Community-Acquired Pneumonia: Defining Quality Care

Gregory B. Seymann, MD

Division of Hospital Medicine, Department of Medicine, University of California, San Diego, School of Medicine, San Diego, California

BACKGROUND: Community-acquired pneumonia (CAP) is one of 3 initial conditions for which the Joint Commission for Accreditation of Healthcare Organizations and the Centers for Medicare & Medicaid Services have defined quality measures. Eight "core measures" of pneumonia care have been targeted for reporting by U.S. hospitals to facilitate performance monitoring.
METHODS: A review of the literature supporting the core measures was performed.
RESULTS: Indicators encouraging influenza vaccination and appropriate antibiotic selection had the most robust evidence. Rapid delivery of antibiotics also showed significant reduction in mortality, though the actual timing (4 versus 8 hours) varied between studies. Other measures, such as performance of blood cultures, pneumococcal vaccination, smoking cessation, and oxygenation assessment, demonstrated less obvious clinical benefit.
CONCLUSIONS: There is inherent value in setting standards of care for high-impact conditions such as CAP, but these standards should be chosen on the basis of high-quality research. Public reporting of the current measures is problematic, as it implies they represent best practices for CAP despite relatively weak evidence.
***Journal of Hospital Medicine* 2006;1:344–353.**

KEY WORDS: community-acquired and nosocomial pneumonia, quality improvement, care standardization.

The quality movement has spawned efforts to define and measure best practices for clinical conditions commonly cared for by hospitalists. Pneumonia is the most frequent infectious cause of death in the United States, and it accounts for more than 1 million hospitalizations annually at an estimated annual cost of $12.2 billion, most of it incurred by inpatients.[1] The morbidity and mortality of the elderly are particularly burdensome.[2,3] For these reasons, attention has been focused on improving the quality of care of inpatients with community-acquired pneumonia (CAP).

Credentialing agencies such as the Joint Commission on Accreditation of Healthcare Organizations (JCAHO) require hospitals to report performance on predefined "core measures" of pneumonia care that they have identified as best practices (see Table 1).[4,5] The performance of individual organizations on these measures is now publicly reported at a website (www.hospitalcompare.hhs.gov) sponsored by the U.S. Department of Health and Human Services in conjunction with the Hospital Quality Alliance. Similar information is available at JCAHO's www.qualitycheck.org. Health care consumers can review quality data from the institution of their choice and compare the performance of various hospitals. The Centers for Medicare & Medicaid Services (CMS)

DOI 10.1002/jhm.128
Published online in Wiley InterScience (www.interscience.wiley.com).

TABLE 1
Core Measures of Quality Care for Pneumonia in Hospitalized Patients

- Collection of blood cultures before antibiotic therapy.
- Collection of blood cultures within 24 hours of admission.
- Mean time of less than 4 hours from arrival to initial administration of antibiotics.
- Choice of initial antibiotics according to established guidelines.*
- Pneumococcal screening and vaccination of eligible patients by discharge.
- Influenza screening and vaccination of eligible patients during flu season.
- Oxygenation assessment within 24 hours of admission.
- Smoking cessation counseling to all smokers.

* Non-ICU: B-lactam + (macrolide or doxycycline) *or* respiratory fluoroquinolone.
ICU: B-lactam + (macrolide *or* respiratory fluoroquinolone).
ICU with pseudomonal risk: IV antipseudomonal B-lactam + (ciprofloxacin or levofloxacin) *or* antipseudomonal B-lactam + aminoglycoside + ([ciprofloxacin or levofloxacin] or macrolide).

provides financial incentives for the public reporting of such data and distributed $8.85 million to the top-performing hospitals participating in a demonstration project in 2005.[6-8] Voluntary reporting of performance on quality measures by individual physicians,[9] as well as hospitals, is now being encouraged. As congress currently considers implementing "pay for performance" measures as a means to improve physician reimbursement, reporting will ultimately be linked to physician payments.

Performance on core measures for pneumonia is less consistent across hospitals than the other conditions currently being monitored.[7] It is instructive, then, to review the evidence base for the existing pneumonia quality measures, which can inform decisions about prioritizing interventions to provide the most effective care for inpatients with CAP.

BLOOD CULTURES

In a large multicenter retrospective study of Medicare patients hospitalized with CAP, Meehan et al.[10] found the performance of blood cultures within 24 hours of arrival to be associated with reduced 30-day mortality. Despite the large sample size of more than 14,000 patients, the risk-adjusted mortality reduction was of only borderline significance (RR 0.9 [0.81-1.00]). The unadjusted data did not show a significant mortality reduction. Notably, collection of blood cultures prior to antibiotic administration did not affect mortality, even excluding patients receiving prehospital antibiotics.

A smaller review of 38 U.S. academic medical centers showed relatively high compliance with blood culture performance, but no mortality reduction, even after adjustment for severity of illness. Similarly, performing blood cultures before administration of antibiotics yielded no significant effect.[11]

Several studies call into question the clinical utility of performing blood cultures drawn from patients with CAP. Combined, these studies evaluated almost 3000 pneumonia patients who had blood cultures drawn; the likelihood of a change in therapy based on results was at most 5%. Among the patients with positive cultures, only 20%-40% had a treatment change based on the result.[12-15]

