Extending the Nurse Practitioner Concurrent Intervention Model to Community-Acquired Pneumonia and Chronic Obstructive Pulmonary Disease

Pneumonia and influenza are responsible for substantial morbidity and mortality among the Medicare population. In the United States, more than 90% of deaths from pneumonia and influenza occur in this group.1 Pneumonia alone accounts for nearly 600,000 hospitalizations, 4.5 million hospital days, and more than 500,000 emergency room visits per year.

Implementation of community-acquired pneumonia (CAP) guidelines can improve the quality of care and reduce mortality, length of stay, and cost for patients with CAP:2–5 At least four sets of CAP guidelines have been written by professional societies and government organizations.4–7 Several recommendations have been derived from these guidelines and converted into performance measures by the Centers for Medicare & Medicaid Services (CMS).8 The CMS measures were chosen on the basis of five criteria, including a substantial gap between observed and expected performance and improvement in processes of care resulting in improved outcomes.9 By creating these measures on the basis of the best medical evidence in the literature, CMS avoided requiring compliance with guideline recommendations derived from low levels of evidence.

Nathwani and colleagues reviewed the impact of compliance with the CMS measures on the care of patients with CAP,10 including the barriers to guideline

Article-at-a-Glance

Background: A Nurse Practitioner (NP) Concurrent Intervention Model shown effective for controlling telemetry usage was extended to patients with community-acquired pneumonia (CAP) and patients with chronic obstructive pulmonary disease (COPD).

Methods: In spring 2000, investigators at Hackensack University Medical Center and the University of Medicine and Dentistry of New Jersey–New Jersey Medical School began an intervention to increase compliance with the Centers for Medicare & Medicaid Services (CMS) performance measures for CAP. Cost-reduction efforts were introduced by using previously described criteria for switching from intravenous to oral medication and for hospital discharge.

Results: Use of the NP intervention model for patients admitted with CAP and for COPD patients resulted in significant reductions in length of stay and cost savings.

Discussion: Concurrent intervention by a nurse practitioner can help achieve excellent compliance with performance measures for CAP and be applied to other chronic respiratory diseases such as COPD.
implementation and the processes that can alter outcomes and improve cost-effectiveness. The guidelines improved outcomes when the rule to administer antibiotics within eight hours of hospital arrival was followed.\textsuperscript{11} Better quality of care is provided when blood cultures were drawn before antibiotics are given because it makes isolation of blood pathogens more likely. Persons who received a second-generation or a third-generation cephalosporin (nonpseudomonal) plus a macrolide or, alternatively, a fluoroquinolone alone had better outcomes than persons who received other antimicrobial combinations.\textsuperscript{12}

The objectives of the study described in this article were to evaluate the following:

- Quality improvement (QI) cycles performed by a nurse practitioner (NP, also called an advanced practice nurse) can improve compliance with CAP performance measures (indicators).
- An NP's interventions to implement an early-switch (from intravenous [IV] to oral antibiotics) and early-discharge protocol can decrease cost of care in CAP.
- A system developed for QI in CAP can be applied to patients with chronic obstructive pulmonary disease (COPD).

**Methods**

**Study Site**

Hackensack University Medical Center (HUMC) is a 641-bed regional medical center located in Hackensack, New Jersey. The Medical Center is affiliated with the University of Medicine and Dentistry of New Jersey (UMDNJ)–New Jersey Medical School. A performance improvement program with pulmonary and other organ-system service lines has been in place since 1999. HUMC participates in the New Jersey Quality Improvement Organization (QIO) to monitor compliance with nationally recommended performance measures.

**NP Concurrent Intervention Model**

The NP Concurrent Intervention Model was developed in 1999, when it was used to improve control of telemetry use.\textsuperscript{13} An NP trained in cardiology would call the physician when telemetry was no longer indicated on the basis of physician-established criteria. A cardiac physician backed up the NP. The reduction in inappropriate telemetry use in a short period was dramatic.

Interventions to Improve Compliance with CAP Indicators

In spring 2000, a group of investigators at HUMC began an intervention in an attempt to increase compliance with the CMS Quality Improvement Project performance measures for CAP. Patients with CAP were captured for analysis using all-payer-refined (APR) diagnosis-related group [DRG] 139. The two periods of study were October 1, 1999 through March 31, 2000 (before the intervention) and October 1, 2000 through March 31, 2001 (after the intervention). The intervention began after April 1, 2000.

