients who cannot care for themselves) and avoiding aspiration pneumonia by ensuring the head of the bed is raised and that patients are alert when eating.

Treatment

The mainstay of treatment in pneumonia of any age group is the use of antibiotics and supportive care, including oxygen therapy when appropriate. There are numerous guidelines on community-acquired pneumonia by various professional associations that give recommendations for empirical antibiotic therapy.[33–35] Empirical antibiotics are used, as pneumonia is rarely defined microbiologically at presentation. Kaplan and Angus[29] found that age was not used as a discriminating factor in defining empiric therapy and age alone had little impact on bacterial etiology in the absence of comorbid illnesses. This has been recognized in the American Thoracic Society guidelines published in 2001 where age was no longer used as a discriminating factor to determine bacterial etiology.[34] Since *Streptococcus pneumoniae* is the most common bacteria, guidelines recommend the use of a beta-lactam in combination with a macrolide (to cover atypical organisms) or an antipneumococcal fluoroquinolone alone as first-line treatment (US and British guidelines).[1,31] An Australian review noted that the fluoroquinolones such as moxifloxacin or gatifloxacin are effective against all common pathogens but they are expensive compared to standard oral agents and their overuse may generate resistance to valuable reserve agents such as ciprofloxacin.[36] The type of antibiotic and method of administration (eg. oral versus intravenous) often depends on the severity of the pneumonia, in which case the pneumonia severity index can act as a guide.[35] It is beyond the scope of this review to go into detail about the possible antibiotics to use, but, in general, treatment should be tailored towards the microbiologic results, aiming for the narrowest spectrum, if possible, to decrease the risk of antibiotic resistance.

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Treatment of Nursing Home-Acquired Pneumonia

Treatment of nursing home patients represents a special challenge. There are a lack of randomized controlled trials in this area in regards to the best management and when hospitalization should occur. There are no validated guidelines at present. A paper by Hutt and Kramer reported the development of evidence-based guidelines for the management of nursing home-acquired pneumonia in the United States.[37] A multidisciplinary and multispecialty panel developed an algorithm based on the patient's wishes for hospitalization and aggressive care to decide when to hospitalize. It focused on communication between nursing staff and physicians within 2 hours of the onset of symptoms (such as tachypnoea, fever, and cognitive decline): factors in other trials that have been found to correlate with symptoms of pneumonia. The guidelines recommend that patients with probable pneumonia should have a chest x-ray. The main decision to hospitalize a resident was divided into three main groups: the first group were those whose severity of illness exceeded the capacity of the nursing home to deliver acute care; the second group comprised those whose illness severity mandated hospitalization; and the last group included those who were stable and did not necessarily need transfer. Transfer was based on the patient's wishes (illustrating that this is an area where advance care planning plays an important role), symptoms such as tachypnea, and the use of prognostic rules such as the pneumonia severity index and the criteria developed by Naughton.[12]

The following recommendations were written by the convening committee as a guide to determine hospitalization and are based on two retrospective series which suggested that patients with an elevated respiratory rate benefit from hospitalization, and that patients hospitalized according to these criteria tended to have better survival.[17,37,38] They suggested that patients with two or more of the following symptoms should be hospitalized: oxygen saturation $<$90% on room air at sea level; systolic blood pressure $<$90 mm Hg or 20 mm Hg less than baseline; respiratory rate $>$30 breaths per minute or 10 breaths per minute more than baseline; requiring 3 liters per minute of oxygen more than baseline; uncontrolled, chronic obstructive pulmonary disease; congestive heart failure or diabetes mellitus; unrousable if previously conscious; or new/increased agitation.[37]

The panel's advice was that the initial antibiotic of choice should be empiric and cover *S pneumoniae*, *H influenza*, Gram-negative rods and *S aureus*. Choices include an antipneumococcal quinolone or extended spectrum beta-lactam plus a macrolide for 10–14 days; however, it was emphasized that inappropriate use of antibiotics in nursing homes adds to the problem of antibiotic resistance in a population which is frail and often has multiple comorbidities. These guidelines need to be prospectively validated to see if they improve mortality, function, cost of care and hospitalization rates.

Conclusion

Mortality for pneumonia is higher in the elderly age group and there are prognostic models that have been developed to try and predict mortality. However, data is lacking in regards to functional and cognitive status postpneumonia, and will be an important area for research in the future. Prevention by use of the pneumococcal vaccine is a controversial but generally accepted practice, whereas the influenza vaccine is universally recommended. Age is not a discriminating factor in the use of empirical antibiotics. More research, particularly related to the indications for and appropriateness of hospitalization, is necessary to determine the best management of nursing home-acquired pneumonia.

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Please see Dr. Muthiah P. Muthiah's editorial on page 1084 of this issue.

"The dance is a poem of which each movement is a word."

—Mata Hari

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