Do Guidelines for Community-Acquired Pneumonia Improve the Cost-Effectiveness of Hospital Care?

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There is growing pressure to demonstrate the value of practice guidelines. We have reviewed the evidence that guidelines for the treatment of community-acquired pneumonia (CAP) change current practices and that the standardization of practices reduces costs and/or improves outcome. The most obvious barrier to implementation of the guidelines is lack of knowledge about their content; equally important are the attitudes and behavior of professionals, patients, and their caregivers. Guidelines may improve the outcome of CAP, provided that there is an association between variations in outcome and some specific processes of care. Conversely, when there is no such relationship, guidelines may reduce the cost of care without having an adverse effect on outcome. The cost-effectiveness of CAP guidelines in an individual hospital depends on the systems that are available to identify patients with CAP and to measure the processes of care. There is good evidence that following the recommendations of the CAP guidelines does improve the cost-effectiveness of care and, therefore, that an audit of CAP may be worth the effort.

There is abundant evidence of variation in the practice of medicine, without apparent justification in relation to variation in the epidemiology of disease [1]. Marked, systematic differences in overall prescription of antibiotics have been demonstrated between different countries [2–4] and between hospitals in the same country [5]. Examination of the quality of prescribing of antibiotics reveals both unnecessary overtreatment [6, 7] and inappropriate undertreatment of patients who have severe sepsis [6]. Community-acquired pneumonia (CAP) can present to primary- and secondary-care physicians in a variety of guises and levels of severity (figure 1). Because many of these patients are initially treated by general (non–respiratory disease or non–infectious disease) physicians, specialist organizations in North America and Europe have produced a number of guidelines and care pathways for management [8–11].

These guidelines are essentially a consensus between physicians on each side of the Atlantic, but there is no evidence to suggest that one country’s health management preferences are superior to those of another country. Indeed, the European guidelines lack a base of evidence, and there are no data to indicate whether practices or outcomes have changed since their publication [10]. The British Thoracic Society is currently preparing new guidelines, and they have taken considerable steps to address these deficiencies.

In the United Kingdom, the 1993 guidelines of the British Thoracic Society [11] are widely adapted in local practice. The aim of practice guidelines is to reduce variation in key methods of care and, thus, to improve both the efficiency and the effectiveness of health care [12–14]. The new generation of guidelines (for example, those published by the Infectious Diseases Society of America in 1998 [9]) has increasingly made recommendations on the basis of evidence. The impact of practice guidelines on physicians is never as great as their authors intend [15]. Important reasons for the potential lack of adherence to published guidelines include an insufficient explanation of their methodology and a lack...
Figure 1. Pathway of care for community-acquired pneumonia, critical control points (1–5) for influencing care, influences on care, and key elements of care. Fonts indicate importance at each control point: bold face type, large numbers, major; light face type, small numbers, minor. The influences and elements of care will be subject to local variation. For example, in countries where antibiotics are available over the counter, patients may initiate antibiotic treatment without seeking medical advice (control point 1). Similarly, the influence of the primary care team on secondary care and vice versa is likely to differ substantially between countries. Most available evidence and practice guidelines address only control points 2 and 4.

of representation of the important stakeholders in the groups that develop the guidelines [16–18]. Nevertheless, failure to comply with guidelines is increasingly being cited as evidence of medical negligence [19].

The American Thoracic Society (ATS) guidelines [8] provide advice about management of CAP in the community, but most currently available guidelines are targeted at care that is provided in the hospital setting (figure 1). This is understandable, given that there has been relatively little research to determine the key processes of care for patients with CAP in the community [20]. Nonetheless, the majority of cases of CAP are managed exclusively in the community [21–23].

The available evidence shows that there is considerable variation in practice [20, 24] and that the process of care for CAP in the community could be improved [25–28]. This is an important area for future research, but we have confined our review to 5 key aspects of the guidelines for hospital management of CAP, addressing control points 2 and 4 in figure 1: (1) Do CAP guidelines change practices? (2) How could CAP guidelines lead to improvement in the outcome of care? (3) How could adherence to CAP guidelines reduce the cost of care? (4) What evidence is there that implementation of recommendations from the CAP guidelines improves the cost-effectiveness of care? (5) How can an individual hospital assess the cost-effectiveness of the implementation of guidelines for CAP?

DO CAP GUIDELINES CHANGE PRACTICES?

Guidelines are systematically developed statements that are developed to assist practitioners and patients in making decisions about health care for specific clinical circumstances [12, 29, 30], and they should be accessible to clinicians when clinicians are making clinical decisions, possibly via computerized information systems [31]. There is extensive literature about the implementation of guidelines: a recent systematic review has identified 76 studies that investigate 1 or more barriers to adherence to the guidelines [15]. The barriers to adherence can be grouped under the headings “knowledge,” “attitudes,” and “behavior” (table 1). The 76 publications that were reviewed included information on 120 separate studies, of which 70 (58%) examined only 1 potential barrier. Of the remaining surveys, 30 (25%) examined 2 barriers, 11 (9%) examined 3, 8 (7%) examined 4, and 1 (0.8%) examined 5; none examined ≥6 types of barriers. In contrast, a recent study comprehensively reviewed the patient-, system-, and physician-related factors that might explain why physicians did not follow a guideline that aimed to reduce the duration of hospitalization of low-risk patients with CAP [32]. This study provides information about all of the potential barriers to physicians’ adherence to guidelines (table 1).