The more severely ill patients with CAP may benefit from blood cultures, though the findings reported in the literature vary.[12,16] Using the Pneumonia Severity Index (PSI) score[17] to classify severity of illness, an observational study of 209 inpatients with CAP found the yield of blood cultures increased from 10% in the lowest-risk groups to 27% in the most severely ill.[16] In contrast, two larger studies with a combined enrollment of almost 14,000 patients were unable to demonstrate a difference in the incidence of bacteremia despite adjustment for the PSI score.[12,18] It is clear from these and other studies that patients in PSI classes I-III derive very little benefit from the performance of blood cultures.[12,16,19]

Metersky et al.[18] described a prospectively validated risk assessment tool that reliably predicted bacteremia in Medicare patients with CAP and explored its utility in reducing unnecessary blood cultures. Independent risk factors for bacteremia included prior antibiotic use, liver disease, hypotension, tachycardia, fever or hypothermia, BUN > 30 mg/dL, sodium < 130 mmol/L, and WBC < 5000 or $> 20{,}000/mm^2$. Use of this tool predicted bacteremia in 89% of patients and avoided 39% of unnecessary blood cultures. The authors also tested a modified version of the tool that excluded the laboratory abnormalities, so rapid assessment could be made at the initial patient presentation. This version advocated a single blood culture for most patients, and 2 blood cultures for patients with 2 or more risk factors. The modified tool accurately identified 88% of the patients with bacteremia and enabled a 44% reduction in unnecessary cultures.

In summary, blood cultures occasionally provide useful clinical information about etiology and resistance patterns, but they do not seem to reliably influence therapeutic decisions. It seems inappro-

priate to recommend against their use in practice, but they are not a solid benchmark for evidence-based quality care. Measures that mandate risk assessment of all inpatients with CAP and require blood cultures only for older patients or those judged at high risk by PSI may better reflect quality. Alternatively, performing blood cultures on patients deemed to be high risk by the model of Metersky et al.[18] may suffice.

ANTIBIOTIC TIMING

In a study of Medicare patients by Meehan et al.,[10] the 30-day mortality rate was reduced by 15% in the subset of patients who received antibiotics within 8 hours of arrival at the hospital. However, a trend toward mortality reduction was noted for those receiving antibiotics as early as 6 hours after arrival. Rapid administration of antibiotics was thus deemed an important measure of the quality of care of patients with CAP.

Additional studies attempted to confirm this observation. Battleman et al.[20] evaluated 700 patients admitted for CAP through the emergency department. They found that a delay of more than 8 hours in the administration of antibiotics was correlated with a prolonged inpatient stay. Mortality rates were not reported. Achieving rapid delivery of antibiotics was closely linked to administration of the first dose of antibiotics in the emergency department.

Conversely, a large retrospective review by Dedier et al.[11] found no reduction in inpatient mortality or in length of stay based on rapid antibiotic delivery, despite adjustment for severity of illness. They did not evaluate 30-day mortality.

The effect of antibiotic timing on the time to clinical stability has also been investigated. Clinical stability was defined as 24 hours of a systolic blood pressure $\geq$ 90 mm Hg, heart rate $\leq$ 100 beats/min, respiratory rate $\leq$ 24 breaths/min, temperature $\leq$ 38.3°C (101°F), room air oxygen saturation $\geq$ 90%, and the ability to eat. Silber et al.,[21] in a review of the records of 409 inpatients with moderate to severe CAP by PSI score, compared patients receiving antibiotics less than 4 hours, between 4 and 8 hours, and more than 8 hours after hospital admission. There was no difference between groups in time to clinical stability, even with adjustment for PSI.

Marrie and Wu[22] attempted to define the factors that influenced inpatient mortality of patients with CAP not admitted to the intensive care unit (ICU). In a prospective study of 3043 patients evaluating a clinical pathway, a multivariate analysis showed antibiotic administration within 4 hours was not correlated with reduced mortality.

Although most studies supporting rapid antibiotic delivery used a target of 8 hours, administration in less than 4 hours is the consensus standard for pneumonia care set by CMS and JCAHO.[23,24]

A benefit of timing antibiotic administration less than 4 hours after admission has been confirmed by a single, very large retrospective study of Medicare patients at least 65 years old.[25] Analysis of a random sample of more than 18,000 patients with CAP who had not received prehospital antibiotics showed that the relative risk reduction for inpatient mortality was 15% in the group receiving antibiotics within 4 hours. Thirty-day mortality was similarly reduced, and benefits continued for every hour of early antibiotic administration up to 9 hours.

The absolute risk reduction was small, however (0.6%), yielding a number needed to treat of 167 patients to prevent 1 death.

Randomized controlled trials, which would more definitively address the issue of antibiotic timing, are unlikely, as intentionally delaying administration of antibiotics to patients with known CAP is unethical. Hence, reliance on observational data must suffice. Intuitively, it makes sense to begin treatment of a bacterial infection at the earliest time possible. However, it is also known that not all patients present in a typical fashion, and diagnosis is uncertain at least 20% of the time.[26] Anecdotal reports suggest that incentivizing physicians on performance measures encourages premature administration of empiric antibiotics to all patients presenting with cough, prior to confirmation of pneumonia.[27,28] Such practices promote further antibiotic resistance, arguably a larger health issue than delay in antibiotic delivery.[29,30]

Houck[31] offers potential solutions to this problem, such as eliminating the pressure on hospitals to perform at 100% on this measure by reporting performance within acceptable ranges (eg, 70%-84% and 85%-100%) Targeting a benchmark of 80% or a duration of 6 hours may also be appropriate. Finally, a 4-hour benchmark has not been shown to benefit younger patients, so it is important to apply this target only to patients more than 65 years of age.