Medical staff education by standard methods, such as grand rounds and guideline dissemination, had not improved compliance with CAP indicators.\textsuperscript{14} Discussions of the performance measurement at pulmonary and infectious disease division meetings, then at a department of internal medicine meeting, led to the institution of the NP model. Preprinted order sets and physician profiling were not used.

Because of the previous success in limiting inappropriate use of telemetry by NP intervention, we asked physicians if they would accept having a pulmonary-trained NP call them to facilitate compliance with the CAP measures.\textsuperscript{15} They agreed. We selected an NP with extensive experience in pulmonary diseases [L.A.] to intervene in patients with CAP and later added another NP [Nancy Van Buitenen]. These two pulmonary-trained NPs ran and participated in the CAP project.

The NP assessed each patient with CAP five days a week. She discussed the case with the patient's nurse. When the patient's care was not consistent with the performance measures, the NP placed a reminder sticker in the physician's progress notes section of the medical record. In the absence of an appropriate response (that is, a change in care), the NP placed a direct call to the patient's physician to suggest the change necessary for compliance.

When questions arose that the NP could not answer, she was backed up by either a pulmonary-trained [H.A.] or an infectious disease–trained physician [J.L., P.A.G.], although backup was infrequently required. The final decision was always the prerogative of the patient's physician. The practicing physicians eventually came to rely on the call from the NP.
An extensive educational program conducted by the NPs and their backup physicians was provided to the medical staff and the nursing staff on a repeated basis. Every quarter, the performance measurement data were quickly fed back to the medical and nursing staff quarterly. The CMS CAP measures are listed in Table 1 (above).

Interventions to Decrease CAP Cost of Care

Our evaluation of the business case for CAP intervention involved assessing the financial picture under conditions of full occupancy or conditions where full occupancy was not the issue. The intervention was assessed for its impact on reducing the cost per case, which would apply under either capacity condition. If length of stay (LOS) was reduced, then capacity would be increased and potentially more patients could be admitted, which would generate additional revenue. Additional revenue would occur if the revenue from the discharged patient was paid on a per case basis (for example, Medicare reimbursement), but no additional revenue would result if the revenue from the discharged patient was paid on a per diem basis (for example, most managed care patients). In reality, either situation occurs in a large group of patients, so the payer mix had to be taken into consideration in the final analysis.

The only expense incurred with the NP intervention model was the cost of the NP position itself; salary and fringe benefits were deducted from the calculated revenue to determine the net revenue.

Early-Switch and Early-Discharge Criteria

The CAP criteria for changing patients from IV to oral antibiotics at an earlier-than-usual time interval are termed early switch therapy. After the early switch is accomplished, criteria are available for discharging the patient earlier than in the usual case. The early-switch and early-discharge criteria, as described by Ramirez et al., are listed in Table 2 (page 380). These criteria were presented to the pulmonary and infectious disease physicians and then to the department of medicine at large to obtain local buy-in. The physicians accepted all criteria except "temperature is ≤ 100°F for eight hours." They preferred that 24 hours be the determining period because some patients who are afebrile for eight hours may not be afebrile for an entire 24-hour period. For example, measuring temperature early in the day often shows a febrile patient to be afebrile, whereas taking the temperature late in the day shows that the fever has recurred. The 24-hour change was accepted, and the criteria were implemented.

When a patient met the criteria for early switch and the patient was not switched, the NP called the physician to determine if there was any reason why the patient was not switched, and, if not, she encouraged him or her to switch to oral therapy. The same approach was taken when the patient was ready for hospital discharge.

Interventions to Improve Care of Patients with COPD

The investigators reviewed the latest research on management of COPD and then decided to adapt the Ramirez et al. early-switch and early-discharge criteria for patients with CAP to patients with COPD. Antibiotics would be switched to the oral route in 24 hours and corticosteroids in 72 hours when criteria were met. The criteria included decrease in amount of sputum production, consistency and purulence, peak flow improving or stable (optional), and adequate gut absorption for oral or enteral intake. Discharge criteria included the above criteria for CAP plus oxygenation stable with or without oxygen and others described in the Methods section (page 378).