The original study described an intervention that provided physicians with the Pneumonia Severity Index score and the corresponding mortality risk for eligible patients [33]. Patients with confirmed CAP were identified as suitable for outpatient management, provided that they were at low risk of dying of CAP (predicted mortality, <2.8%), did not have significant immunodeficiency or psychiatric disease, were not pregnant, and had
Table 1. Reasons for physicians' nonadherence to the recommendations of practice guidelines, as identified in a systematic review of the literature.

<table>
<thead>
<tr>
<th>Known reasons for nonadherence to guidelines [15]</th>
<th>Evidence from a study of adherence to guidelines that aimed to reduce admission of patients at low risk of dying of CAP [32]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge</td>
<td></td>
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<tr>
<td>Lack of awareness</td>
<td>ER physicians were involved in the guideline development, and a full-time study nurse working in the ER reinforced the use of guidelines.</td>
</tr>
<tr>
<td>Lack of familiarity</td>
<td>None of the physicians said they were “not at all familiar” with the guideline.</td>
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<tr>
<td>Attitudes</td>
<td>The most-frequent reasons given for nonadherence were that (1) other medical problems made patient sicker than protocol indicated (55%); (2) the primary care physician wanted the patient to be admitted (41%); and (3) the patient’s pneumonia was clinically worse than the PSI indicated (36%).</td>
</tr>
<tr>
<td>Nonagreement with Interpretation of evidence</td>
<td>This was not mentioned as a reason for nonadherence; indeed, there was strong evidence that the physicians agreed that outpatient management was likely to be more cost-effective for low-risk patients.</td>
</tr>
<tr>
<td>Applicability to own patients</td>
<td>Physicians did not fully trust the PSI as an index of pneumonia severity. In particular, the presence of multilobar disease was significantly associated with admission, against guideline recommendations, in a multivariate analysis. Adherence was lowest among the most experienced physicians and those who had managed the most cases of pneumonia in the previous 12 mo. (mean no. of cases, 59 [nonadherent physicians] versus 47 [adherent physicians]; P &lt; .001). The original study results did show that 9% of patients selected for outpatient management were subsequently admitted, whereas there were no admissions of patients selected for outpatient management in the year before the introduction of the guideline [33].</td>
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<tr>
<td>Cost-effectiveness</td>
<td>Physicians were provided with extra resources to help with outpatient management.</td>
</tr>
<tr>
<td>Lack of outcome expectation (compliance with guideline will not lead to the expected outcome)</td>
<td>Physicians were involved in guideline development and said they were motivated to implement the recommendations.</td>
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<tr>
<td>Lack of self-efficacy (cannot perform recommendations)</td>
<td>Three patient-related issues were given as reasons for admitting patients against guideline recommendations: (1) the patient or family wanted the admission (17%); (2) the patient did not have adequate home care support to be treated as an outpatient (16%); and (3) the patient was not reliable enough to be treated as an outpatient (6%). Patient characteristics that were not believed to influence admission were race, living arrangements, education level, and marital status.</td>
</tr>
<tr>
<td>Inertia or lack of motivation</td>
<td></td>
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<tr>
<td>Guidelines</td>
<td>The guidelines were readily available in the ER and were reinforced by the study nurse.</td>
</tr>
<tr>
<td>Not readily available</td>
<td>The guidelines were readily available in the ER and were reinforced by the study nurse.</td>
</tr>
<tr>
<td>Difficult format</td>
<td>The format was agreed to by the physicians.</td>
</tr>
<tr>
<td>Contradictory</td>
<td>There was no evidence of contradictory guidelines.</td>
</tr>
<tr>
<td>Environment</td>
<td>All of these factors were addressed in guideline implementation. In addition to the support of the study nurse, outpatients were offered additional community nursing support, and outpatient drugs were provided by the hospital. Time of day was mentioned as a reason for admission (against guideline recommendations) in only 2% of cases. Adherence to the guidelines was better at night and weekends, when the study nurse was not available to help.</td>
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<tr>
<td>Insufficient time, insufficient resources, organizational barriers, and reimbursement problems</td>
<td>Risk of malpractice litigation was not given as a reason for admission of any patient.</td>
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</table>

**NOTE.** The classification has been used to review the results of a comprehensive investigation of adherence to guidelines that specifically aimed to reduce hospital admission of low-risk patients with community-acquired pneumonia (CAP) [32]. Factors that were identified as being responsible for nonadherence with the CAP guidelines are shown in boldface text. ER, emergency room/department; mo., month; PSI, pneumonia severity index. Data are from [15].
a telephone and suitable home environment (nursing home patients were excluded). Patients were offered enhanced visiting-nurse services and a course of treatment with clarithromycin provided by the hospital.

Patients with CAP who presented to an emergency department during the intervention were compared both with retrospective control subjects who were identified during the prior year and with patients who participated in the Pneumonia Patient Outcomes Research Team cohort. The percentage initially treated as outpatients increased from 42% in the control period to 57% in the intervention period (relative increase, 36%; 95% CI, 8%-72%; \( P = .01 \) [32]).

The 2 principle reasons for nonadherence to guidelines were (1) the physicians did not fully trust the guidelines, and (2) patients or their relatives objected to being sent home (table 1). Although the physicians had been involved in development of guidelines, they still had residual concerns about sending some patients home. The study provided evidence to support these concerns, because, during the intervention period, more outpatients were subsequently admitted to the study hospital (9% in the intervention period vs. zero in the year before the introduction of the guidelines). It was also found that the most experienced physicians were the least likely to adhere to the guidelines (table 1). The authors interpreted this finding as evidence that "guidelines may be most influential when clinicians are less experienced and/or lack a dominant practice style" [32].