CHOICE OF ANTIBIOTIC

A retrospective review of 12,945 cases of inpatients with CAP found that, in comparison to ceftriaxone alone, initial antibiotic regimens consisting either of a second- or third-generation cephalosporin plus a macrolide or of a fluoroquinolone alone were associated with an approximately 30% reduction in 30-day mortality.[32] Hence, current guidelines recommend the combination of a B-lactam and macrolide, a B-lactam and doxycycline, or a respiratory fluoroquinolone for inpatients with CAP not admitted to the ICU.[33-35]

The results of subsequent studies supported the contention that guideline-compliant antibiotics improve outcomes. A prospective multicenter study of a clinical pathway that encouraged use of either levofloxacin or cefuroxime plus azithromycin for the initial treatment of inpatient CAP showed significantly reduced mortality. Compared with any other antibiotic regimen, the odds ratio for death was 0.22 with the cephalosporin/macrolide combination and 0.43 with the fluoroquinolone. Of note, early mortality (within 5 days of admission) was not reduced by antibiotic choice.[22] Similar results were found in a retrospective analysis, which found the odds of 30-day mortality increased by 5.7 in patients not receiving guideline-compliant therapy.[36] A third study found guideline-compliant antibiotics reduced the likelihood of a prolonged length of stay by 45%.[20]

Of note, data on the effectiveness of the cephalosporin/doxycycline combination are limited, and the major guidelines differ about whether this regimen is appropriate for inpatients with CAP.[33,34] Important findings from a recent retrospective cohort study showed that initial therapy with ceftriaxone plus doxycycline was associated with reduced inpatient mortality (OR = 0.26) as well as reduced 30-day mortality (OR = 0.37) compared with other guideline-compliant therapies for CAP.[37] When patients who would not have been considered appropriate for initial doxycycline therapy (those resident in nursing homes, with aspiration pneumonia, or in the ICU) were excluded, a large reduction in inpatient mortality remained (OR = 0.17), without any increase in length of stay or readmission rate. Interestingly, this study suggests the potential superiority of this regimen, though a randomized controlled trial is needed to confirm this. The current core measures do include doxycycline as an acceptable option for CAP therapy (see Table 1).

Currently, controversy remains about whether the benefit of these selected regimens results from their activity against "atypical" pathogens (*Mycoplasma, Legionella, Chlamydia*) and whether there is additional benefit from using combination antibiotic therapy.[38,39] Waterer[40] described 225 inpatients with bacteremic pneumococcal pneumonia, noting the antibiotic regimen received during the first 24 hours of hospitalization. Patients were classified retrospectively into 3 groups—single effective therapy (SET), dual effective therapy (DET), or more than dual effective therapy (MET)—on the basis of the concordance of pneumococcal sensitivity with the initial antibiotics. Patients on 2 antibiotics were classified in the DET group if the organism was sensitive to both and in the SET group if the organism was resistant to 1 of the 2. Those in the MET group were analyzed separately, as they were found to have a higher baseline severity of illness based on the PSI score; the SET and DET groups were equivalent.

Surprisingly, the SET group was found to have a 3-fold increase in inpatient mortality; adjustment for severity of illness increased the odds ratio for death to 6.4. Of note, all deaths were in the most severely ill patients (PSI IV-V). The protective effects of receiving DET were not specifically limited to those receiving a macrolide as the second agent, and multivariate analysis did not find coverage of atypical organisms to be an independent predictor of mortality.

A recent prospective multicenter trial of 844 patients with bacteremic pneumococcal pneumonia at 21 hospitals confirmed these findings.[41] A significant 14-day survival advantage (23% versus 55%) was found in the subgroup of critically ill patients who received at least 2 effective antibiotics. Though survival benefit was restricted to the sickest patients, severity of illness was similar among the groups.

The specific importance of macrolides in combination therapy remains under investigation. A review of a database of inpatients with bacteremic pneumococcal pneumonia over a 10-year period found that 58% received initial empiric therapy with a B-lactam/macrolide combination and 42% received B-lactam without a macrolide (though other antibiotic combinations were not excluded).[42] After logistic regression analysis, the investigators found a relative reduction in inpatient

mortality of 60% in the patients receiving combination therapy with macrolides. Unfortunately, neither comparison to fluoroquinolone monotherapy nor risk stratification by PSI was reported. A similar study from Canada that did stratify for risk confirmed a mortality benefit of combination therapy.[43]

A subsequent, extremely large study of more than 44,000 patients from a hospital claims-made database lent support to these findings.[44] This study included all CAP patients regardless of microbiology and was not restricted to those with bacteremia. Outcomes among groups receiving monotherapy with any of the standard agents for CAP were compared with those in groups receiving combination therapy with a macrolide as the second agent. Statistically significant reductions in 30-day mortality were observed in all groups receiving dual therapy with macrolides. Consistent with other studies, the benefit applied only to patients with more severe CAP. The percentage of patients with bacteremia was not specified.

Of note, this study did not allow direct comparison of fluoroquinolone monotherapy to combination therapy with a B-lactam and a macrolide. However, the fluoroquinolone/macrolide combination conferred no additional benefit beyond fluoroquinolone monotherapy when adjusted for severity of illness or age. This implies that fluoroquinolone monotherapy is adequate, at least in some subpopulations. This is consistent with initial studies that established the superiority of the antibiotic combinations recommended by the guidelines.[20,22,32]

The potential benefit of combination therapy appears limited to patients with higher severity of illness and pneumococcal bacteremia. However, outcomes are affected by the antibiotic regimen selected in the initial 24-48 hours of hospitalization, before results of blood cultures are routinely available. At present, clinical prediction of patients who will benefit from combination therapy is difficult.