However, an equally plausible explanation is that the guidelines were not as sensitive as the judgement of experienced physicians with regard to identification of patients who benefit from hospital admission. Explicit comparison of the sensitivity and specificity of physician judgment with those of 4 rules for deciding whether chest radiographs should be ordered for the diagnosis of pneumonia revealed that physician judgment was more sensitive than were all 4 rules [34]. However, 2 of the rules were more specific and accurate than was physician judgment [34].

Patient satisfaction with overall care was similar, but patients treated in the outpatient setting during the intervention period were less frequently satisfied with the initial treatment location than were comparable control patients (71% vs. 90%, respectively; \( P = .04 \) [32]). A survey of recently hospitalized elderly patients found that only 103 (42%) of 246 would have felt safe being treated at home, whereas 93% felt safe in the hospital [35]. The subjects were aged \( \geq 65 \) years and had been hospitalized with congestive cardiac failure, acute exacerbations of chronic obstructive airway disease, or pneumonia 2 months prior to the survey. The marked difference in perception of safety in the home or in the hospital contrasted with the nearly equal proportions of subjects who agreed that the home and the hospital would be comfortable sites of care (54% vs. 55%, respectively) and would provide for rapid recovery (41% vs. 37%, respectively). Almost equal proportions thought that home treatment and hospital treatment would be burdensome on family and friends (40% vs. 33%, respectively). These findings suggest that successful expansion of acute home care will require education to change perceptions about the safety and efficacy of treatment at home.

When considering the application of guidelines for hospital admission in other geographic settings, it is interesting to note that only 84 (50%) of 163 patients in the Boston study had a primary care physician [32]. Low-risk patients were significantly more likely to be hospitalized if their primary care physician had requested admission (OR, 4.9; 95% CI, 2.2-11.0). This suggests that the guidelines may be more difficult to implement in countries where all people have primary care physicians, as is the case in the United Kingdom.

How do these results compare with those of other studies of adherence to guidelines? After implementation of the guidelines, the rate difference in admission of low-risk patients with CAP (this is a 15% difference in patients who were admitted before and after guideline implementation) compares favorably with the rate differences reported in a review of the effectiveness of prompting physicians to provide effective preventive care (from 6% for a Papanicolaou smear to 18% for influenza vaccination) [36]. Although there was still a considerable gap between actual clinical practice and the guideline ideal [32], this should not detract from the fact that this is one of a minority of studies that demonstrate a significant impact of guidelines on practice [37].

The success of this intervention is attributable to several factors: the guidelines had a very specific aim, with recommendations supported by evidence; the physicians who were the targets of the guidelines were involved in their development; and the study design provided constant reinforcement of the guideline recommendations. Nonetheless, this study shows that, even after one overcomes these important barriers to guideline implementation, there are still plenty of other challenges to face, the most important of which involves professionals and patients who haven’t been convinced that the guidelines recommend the best possible means of care (table 1). A recent survey of 627 general pediatricians showed that 94% believed that the formation of guidelines should be motivated by a desire to improve quality, and 73% believed that the formation of guidelines should not be motivated purely by a desire to reduce costs [38].

**HOW COULD CAP GUIDELINES LEAD TO IMPROVED OUTCOME OF CARE?**

Guidelines can influence outcome only if there is evidence that links process to...
outcome and evidence that there are potentially important variations in the process of routine care [13]. Several observational studies have assessed the association between process and outcome of care for patients who are hospitalized with CAP (tables 2 and 3). Where there is an association between variations in process and variations in outcome (table 2), the implication is that improvements in the process of care will improve the patient’s outcome. However, strength of association is just 1 of 5 criteria used to assess whether a valid statistical association can be judged as cause and effect [39]. The other 4 questions that need to be addressed are as follows: (1) Is there biological credibility to the hypothesis? (2) Is there consistency with other studies? (3) Is the time sequence compatible with any proposed biological mechanism? (4) Is there evidence of a dose-response relationship?

“Biological credibility” means that the hypothesis is consistent with current understanding of the pathogenesis of disease and of its modification by treatment. “Consistency with other studies” means that the most persuasive evidence to support a judgment of a cause-effect relationship arises when “a number of studies, conducted by different investigators at various times using alternative methodology in a variety of geographic or cultural settings and among different populations, all show similar results” [39].

“Time sequence” refers to the evidence that exposure to an intervention precedes the outcome by a period of time consistent with that of any proposed biological mechanism. “Dose response” indicates that most biological response modifiers have a sigmoid dose-response curve, with both a minimum and a maximum effective concentration [40, 41]. Why is it important to establish cause and effect between the process and outcome of care? One of the aims of conducting this type of research is to identify indicators of the quality of care that can be used to design or modify quality-improvement programs [42]. This program used 2 indicators of the quality of care for patients with CAP: timely delivery of

Table 2. Variations in processes of care that are associated with variations in outcome for patients who are hospitalized with community-acquired pneumonia (CAP).

<table>
<thead>
<tr>
<th>Reference</th>
<th>Process of care</th>
<th>Outcome of care</th>
<th>Result</th>
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<tbody>
<tr>
<td>[102]</td>
<td>Identification of patients with severe pneumonia on admission</td>
<td>Mortality; admission to ICU</td>
<td>Cases were classified as severe if any 2 of the following were noted on admission: respiratory rate of &gt;30/min, diastolic BP of &lt;60 mm Hg, urea of &gt;7 mmol/L, or confusion. The severity rule correctly identified 25 (89%) of 28 patients who died or were admitted to ICU. In contrast, the clinical team identified only 15 (54%) of these patients as having severe pneumonia, rating 7 (37%) of 19 patients who died as having moderate or mild illness.</td>
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<td>[46]</td>
<td>Time from hospital arrival to initial antibiotic administration; blood culture done before initial hospital antibiotic therapy; blood culture done within 24 h of hospital arrival; oxygenation assessed within 24 h of hospital arrival</td>
<td>Mortality among 14,069 patients &gt;65 years old</td>
<td>Lower 30-day mortality rate was associated with antibiotic administration within 8 h of hospital arrival (OR, 0.85; 95% CI, 0.75–0.96) and performance of blood culture within 24 h of arrival (OR, 0.90; 95% CI, 0.81–1.00). State and territory performance estimates varied from 49.0% to 89.7% for antibiotics given within 8 h and from 45.6% to 82.6% for blood cultures done within 24 h of arrival.</td>
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<td>[47]</td>
<td>Choice of empirical antibiotic treatment; inclusion of a macrolide antibiotic in the empirical regimen</td>
<td>Mortality and duration of hospitalization for 12,945 patients &gt;65 years old</td>
<td>Initial treatment with a second-generation cephalosporin plus macrolide (HR, 0.71; 95% CI, 0.52–0.96), a nonpseudomonal third-generation cephalosporin plus macrolide (HR, 0.74; 95% CI, 0.60–0.92), or a fluoroquinolone alone (HR, 0.64; 95% CI, 0.43–0.94) was independently associated with lower 30-day mortality rate. Use of a β-lactamase inhibitor plus macrolide (HR, 1.77; 95% CI, 1.28–2.46) and an aminoglycoside plus another agent (HR, 1.21; 95% CI, 1.02–1.43) was associated with increased 30-day mortality rate. Empirical macrolide treatment was not associated with reduced length of hospital stay.</td>
</tr>
<tr>
<td>[48]</td>
<td>Choice of empirical antibiotic treatment; administration of a macrolide antibiotic within the first 24 h of admission</td>
<td>Mortality and duration of hospitalization for 76 patients with CAP</td>
<td>Patients who received macrolides within the first 24 h of admission had a markedly shorter DOS (2.8 d) than did those who were not so treated (5.3 d; P = .01). This effect diminished as the interval before administration of macrolides increased. Including ceftriaxone as part of the initial regimen did not appear to affect DOS. The results of treatment for patients given a macrolide for initial treatment did not differ significantly from those not treated, with regard to mean age and mortality.</td>
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**NOTE.** BP, blood pressure; DOS, duration of stay; HR, hazard ratio; ICU, intensive care unit.
antibiotics and collection of sputum or blood samples before antibiotic therapy. Timely delivery of antibiotics does meet the 4 additional criteria that support recognition of a cause and effect relationship. It is biologically plausible that antibiotic treatment modifies the course of infection, and there is experimental evidence to support the hypothesis that early treatment is more effective than delayed treatment [43, 44]. A consistent association between early, appropriate antibiotic treatment and outcome has been demonstrated in a number of studies of patients with CAP [45–48] and bacteremia [49–52].

There is a dose-response relationship in 2 senses. First, the patient tends to respond to treatment if the dose of the antibiotic that is administered is adequate [53, 54]. Second, there is evidence to show that delayed appropriate treatment of bacterial infection is less effective than immediate appropriate treatment but is more effective than continued inappropriate treatment [55]. However, it is less likely that microbiological investigation influences outcome directly. There is no biological mechanism to support the hypothesis that performance of a blood culture directly influences outcome. Early microbiological investigation of CAP is not consistently associated with outcome [56]. The results of blood cultures have been shown to influence the choice of antimicrobial agents and, therefore, to increase the number of patients who receive appropriate antibacterial treatment [49, 57–61]. Therefore, we believe that the performance of blood cultures is part of good clinical practice. However, we believe that it is not a true indicator of the quality of management of CAP, because there is no evidence that this process directly influences outcome. When proposing indicators of the quality of health care, we believe that it is important to distinguish between those that directly influence outcome and those that do not.

The major value of microbiological investigations is in the definition of the epidemiology of causative organisms and antibiotic resistance. This information is essential for the determination of appropriate antibiotic treatment, and it should remain part of the pathway of care. Drawing blood for cultures and recording the results in the case notes [57] are likely to be associated with patient outcome, because they are markers of the overall standard of care and attention to detail. However, if one makes performance of blood cultures a quality indicator, one runs the risk of paying undue attention to this single component of the management of CAP, without the assurance that this will necessarily lead to improvement in patient outcome. In contrast, hospitals that observe a steady improvement in the time that it takes to initiate appropriate antibiotic treatment of CAP should be reasonably confident that this will be associated with an improvement in outcome.

Existing guidelines are not completely

Table 3. Variations in the processes of care that have not been associated with variations in outcome for patients who were hospitalized with community-acquired pneumonia (CAP).