Coverage of undiagnosed mixed infections with atypical organisms is probably not a major factor benefiting patients receiving combination therapy. Several recent meta-analyses found no reduction in mortality or the rate of clinical failure among patients receiving antibiotics covering atypical organisms compared with those for patients whose regimens did not have such coverage.[45-47] Subgroups of patients with *Legionella* pneumonia do benefit from antibiotics with targeted activity against atypical organisms, but fewer than 1% of all patients were so identified. Evidence for antibiotic synergy is similarly lacking.[48,49] The immunomodulatory effects of macrolides, which decrease cytokine production and inflammation and subsequently reduce the severity of lung injury and other complications of sepsis, are considered potential factors in the reduction of mortality.[50]

The definition of severe CAP and the indications for ICU admission remain controversial, evidence for which is reviewed elsewhere.[34,51,52] Antibiotic recommendations for ICU patients are included in Table 1 for completeness, but a detailed review of the evidence is lacking because current guidelines are based on consensus opinion.[34] The use of fluoroquinolone monotherapy in severe CAP is not currently recommended because of limitations of the existing evidence. The majority of quinolone trials have excluded severely ill patients, and approval trials of newer respiratory fluoroquinolones have used levofloxacin as a comparator. Studies comparing fluoroquinolones typically allowed investigators in the B-lactam arm the option of adding macrolides or tetracycline at their discretion. In addition, such trials have been designed as noninferiority trials.[38] Clearly, randomized controlled trials are needed to resolve this issue.

Currently, selecting appropriate antibiotics should follow established guidelines, with consideration of using combination therapy for patients with a higher severity of illness. Emphasis on this measure should be stronger than that on antibiotic timing, as the bulk of the evidence favors significant mortality reduction from following guidelines for antibiotic therapy.

VACCINATION

Guidelines recommend all eligible adults hospitalized with CAP receive pneumococcal vaccination on discharge,[33-35,53] though there is no evidence this reduces the incidence of pneumonia or death.[54,55] Retrospective studies have shown reduced incidence of invasive disease (bacteremia and meningitis), but not of other end points.[54-57] The estimated mortality from pneumococcal bacteremia remain as high as 20%-30%, with no evidence that this rate has decreased over the last 30 years.[58-61] Despite this, a recent meta-analysis from the Cochrane database that included only randomized, controlled trials (75,197 patients in 15 trials) was unable to show significant reductions in all-cause pneumonia or mortality for vaccinated sub-

jects.[62] Cohort studies, evaluated separately in this analysis, showed an efficacy of 53% in reducing the incidence of invasive pneumococcal disease. Given the relatively low incidence of invasive disease in the general population, the number needed to treat was estimated at 20,000, or 4000 if only older patients were considered. A subsequent retrospective cohort study showed no reduction in pneumonia hospitalizations, cases of outpatient pneumonia, or mortality among 45,365 elderly vaccinees.[56] Some specific subgroups may benefit, however. Vaccinated patients with chronic lung disease did show a reduction in hospitalization for pneumonia (RR 0.57 [0.38-0.84]) and in mortality (RR 0.7 [0.56-0.9]) in a retrospective study of HMO patients older than age 65.[63]

It is of interest that since the licensure of the pediatric 7-valent protein-polysaccharide conjugate vaccine in 2000, the incidence of invasive pneumococcal disease among adults has dropped significantly. Overall reduction in invasive disease in adults more than 50 years old was 11% from 1998 to 2003 (relative risk reduction [RRR] = 28%). This is likely the result of decreased transmission from colonized or infected children and not a coincidental increase in adult pneumococcal vaccination, as the rates of disease caused by the 16 strains unique to the 23-valent vaccine did not change.[64,65] The overall reduction in the incidence of invasive disease is still superior with the adult vaccine, up to 30% in vaccinated subjects (RRR = 44%).[56] Invasive disease caused specifically by penicillin-nonsusceptible serotypes has dropped by 49% in the elderly since introduction of the vaccine.[66] Thus, the combined impact of the 2 vaccines may be significant. It is not yet clear what effect, if any, the 7-valent vaccine will have on the hospitalization rate or mortality.

In contrast to the results for pneumococcal vaccination, studies of the benefits of influenza vaccination have shown clear and consistent reductions in mortality, respiratory illness, hospitalization, and pneumonia, especially among patients with comorbidities.[67-71] Cost effectiveness has been demonstrated for all populations,[72,73] and the reduction in mortality among high-risk patients younger than age 65 has been estimated to be as high as 78%.[68] Among the elderly, reduction in mortality of about 50% has been reported, along with 20%-30% reductions in hospitalizations for pneumonia, influenza, cardiac disease, and stroke.[70] Reduced incidence of pneumonia in vaccinated patients has even been documented among elderly patients without specific comorbidities.[67] Annual revaccination has the most significant impact on mortality.[74]

The pneumococcal vaccine remains important in the effort to reduce the severity of and complications from invasive pneumococcal disease in the elderly, but the lack of significant benefits on hard end points such as mortality or hospitalizations makes it a less robust measure of quality pneumonia care. In contrast, influenza vaccination has a much larger impact on outcomes in the population at risk. Emphasis should be shifted from pneumococcal to influenza vaccine in pneumonia performance measures.