<table>
<thead>
<tr>
<th>Reference(s)</th>
<th>Organization of process of care</th>
<th>Outcome of care</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>[71] DOS in 4 hospitals</td>
<td>Mortality; mean DOS, readmissions; return to usual activity</td>
<td>Adjusted interhospital differences in DOS ranged from 0.9 to 2.3 d (P &lt; .001). There were no differences in mortality rates (RR = 0.7; 95% CI, 0.3–1.7); hospital readmission rates (RR = 0.8; 95% CI, 0.5–1.2), or return to usual activities (RR = 1.1; 95% CI, 0.9–1.3) during the first 14 d after discharge.</td>
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<tr>
<td>[70, 103] Setting of care: rural versus urban hospitals; teaching versus nonteaching hospitals</td>
<td>Mortality</td>
<td>Rural patients were more likely to be treated by a family physician and were somewhat less likely to be admitted to an ICU or to be mechanically ventilated. In-hospital mortality rates, with controls for admission severity, were comparable or better for rural patients than for urban patients. After adjustment for patient characteristics, 30-d mortality and readmission rates were unrelated to hospital teaching status, urban location, or physician specialty. Use of procedures and physician consultations was more common in teaching hospitals, and costs were 11% higher for patients who were discharged from teaching hospitals, compared with nonteaching hospitals. Of similar interest, costs were 15% higher at urban hospitals than at rural hospitals.</td>
<td></td>
</tr>
<tr>
<td>[73] DOS after clinical stabilization (of heart rate, respiratory rate, oxygenation, systolic BP, temperature, and ability to eat)</td>
<td>Admission to ICU</td>
<td>The median time to overall clinical stability was 3 d for the most lenient definition of stability and 7 d for the most conservative definition. Once stability was achieved, clinical deterioration requiring intensive care, coronary care, or telemetry monitoring occurred in &lt;1% of cases. A range of 65%–86% of patients stayed in the hospital &gt;1 d after reaching stability, and &gt;29%–46% were converted to oral antibiotics within 1 d of stability, depending on the definition of stability.</td>
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NOTE. BP, blood pressure; DOS, duration of stay; ICU, intensive care unit.
consistent with respect to their recommendations about appropriate empirical antibiotic treatment. All guidelines recommend monotherapy for patients with milder cases of CAP, and all recommend combination therapy with a β-lactam antibiotic plus a macrolide for patients with more-severe cases [8, 9]. However, there are important differences in the details of the recommendations. For example, the recommended monotherapy for patients with mild cases is a β-lactam in some guidelines [10] but a macrolide in others [8]. Second, not all guidelines provide specific criteria for classification of severity [10], and when they do, the criteria are not the same [8, 11].

Recent epidemiological studies that use sensitive diagnostic techniques have shown that atypical bacteria more frequently cause of CAP than was previously thought and that mixed infection by Streptococcus pneumoniae and atypical organisms is not unusual [25, 62–64]. These results provide biological plausibility to data from observational studies that show an association between therapy with drugs that are active against atypical bacteria and reduced mortality or length of hospital stay for patients who are hospitalized with CAP [47, 48]. Furthermore, there is some evidence of a dose response, because one study showed that macrolide treatment was associated with improved outcome only if it was started within 24 h of hospitalization [48]. These data suggest that, for hospitalized patients with CAP, early treatment with antibiotics that are active against atypical bacteria improves patient outcome, and that it should be a quality indicator.

**HOW COULD CAP GUIDELINES LEAD TO REDUCTIONS IN THE COST OF CARE?**

Reduction in health care costs is often a major factor that drives the development of critical pathways or guidelines [65–67]. Studies that show marked variations in the process of care that are unrelated to variations in outcome (table 3) can be used to identify potential targets for cost-containment. Large-scale epidemiological studies have shown that the cost of antimicrobial therapy that is administered to outpatients [68] or inpatients [68, 69] varies markedly according to geographic location. With regard to inpatients, there is also marked variation in the use of procedures or physician consultations [70] and in the duration of hospitalization [71], which are apparently not associated with variation in outcome (table 3). This suggests that there are means for reducing the cost of care for patients with CAP that do not adversely influence the patient’s outcome.

Duration of hospital stay after clinical stabilization is one target for cost minimization. In a prospective study of 332 patients with CAP, physicians believed that 71 patients (22%) were discharged from the hospital >1 day (median, 2.5 days) after reaching clinical stability. The factors that most frequently led to delayed discharge were diagnostic evaluation or treatment of comorbidity (56%), completion of a standard course of antimicrobial therapy (15%), and delays and difficulties in arrangement of long-term care (14%). Frequently cited medical services that probably or definitely would have allowed for earlier patient discharge included availability of home iv antimicrobial infusion (26%) and availability of home visits by nurses (20%) [72]. In a second study, 65%–86% of 686 patients with CAP stayed in the hospital for >1 day after they reached stability, depending on the definition of stability [73]. Only 6 patients (0.9%) required admission to a special care unit after they had initially achieved clinical stability according to the most lenient definition of stability, and 2 patients (0.3%) required such admission after achieving stability according to its most conservative definition.

A second potential means for minimizing the cost of treatment of hospitalized patients involves switching from iv to oral administration of antibiotics. In a prospective study by Halm et al. [73], <29%–46% of patients were switched to therapy with oral antibiotics within 1 day of achieving stability. In the United States, duration of iv therapy is much longer than that in the United Kingdom. For example, in a clinical trial in the United States that aimed to establish the optimum duration of iv treatment for patients with CAP, investigators randomized 73 patients to receive either 2 days of iv therapy plus 8 days of oral therapy or 5 days of iv therapy plus 5 or 10 days of oral therapy [74]. The 3 regimens were equivalent. The authors concluded that 2 days was the optimum duration of iv treatment for patients with CAP.

However, a much larger trial that involved 541 patients who were admitted, during a 1-year period, to a Dublin hospital because of lower respiratory tract infection found no difference between the outcomes of treatment with oral amoxicillin clavulanate, iv amoxicillin clavulanate, or iv cephalexin followed by oral treatment. The patients enrolled in the trial represented 87% of all patients admitted for lower respiratory tract infection, and the only patients excluded from the trial were those patients who were immunocompromised or who had severe, life-threatening infections [75]. Once patients have been switched to oral therapy, it has become traditional to observe them for at least 24 h in the hospital before discharge, even though studies have failed to show a clear clinical benefit from this period of observation [76–78].

The available evidence suggests that the cost of hospital care for patients with CAP can be reduced by avoiding admission of low-risk cases, minimizing the duration of iv antibiotic administration, and discharging the patient as soon as possible after stabilization of the clinical condition. However, there are residual concerns that each of these interventions may impair the outcome of care. Therefore, cost-effectiveness analysis [79] of
Compliance with the ATS guidelines (i.e., use of erythromycin for treatment) for outpatients who were <60 years of age and who had no comorbid risk factors was associated with a 3-fold decrease in drug costs and had no impact on clinical outcome. However, for the group of patients who were >60 years old and who had comorbid risk factors, compliance with the ATS guidelines (i.e., use of a second-generation cephalosporin, cotrimoxazole, or a β-lactam/β-lactamase inhibitor with or without a macrolide) was associated with a 10-fold increase in cost (when compared with the cost of non-protocol drugs) and with no significant impact on any medical outcome.

These results are not surprising, given that the only evidence that links choice of antimicrobial agent to outcome is observational (table 2), and that it is likely to be influenced by selection bias or confounding by comorbidities [84]. The Canadian Coordinating Office for Health Technology Assessment was unable to find any evidence from randomized trials with regard to the cost-effectiveness of treatment with quinolones in patients with CAP [85]. Further randomized, controlled studies may be warranted to confirm the findings of observational studies before they should be adopted into clinical practice [84]. At present, recommendations about the choice of antibacterial agent for treatment of patients with CAP are based on knowledge of microbial epidemiology, rather than on evidence from randomized controlled trials of the relative effectiveness of different regimens [84].

Five studies have shown significant changes in the processes of care after implementation of guideline recommendations for treatment of patients with CAP (table 4). The most robust of these studies was a randomized trial that was conducted in 19 hospitals and that included 1743 patients [86]. This study design provides good internal validity (i.e., it is likely that the differences in the process of care between the 9 intervention hospitals and the 10 control hospitals were due to the implementation of the critical pathway). Moreover, the large number of hospitals that were involved provides good external validity (i.e., implementation of the pathway in other hospitals is also likely to change the process of care).

Although this trial undoubtedly provides quality evidence, the trial’s motivation was a desire to find means of cost-containment, because the primary hypothesis was that the critical pathway would reduce the use of institutional resources without compromising the safety and efficacy of therapy [86]. This was also the motivation behind a study in one hospital in Boston [33], and the concentration on means of cost containment may have been one reason why the results of the implementation of guidelines were not as impressive as the authors had hoped (table 1).

Two studies have demonstrated an improvement in outcome after implementation of guidelines: improvement of patient response to antibacterial treatment in one [87] and lower mortality rates in the other [88]. Both studies used an uncontrolled, before-and-after design, but in one of the studies, the changes in the mortality rate in the intervention hospital were compared with data from 23 other hospitals [88]. In both of these studies, the improvement in outcome was accompanied by a reduction in the cost of care (table 4). A third study [42] used an uncontrolled, before-and-after design to show that a quality improvement program reduced time to initiation of antibacterial treatment of patients with CAP, which is likely to improve patient outcome. However, there was no direct measurement of outcome.

In summary, the best-quality evidence about the effects of guideline implementation shows that they can be used to reduce unnecessary use of resources without compromising the quality of care or patient outcomes [33, 86]. There have been no randomized trials or controlled,
Table 4. Studies evaluating the implementation of critical pathways or quality-improvement programs for the treatment of patients hospitalized with community-acquired pneumonia (CAP).

<table>
<thead>
<tr>
<th>Reference</th>
<th>Design</th>
<th>Elements</th>
<th>Results</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>[88]</td>
<td>Uncontrolled, before-and-after study in 1 hospital; 870 patients; comparison of mortality rate with that in 22 hospitals</td>
<td>Time to initiation of antibacterial treatment; choice of antibacterial treatment; blood culture performed on admission; sputum culture performed on admission</td>
<td>Increase in the percentage of patients who received prompt antibiotic treatment, from 42% to 87%; blood culture, from 36% to 96%; sputum culture increased from 53% to 86%. Mortality decreased from 10.2% to 6.8% (RR = 0.66; 95% CI, 0.43–1.04); total charges decreased from $10,574 to $9629.</td>
<td>Control data available for mortality rate only; marked improvement in mortality rate compared with that at other hospitals; reduction in charges for pneumonia occurred despite a 6% increase in charges for the hospital as a whole</td>
</tr>
<tr>
<td>[42]</td>
<td>Uncontrolled, before-and-after study in 7 hospitals; 353 patients</td>
<td>Time to initiation of antibacterial treatment; percentage of patients with blood cultures and sputum cultures done before start of antibiotic therapy</td>
<td>Percentage of increase, from 32% to 52% of patients receiving antibiotics within 4 h of admission; no significant change in percentage with cultures done before antibiotic therapy</td>
<td>Uncontrolled study with low internal validity; no measurement of impact of program on costs or outcomes of care</td>
</tr>
<tr>
<td>[87]</td>
<td>Uncontrolled, before-and-after study in 1 hospital; 227 patients</td>
<td>Clinical and laboratory assessment of diagnosis and severity; choice of antibacterial treatment; switch from iv to oral therapy</td>
<td>Mean duration of stay was reduced from 9.2 d to 4.5 d; percentage of patients with initial iv drug administration was reduced from 62% to 35%; mean duration of iv therapy was reduced from 5.7 to 2.1 d; percentage of patients with treatment failures was reduced from 31% to 8%; mean cost of care was reduced from £2024 to £1020; mean antibiotic cost was reduced from £54 to £11</td>
<td>Uncontrolled study with low internal validity; single hospital, therefore low external validity</td>
</tr>
<tr>
<td>[33]</td>
<td>Before-and-after study with historical control cohort in 1 hospital; 521 patients</td>
<td>Identification of low-risk patients by use of a modified Pneumonia Severity Index; supporting outpatient management with enhanced visiting-nurse services, an antibiotic, and access to a primary care physician</td>
<td>Percentage of patients treated as outpatients increased from 42% to 57% (15% absolute difference; 95% CI, 8%–72%); percentage of patients admitted after initial outpatient treatment increased from 0% to 9%; outpatients were less frequently satisfied with their site of care in the intervention versus the control cohort (71% vs. 90%; P = .04)</td>
<td>Quasi-experimental design with moderate internal validity; single hospital, therefore low external validity; net relative increase in patients successfully treated as outpatients not significant: 25% (95% CI, 2%–69%; P = .07)</td>
</tr>
<tr>
<td>[86]</td>
<td>Randomized controlled trial in 19 hospitals; 1743 patients</td>
<td>Defined criteria for admission to hospital, switching from iv to oral treatment, and discharge from hospital</td>
<td>Reduction by 1.7 bed-days per case managed (P = .04), with no difference in outcome; despite having more severe disease, patients in the intervention hospitals were switched to oral therapy earlier than those in the control hospitals</td>
<td>RCT with good internal validity; 19 hospitals, good external validity; trial not designed to evaluate the effectiveness of each component of the critical pathway</td>
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</table>