OXYGENATION ASSESSMENT

It seems intuitive that oxygenation assessment is important in the initial evaluation of patients with CAP, though there is not direct evidence to support this. The recommendation for oxygenation assessment in the published guidelines for CAP is by consensus.[33-35] Documented hypoxemia is associated with increased pneumonia-related mortality,[17,75] and clinical judgment does not adequately predict hypoxemia.[76] Though the assessment of oxygenation has been found to vary widely among practitioners,[77] performance has remained consistent since the advent of monitoring and reporting of quality measures, with compliance rates of 99%.[4,7] Monitoring performance of this measure should continue, though high compliance rates limit its ability to discriminate among institutions.

SMOKING CESSATION COUNSELING

Counseling patients to stop smoking was found to be modestly (2%) but statistically significantly effective in promoting abstinence at 1 year.[78] In its report on treating tobacco use, the U.S. Public Health Services recommended that all smokers receive hospital- and system-based interventions at every visit.[79] As part of the Pneumonia Patient Outcomes Research Team (PORT) study, smokers with pneumonia underwent a tobacco cessation interview. Though only 15% of these patients quit smoking, 93% of those who quit did so at the time they developed CAP.[80] A retrospective study of patients with bacteremic pneumococcal pneumonia found tobacco exposure, including passive smoking, to be a strong independent risk factor for invasive disease.[81] The most recent CAP guidelines from the Infectious Disease Society of America (IDSA) recommend smoking cessation counseling for all hos-

pitalized patients who smoke.[33] However, hospitals are not likely to have the impact that a more comprehensive, outpatient-based smoking cessation program would. Without ongoing support, counseling, and pharmacotherapy, the effects of an intervention would be expected to be small.[79] Though evidence of benefit is limited, smoking cessation interventions should be encouraged at all sites of care. Quality care merits this regardless of admitting diagnosis, but benefits specific to CAP outcomes have not yet been demonstrated.

CONCLUSIONS

The burden of illness caused by CAP mandates that clinicians strive to deliver the highest quality of care to afflicted patients. Critical evaluation of the strength of the evidence will continue to guide such endeavors, and changes in practice will follow as new information surfaces. Standards of care, as adopted by consensus groups such as the IDSA and American Thoracic Society, will continue to inform the practice of hospitalists.

How quality is defined for public reporting requires particularly careful assessment. The definition of quality should be based on evidence more rigorous than that ascribed to consensus guidelines. Within the profession, guidelines offer reasonable standards of care and delineate areas for further research and are invaluable tools for practicing clinicians. In the public arena, however, proclaiming practices as "good" or "bad" sets expectations of health care consumers not educated in the nuances of evaluating clinical evidence and can unfairly bias them against conscientious and effective providers whose standards reflect different interpretations of controversial issues. Regulatory agencies should publicly target interventions using only the most solid evidentiary foundation while internally striving to monitor the effects of different practice patterns and report measurable differences in outcomes revealed by careful investigation. Areas where controversy remains should be the primary targets of further research but should not be offered as benchmarks for public scrutiny until the medical community has settled on a position.

Furthermore, when evidence remains questionable, financial incentives should be linked to performance indicators with extreme caution. It would be counterproductive if health care organizations, driven to achieve "optimal" antibiotic timing to obtain payment updates from CMS, began to administer antibiotics prior to completing workups on all patients with respiratory complaints, as this would likely lead to antibiotic overuse. Similarly, institutions pushed to collect blood cultures before antibiotics are given may inappropriately delay administration in order to perform well on quality measures, resulting in potential harm to patients.

The measures of quality care for CAP for which the evidence on outcomes is the most convincing are antibiotic selection (mortality benefit, reduction in LOS) and influenza vaccination (mortality benefit, reduction in hospitalizations, reduction in respiratory illness). Antibiotic timing also shows a smaller but convincing reduction in mortality, though the advantages of receiving antibiotics within 4 hours instead of 8 hours are not clearly established for younger patients. These measures should be emphasized most heavily in the arena of public reporting and incentives for quality care, with additions and modifications guided by emerging evidence. Revision of the other measures to conform with current evidence would allow public reporting to more accurately reflect quality.

Address for correspondence and reprint requests: Gregory B. Seymann, MD, Associate Clinical Professor, Division of Hospital Medicine, Department of Medicine, University of California, San Diego, School of Medicine, 200 West Arbor Dr., San Diego, CA 92103-8485; Fax: (619) 543-8255; E-mail: gseymann@ucsd.edu

Received 21 December 2005; revision received 29 March 2006; accepted 10 April 2006

REFERENCES

1. Colice GL, Morley MA, Asche C, Birnbaum HG. Treatment costs of community-acquired pneumonia in an employed population. *Chest.* 2004;125:2140-2145.
2. Kaplan V, Clermont G, Griffin MF, et al. Pneumonia: still the old man's friend? *Arch Intern Med.* 2003;163:317-323.
3. Fry A SD, Holman R, Curns A, Anderson L. Trends in hospitalizations for pneumonia among persons aged 65 years or older in the United States, 1988-2002. *JAMA.* 2005;294:2712-2719.
4. Williams SC, Schmaltz SP, Morton DJ, Koss RG, Loeb JM. Quality of care in U.S. hospitals as reflected by standardized measures, 2002-2004. *N Engl J Med.* 2005;353:255-264.
5. Performance Measurement: Core Measures. Joint Commission on Accreditation of Healthcare Organizations, 2005. Available at: http://www.jcaho.org/pms/core+measures/index.htm. Accessed November 7, 2005.
6. Medicare Quality Improvement Program Priorities: DRAFT, August 2005. Centers for Medicare & Medicaid Services. Available at: http://www.medqic.org/dcs/ContentServer?cid=1097592510511&pagename=Medqic%2FMQ Literature%2FLiteratureTemplate&c=MQLiterature. Accessed November 7, 2005.