NOTE. RCT, randomized controlled trial.
quasi-experimental studies of guidelines that are targeted at processes that may improve the outcome of care (table 2). Experience with bacteremia shows that interventions consistently identify patients who are being undertreated as well as patients who are being overtreated [50, 52, 60, 89–92]. Guidelines that are designed to improve the outcome of care are more likely to win the hearts and minds of patients and professionals than would guidelines that are motivated solely by cost-containment.

HOW CAN AN INDIVIDUAL HOSPITAL ASSESS THE COST-EFFECTIVENESS OF IMPLEMENTING CAP GUIDELINES?

To date, there has been no formal cost-effectiveness analysis of the implementation of guidelines for treatment of patients with CAP. The successful interventions (reviewed in table 4) have required the use of a considerable amount of resources, which include the employment of additional nursing staff, to encourage guideline implementation and to support outpatient management [33, 86]; dialogue with the medical staff [88]; and chart review, to measure the impact of implementation [42, 88].

Producing valid evidence about the cost-effectiveness of guideline implementation presents major methodological problems, as is illustrated by a study that attempted to measure the impact of audit of thrombolysis after myocardial infarction in 4 hospitals, in comparison with a control hospital that did not implement an audit program [93]. Between the first and last audits, in 3 of the hospitals that performed audits, the proportion of cases of suspected acute myocardial infarctions that involved thrombolysis increased by 20%–57%, and decreased by 6% in the fourth hospital (however, in this latter hospital, the proportion at the start was >90%). In the control hospital, the corresponding change was an increase of 15%.

The differences between each of the auditing hospitals and the control hospital were not significant, except in 1 instance, in which 51 extra treatments per year were attributable to the audit (95% CI, 0.5–61 cases per year). The estimated overall costs at each hospital ranged from £3700 (~$5200) to £5200 (~$7300) for data collection, a series of 4 audit meetings, and subsequent actions. The central estimate of cost-effectiveness in the 3 hospitals that showed an increase in the proportion of cases of suspected acute myocardial infection ranged from £101 (~$141) to £392 (~$550) per extra case that involved thrombolysis, with very wide 95% CIs. In the fourth hospital, the audit had no effectiveness, as defined in this study. The authors concluded that there were 3 key methodological difficulties that need to be considered in future economic evaluations of clinical audit and related activities: (1) adequate control for other factors that influence clinical behavior; (2) uncertainties about the sustainability of changes in behavior associated with an audit; and (3) the relative infrequency (in a single hospital) of specific clinical events, which might lead to small numbers of patients for analysis.

Any hospital that is contemplating implementation of a guideline should remember the audit cycle [94]. If evidence exists about critical processes of care (tables 2 and 3), then the next logical step in the cycle is to try to measure these processes in the hospital. It makes no sense to embark on an expensive quality-improvement program unless there is some evidence that existing practices fall below the standards of the proposed guideline. For example, in 6 hospitals, an intervention trial that was designed to reduce the duration of hospitalization for patients with CAP failed to yield any significant reduction [95]. However, before implementation of the guideline, 77% of patients had a duration of stay that was within the guideline recommendation; often, the duration was shorter. Therefore, there was little need for improvement.

It is relatively easy to assess the cost-effectiveness of implementing processes that improve the outcome of care. Dividing the approximate cost of the quality-improvement program by any measured change in practice provides, for example, the cost per additional patient receiving appropriate antibiotics for treatment of CAP within 4 h of admission. There is no evidence that this could be harmful to patients, so the only question is, does the magnitude of change justify the effort put toward achieving it? In the competitive environment in the United States, there are potential benefits to a hospital for demonstrating quality improvement through benchmarking programs [88]. Conversely, hospitals on both sides of the Atlantic are under increasing threat of litigation [38, 96–98]. Demonstration of effective quality-improvement programs is one way to defend against litigation.