7. Jha AK, Li Z, Orav EJ, Epstein AM. Care in U.S. hospitals—the Hospital Quality Alliance program. *N Engl J Med*. 2005; 353:265-274.
8. Medicare demonstration shows hospital quality of care improves with payments tied to quality. Centers for Medicare & Medicaid Services: *Medicare News,* 2005. Available at: http://www.cms.hhs.gov/media/press/release.asp?Counter=1729. Accessed November 21, 2005.
9. Pub 100-19. Demonstrations: Physician's Voluntary Reporting Program. Center for Medicare & Medicaid Services, 2005. Available at: http://www.cms.hhs.gov/manuals/pm_trans/R31DEMO.pdf. Accessed November 21, 2005.
10. Meehan TP, Fine MJ, Krumholz HM, et al. Quality of care, process, and outcomes in elderly patients with pneumonia. *JAMA*. 1997;278:2080-2084.
11. Dedier J, Singer DE, Chang Y, Moore M, Atlas SJ. Processes of care, illness severity, and outcomes in the management of community-acquired pneumonia at academic hospitals. *Arch Intern Med*. 2001;161:2099-2104.
12. Campbell SG, Marrie TJ, Anstey R, Dickinson G, Ackroyd-Stolarz S. The contribution of blood cultures to the clinical management of adult patients admitted to the hospital with community-acquired pneumonia: a prospective observational study. *Chest*. 2003;123:1142-1150.
13. Chalasani NP, Valdecanas MA, Gopal AK, McGowan JE Jr, Jurado RL. Clinical utility of blood cultures in adult patients with community-acquired pneumonia without defined underlying risks. *Chest*. 1995;108:932-936.
14. Corbo J, Friedman B, Bijur P, Gallagher EJ. Limited usefulness of initial blood cultures in community acquired pneumonia. *Emerg Med J*. 2004;21:446-448.
15. Waterer GW, Jennings SG, Wunderink RG. The impact of blood cultures on antibiotic therapy in pneumococcal pneumonia. *Chest*. 1999;116:1278-1281.
16. Waterer GW, Wunderink RG. The influence of the severity of community-acquired pneumonia on the usefulness of blood cultures. *Respir Med*. 2001;95(1):78-82.
17. Fine MJ, Auble TE, Yealy DM, et al. A prediction rule to identify low-risk patients with community-acquired pneumonia. *N Engl J Med*. 1997;336:243-250.
18. Metersky ML, Ma A, Bratzler DW, Houck PM. Predicting bacteremia in patients with community-acquired pneumonia. *Am J Respir Crit Care Med*. 2004;169:342-347.
19. Theerthakarai R, El-Halees W, Ismail M, Solis RA, Khan MA. Nonvalue of the initial microbiological studies in the management of nonsevere community-acquired pneumonia. *Chest*. 2001;119:181-184.
20. Battleman DS, Callahan M, Thaler HT. Rapid antibiotic delivery and appropriate antibiotic selection reduce length of hospital stay of patients with community-acquired pneumonia: link between quality of care and resource utilization. *Arch Intern Med*. 2002;162:682-688.
21. Silber SH, Garrett C, Singh R, et al. Early administration of antibiotics does not shorten time to clinical stability in patients with moderate-to-severe community-acquired pneumonia. *Chest*. 2003;124:1798-1804.
22. Marrie TJ, Wu L. Factors influencing in-hospital mortality in community-acquired pneumonia: a prospective study of patients not initially admitted to the ICU. *Chest*. 2005;127: 1260-1270.
23. Hospital Quality Measures: 2004-2007. Available at: http://www.cms.hhs.gov/quality/hospital/. Accessed November 17, 2005.
24. National Hospital Quality Measures Specification Manual version 1.02. Joint Commission on Accreditation of Healthcare Organizations, 2005. Available at: http://www.jcaho.org/pms/core+measures/aligned_manual.htm.
25. Houck PM, Bratzler DW, Nsa W, Ma A, Bartlett JG. Timing of antibiotic administration and outcomes for Medicare patients hospitalized with community-acquired pneumonia. *Arch Intern Med*. 2004;164:637-644.
26. Metersky ML, Sweeney TA, Getzow MB, Siddiqui F, Nsa W, Bratzler DW. Antibiotic timing and diagnostic uncertainty in Medicare patients with pneumonia: is it reasonable to expect all patients to receive antibiotics within 4 hours? *Chest*. 2006;130:16-21.
27. Houck PM, Bratzler DW. Administration of first hospital antibiotics for community-acquired pneumonia: does timeliness affect outcomes? *Curr Opin Infect Dis*. 2005;18(2):151-156.
28. Thompson D. The pneumonia controversy: hospitals grapple with 4 hour benchmark. *Ann Emerg Med*. 2006;47:259-261.
29. Gonzales R, Bartlett JG, Besser RE, et al. Principles of appropriate antibiotic use for treatment of acute respiratory tract infections in adults: background, specific aims, and methods. *Ann Intern Med*. 2001;134:479-486.
30. Garau J. The hidden impact of antibacterial resistance in respiratory tract infection. Clinical failures: the tip of the iceberg? Respir Med 2001;95 Suppl A:S5–11; discussion S26–S27.
31. Houck PM. Antibiotics and pneumonia: is timing everything or just a cause of more problems? *Chest*. 2006;130:1-3.
32. Gleason PP, Meehan TP, Fine JM, Galusha DH, Fine MJ. Associations between initial antimicrobial therapy and medical outcomes for hospitalized elderly patients with pneumonia. *Arch Intern Med*. 1999;159:2562-2572.
33. Mandell LA, Bartlett JG, Dowell SF, File TM Jr, Musher DM, Whitney C. Update of practice guidelines for the management of community-acquired pneumonia in immunocompetent adults. *Clin Infect Dis*. 2003;37:1405-1433.
34. Niederman MS, Mandell LA, Anzueto A, et al. Guidelines for the management of adults with community-acquired pneumonia. Diagnosis, assessment of severity, antimicrobial therapy, and prevention. *Am J Respir Crit Care Med*. 2001; 163:1730-1754.
35. Bartlett JG, Dowell SF, Mandell LA, File TM Jr, Musher DM, Fine MJ. Practice guidelines for the management of community-acquired pneumonia in adults. Infectious Diseases Society of America. *Clin Infect Dis*. 2000;31:347-382.
36. Mortensen EM, Restrepo M, Anzueto A, Pugh J. Effects of guideline-concordant antimicrobial therapy on mortality among patients with community-acquired pneumonia. *Am J Med*. 2004;117:726-731.
37. Flanders SA, Dudas V, Kerr K, McCulloch CE, Gonzales R. Effectiveness of ceftriaxone plus doxycycline in the treatment of patients hospitalized with community-acquired pneumonia. *J Hosp Med*. 2006;1:7-12.
38. Waterer GW. Monotherapy versus combination antimicrobial therapy for pneumococcal pneumonia. *Curr Opin Infect Dis*. 2005;18:157-163.