In contrast, hospitals should be more critical about guideline recommendations that are designed purely to reduce the costs of care. There is now good evidence that patients at low risk of death can be identified and managed safely at home [86]. Nonetheless, prevention of death is only 1 reason for admitting a patient with CAP to the hospital. Convincing professionals, patients, and their caregivers that management of CAP at home is an appropriate standard of care is likely to be much more challenging in Europe, where the financial pressure to reduce the duration and amount of hospitalization is less intense. As with the development of home IV antibiotic programs, it would be naive to assume that successful initiatives from North America can be automatically transported to a European setting [99]. Hospitals that do implement such programs will be asked to provide evidence that the programs do not adversely affect patient outcome. The
most rigorous way to do this would be for hospitals to join forces to conduct a clinical trial, but this would be expensive. European hospitals may prefer to focus initially on processes, such as an early switch from iv to oral antibiotics and discharge that occurs 24 h after clinical stabilization, because there is less likely to be concern that these processes adversely affect outcome.

The evidence that we have reviewed provides several indicators that can be used to improve the outcome or cost of care for patients with CAP and that can form the basis for a critical pathway of care (table 5).

### INCLUSION OF COST-EFFECTIVENESS INFORMATION IN GUIDELINES

Existing CAP guidelines lack any helpful information on cost-effectiveness [8, 9, 11]. This situation is not unique to CAP guidelines. As part of the local implementation process, the Scottish Intercollegiate Guidelines Network has specifically excluded detailed information related to cost-effectiveness; it has instead concentrated on highlighting, for further discussion, those recommendations that have significant cost or resource implications [12]. In contrast, the North of England Group has developed explicit methods for estimating the cost-effectiveness of the implementation of guideline recommendations [100]. An early attempt at progressing to a more “real-life” health economic argument on the basis of available clinical trial data is currently being made by the Scottish Intercollegiate Guidelines Network development group on antibiotic surgical prophylaxis. This document provides decision rules that a decision-maker can use to estimate the likely cost-effectiveness of embarking upon a particular preventative strategy. The key method is to provide local clinical-effectiveness committees with available information on ORs from pertinent clinical trials so that the numbers that are needed to treat (NNT) to prevent 1 wound infection can be calculated [101] and, hence, can provide an estimate of the cost that was avoided per wound infection. Future CAP guidelines should address the cost-effectiveness of options for care.

### CONCLUSIONS

The data that we have reviewed show that locally developed guidelines and pathways of care have helped hospitals both to improve the quality and to reduce the cost of care for patients with CAP. These improvements have been achieved by focusing on control points 2 and 4 in the pathway of care (figure 1). Prompt initiation of appropriate antibiotic treatment, with an early switch from iv to oral therapy, has been a common element in all of the studies of guideline implementation (table 4). The key to the success of these studies has been the development of local guidelines by the hospitals in which they are to be implemented. Some success has also been achieved in reducing the number of hospital admissions of patients who are at low risk of dying of CAP. Further progress in the limiting of hospitalizations for less severe cases will require development of consensus between professionals in primary and sec-

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**Table 5. Suggested quality indicators for hospitalized patients with community-acquired pneumonia (CAP).**

<table>
<thead>
<tr>
<th>Variable Factor</th>
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<tr>
<td>Likely to improve outcome of CAP</td>
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<tr>
<td>Percentage of patients for whom a PA chest radiograph was obtained within 24 h of admission</td>
</tr>
<tr>
<td>Percentage of patients with proven indicators of severity of CAP documented in case records</td>
</tr>
<tr>
<td>Median interval between admission to hospital and initiation of appropriate antibiotic therapy</td>
</tr>
<tr>
<td>Percentage of patients who received treatment with an antibiotic regimen that is active against all of the likely causative pathogens</td>
</tr>
<tr>
<td>Percentage of patients with severe pneumonia who received iv antibiotics</td>
</tr>
<tr>
<td>Percentage of patients with severe pneumonia who received adequate oxygenation and respiratory support</td>
</tr>
<tr>
<td>Percentage of patients with severe pneumonia who received adequate fluid replacement</td>
</tr>
<tr>
<td>Median interval between diagnosis of respiratory failure and transfer to ICU</td>
</tr>
</tbody>
</table>

| Likely to reduce costs of management of CAP                                      |
| Percentage of low-risk patients who are admitted to hospital                    |
| Percentage of patients who received unnecessarily intensive or expensive antibiotic treatment |
| Percentage of patients who were not switched from iv to oral therapy, according to existing criteria and clinical stability |
| Percentage of patients who were discharged within 24 h of switching to oral therapy |
| Duration of hospital stay                                                        |
| Percentage of patients requiring ICU admission                                  |
| 30-d mortality rate                                                             |
| Readmission with an associated illness within 30 d of hospital discharge        |
| Cost of care                                                                     |

**NOTE.** One would need to identify the presence of comorbidity and severity indicators in all patients. PA, posteroanterior.
ondary care. Furthermore, success will be dependent on the ability to convince patients and their caregivers of the appropriateness of care in the community (figure 1 and table 1).

With the establishment of evidence-based criteria for management of patients who are hospitalized with CAP, the focus of guidelines needs to shift toward management of CAP in the community. Research is also required on the factors that influence how patients with CAP present to primary or secondary care. It is plausible that a reduction in the interval between onset of symptoms and initiation of appropriate antibiotic treatment in the community will improve outcome. However, achieving this aim will require education of people who are at risk for infection with CAP (figure 1, control point 1).

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