39. Weiss K, Tillotson GS. The controversy of combination vs monotherapy in the treatment of hospitalized community-acquired pneumonia. *Chest.* 2005;128:940-946.
40. Waterer GW, Somes GW, Wunderink RG. Monotherapy may be suboptimal for severe bacteremic pneumococcal pneumonia. *Arch Intern Med.* 2001;161:1837-1842.
41. Baddour LM, Yu VL, Klugman KP, et al. Combination antibiotic therapy lowers mortality among severely ill patients with pneumococcal bacteremia. *Am J Respir Crit Care Med.* 2004;170:440-444.
42. Martinez JA, Horcajada JP, Almela M, et al. Addition of a macrolide to a beta-lactam-based empirical antibiotic regimen is associated with lower in-hospital mortality for patients with bacteremic pneumococcal pneumonia. *Clin Infect Dis.* 2003;36:389-395.
43. Weiss K, Low DE, Cortes L, et al. Clinical characteristics at initial presentation and impact of dual therapy on the outcome of bacteremic Streptococcus pneumoniae pneumonia in adults. *Can Respir J.* 2004;11:589-593.
44. Brown RB, Iannini P, Gross P, Kunkel M. Impact of initial antibiotic choice on clinical outcomes in community-acquired pneumonia: analysis of a hospital claims-made database. *Chest.* 2003;123:1503-1511.
45. Shefet D, Robenshtok E, Paul M, Leibovici L. Empirical atypical coverage for inpatients with community-acquired pneumonia: systematic review of randomized controlled trials. *Arch Intern Med.* 2005;165:1992-2000.
46. Shefet D, Robenshtock E, Paul M, Leibovici L. Empiric antibiotic coverage of atypical pathogens for community acquired pneumonia in hospitalized adults. *Cochrane Database Syst. Rev.* 2005:CD004418.
47. Mills GD, Oehley MR, Arrol B. Effectiveness of beta lactam antibiotics compared with antibiotics active against atypical pathogens in non-severe community acquired pneumonia: meta-analysis. *Br Med J.* 2005;330:456.
48. Lin E, Stanek RJ, Mufson MA. Lack of synergy of erythromycin combined with penicillin or cefotaxime against Streptococcus pneumoniae in vitro. *Antimicrob Agents Chemother.* 2003;47:1151-1153.
49. Johansen HK, Jensen TG, Dessau RB, Lundgren B, Frimodt-Moller N. Antagonism between penicillin and erythromycin against Streptococcus pneumoniae in vitro and in vivo. *J Antimicrob Chemother.* 2000;46:973-980.
50. Tamaoki J. The effects of macrolides on inflammatory cells. *Chest.* 2004;125(2 Suppl):41S–50S; quiz 1S.
51. Ruiz M, Ewig S, Torres A, et al. Severe community-acquired pneumonia. Risk factors and follow-up epidemiology. *Am J Respir Crit Care Med.* 1999;160:923-929.
52. Ewig S, Ruiz M, Mensa J, et al. Severe community-acquired pneumonia. Assessment of severity criteria. *Am J Respir Crit Care Med.* 1998;158:1102-1108.
53. Willis BC, Ndiaye SM, Hopkins DP, Shefer A. Improving influenza, pneumococcal polysaccharide, and hepatitis B vaccination coverage among adults aged <65 years at high risk: a report on recommendations of the Task Force on Community Preventive Services. *MMWR Recomm Rep.* 2005; 54(RR-5):1-11.
54. Conaty S, Watson L, Dinnes J, Waugh N. The effectiveness of pneumococcal polysaccharide vaccines in adults: a systematic review of observational studies and comparison with results from randomised controlled trials. *Vaccine.* 2004;22: 3214-3224.
55. Watson L, Wilson BJ, Waugh N. Pneumococcal polysaccharide vaccine: a systematic review of clinical effectiveness in adults. *Vaccine.* 2002;20:2166-2173.
56. Jackson LA, Neuzil KM, Yu O, et al. Effectiveness of pneumococcal polysaccharide vaccine in older adults. *N Engl J Med.* 2003;348:1747-1755.
57. Butler JC, Breiman RF, Campbell JF, Lipman HB, Broome CV, Facklam RR. Pneumococcal polysaccharide vaccine efficacy. An evaluation of current recommendations. *JAMA.* 1993;270:1826-1831.
58. Balakrishnan I, Crook P, Morris R, Gillespie SH. Early predictors of mortality in pneumococcal bacteraemia. *J Infect.* 2000;40:256-261.
59. Afessa B, Greaves WL, Frederick WR. Pneumococcal bacteremia in adults: a 14-year experience in an inner-city university hospital. *Clin Infect Dis.* 1995;21:345-351.
60. Laurichesse H, Grimaud O, Waight P, Johnson AP, George RC, Miller E. Pneumococcal bacteraemia and meningitis in England and Wales, 1993 to 1995. *Commun Dis Public Health.* 1998;1(1):22-27.
61. Kramer MR, Rudensky B, Hadas-Halperin I, Isacsohn M, Melzer E. Pneumococcal bacteremia—no change in mortality in 30 years: analysis of 104 cases and review of the literature. *Isr J Med Sci.* 1987;23:174-180.
62. Dear K, Holden J, Andrews R, Tatham D. Vaccines for preventing pneumococcal infection in adults. *Cochrane Database Syst Rev.* 2003:CD000422.
63. Nichol KL, Baken L, Wuorenma J, Nelson A. The health and economic benefits associated with pneumococcal vaccination of elderly persons with chronic lung disease. *Arch Intern Med.* 1999;159:2437-2442.
64. Lexau CA, Lynfield R, Danila R, et al. Changing epidemiology of invasive pneumococcal disease among older adults in the era of pediatric pneumococcal conjugate vaccine. *JAMA.* 2005;294:2043-2051.
65. Whitney CG, Farley MM, Hadler J, et al. Decline in invasive pneumococcal disease after the introduction of protein-polysaccharide conjugate vaccine. *N Engl J Med.* 2003;348: 1737-1746.
66. Kyaw MH, Lynfield R, Schaffner W, et al. Effect of introduction of the pneumococcal conjugate vaccine on drug-resistant *Streptococcus pneumoniae*. *N Engl J Med.* 2006;354: 1455-1463.
67. Voordouw BC, van der Linden PD, Simonian S, van der Lei J, Sturkenboom MC, Stricker BH. Influenza vaccination in community-dwelling elderly: impact on mortality and influenza-associated morbidity. *Arch Intern Med.* 2003;163:1089-1094.
68. Hak E, Buskens E, van Essen GA, et al. Clinical effectiveness of influenza vaccination in persons younger than 65 years with high-risk medical conditions: the PRISMA study. *Arch Intern Med.* 2005;165:274-280.
69. Hak E, Nordin J, Wei F, et al. Influence of high-risk medical conditions on the effectiveness of influenza vaccination among elderly members of 3 large managed-care organizations. *Clin Infect Dis.* 2002;35:370-377.
70. Nichol KL, Nordin J, Mullooly J, Lask R, Fillbrandt K, Iwane M. Influenza vaccination and reduction in hospitalizations for cardiac disease and stroke among the elderly. *N Engl J Med.* 2003;348:1322-1332.

71. Wongsurakiat P, Maranetra KN, Wasi C, Kositanont U, Dejsomritrutai W, Charoenratanakul S. Acute respiratory illness in patients with COPD and the effectiveness of influenza vaccination: a randomized controlled study. *Chest.* 2004;125:2011-2020.
72. Lee PY, Matchar DB, Clements DA, Huber J, Hamilton JD, Peterson ED. Economic analysis of influenza vaccination and antiviral treatment for healthy working adults. *Ann Intern Med.* 2002;137:225-331.
73. Gross PA, Hermogenes AW, Sacks HS, Lau J, Levandowski RA. The efficacy of influenza vaccine in elderly persons. A meta-analysis and review of the literature. *Ann Intern Med.* 1995;123:518-527.
74. Voordouw AC, Sturkenboom MC, Dieleman JP, et al. Annual revaccination against influenza and mortality risk in community-dwelling elderly persons. *JAMA.* 2004;292:2089-2095.
75. Mortensen EM, Coley CM, Singer DE, et al. Causes of death for patients with community-acquired pneumonia: results from the Pneumonia Patient Outcomes Research Team cohort study. *Arch Intern Med.* 2002;162:1059-1064.
76. Maneker AJ, Petrack EM, Krug SE. Contribution of routine pulse oximetry to evaluation and management of patients with respiratory illness in a pediatric emergency department. *Ann Emerg Med.* 1995;25(1):36-40.
77. Levin KP, Hanusa BH, Rotondi A, et al. Arterial blood gas and pulse oximetry in initial management of patients with community-acquired pneumonia. *J Gen Intern Med.* 2001; 16:590-598.
78. Law M, Tang JL. An analysis of the effectiveness of interventions intended to help people stop smoking. *Arch Intern Med.* 1995;155:1933-1941.
79. A clinical practice guideline for treating tobacco use and dependence: A US Public Health Service report. The Tobacco Use and Dependence Clinical Practice Guideline Panel, Staff, and Consortium Representatives. *JAMA.* 2000; 283:3244-3254.
80. Rhew DC. Quality indicators for the management of pneumonia in vulnerable elders. *Ann Intern Med.* 2001;135:736-743.
81. Nuorti JP, Butler JC, Farley MM, et al. Cigarette smoking and invasive pneumococcal disease. Active Bacterial Core Surveillance Team. *N Engl J Med.* 2000;342:681-689.