Results

Compliance with CAP Indicators

After the NP intervention program was instituted in July 2000, compliance with the CAP performance measures

<table>
<thead>
<tr>
<th>Table 1. The CMS Performance Measures for Community-Acquired Pneumonia*</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Proportion of patients who receive the initial antibiotic dose within 8 hours of hospital arrival</td>
</tr>
<tr>
<td>2. Proportion of patients given an initial antibiotic consistent with current recommendations</td>
</tr>
<tr>
<td>3. Proportion of patients who have blood cultures collected before antibiotics administered</td>
</tr>
<tr>
<td>4. Proportion of inpatients with pneumonia screened for or given influenza vaccination</td>
</tr>
<tr>
<td>5. Proportion of inpatients with pneumonia screened for or given pneumococcal vaccination</td>
</tr>
</tbody>
</table>

* CMS, Centers for Medicare & Medicaid Services
dramatically improved, as shown in Figure 1 (page 381) and Figure 2 (page 382). Quarterly results were fed back to members at the regular departmental meetings. Although performance on all the measures improved, the first three measures increased from 67.9%–87.2% to 97.0%–100% (Figure 1). Influenza vaccine screening or administration increased from 3.3% to 90.0% when last measured September 1–December 31, 2001. Pneumococcal vaccine screening or administration increased from 0.0% to 87.0%.

Figure 2 is a run chart that shows each performance measure as a time series. Compliance with each measure was assessed monthly, except for the influenza vaccine measure, which was assessed in the last quarter of each calendar year. All measures started below 90%, and all but one finished at ≥ 90%. The first three periods are irregular in length because we were collecting our own baseline data before reporting to the New Jersey QIO was required starting January 1, 2001.

**CAP Cost of Care**

After a six-month implementation of the NP Concurrent Intervention Model for patients with CAP, we compared the LOS and cost per case for the 307 pneumonia patients (mean age, 70.1 years) with APR-DRG 139 for the current six-month period (October 1, 2000, through March 31, 2001) with the cost per case for the 327 patients (mean age, 72.3 years) during the same pre-intervention six-month period (October 1, 1999, through March 31, 2000). Mean ages were 72.3 years before and 70.1 years after the intervention.

After the intervention, the mean LOS was reduced from 7.17 days to 5.83 days or by 1.34 days. In a hospital with a high bed census like ours, new patients are admitted to fill the empty beds. On the basis of an estimated one-year population of 720 Medicare patients with CAP, the 1.34 LOS reduction would generate 965 bed days (720 × 1.34). Of the 965 additional bed days generated, 75% of them (724 days) would likely be Medicare patients for whom care is paid per case rather than per diem. Dividing the 724 additional bed days by the average LOS of 5.83 days for a Medicare patient, we estimated that 124 new Medicare patients would be admitted to the medical center.

The revenue from an average Medicare case is approximately $7,000—less the cost of care of $4,424, leaving a profit of $2,576 per case. Multiplying 124 new patients by a $2,576-profit per case yields created revenue of $319,424 from the CAP intervention program. The cost of the NP was $80,000 per year. Although two NPs worked on the project, only one worked on it at a time; the rest of the NPs’ time was spent in other activities. For the cost analysis, therefore, the NP salary was counted once not twice.

In contrast, in a hospital with a lower bed census, the LOS reduction would result in a cost saving rather than additional revenue. We estimated the reduction in cost per case to be $444, mostly from lower total antibiotic costs. For an estimated 720 cases of CAP per year, the annual cost savings was projected to be $319,680 (444 × 720). During the same periods, the LOS for all cases and all diagnoses declined by 0.13 days and the cost per case decreased by $86.

We monitored the chance of readmission carefully. Following the intervention, the 15- and 31-day readmission rate actually decreased (Figure 3, page 383). Implementation of the NP model was also underway at the same time for patients with congestive heart failure.

---

**Table 2. Early-Switch and Early-Discharge Criteria***

<table>
<thead>
<tr>
<th>Early-Switch Criteria</th>
<th>1. Oral/enteral intake and gastrointestinal absorption is adequate.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2. Cough and shortness of breath are improving.</td>
</tr>
<tr>
<td></td>
<td>3. White blood cell count and differential are returning to normal.</td>
</tr>
<tr>
<td></td>
<td>4. Temperature is ≤ 100°F for 8 hours.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Early-Discharge Criteria</th>
<th>1. Fulfill the criteria for early-switch therapy.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2. White blood cell count is &lt; 12,000.</td>
</tr>
<tr>
<td></td>
<td>3. Comorbid diseases are stable.</td>
</tr>
<tr>
<td></td>
<td>4. Clinical values for oxygenation should be O₂ saturation &gt; 90% on room air or a PaO₂ &gt; 60 mmHg and PaCO₂ &lt; 45 mmHg or baseline.</td>
</tr>
</tbody>
</table>

(CHF) and for patients in three other CMS quality improvement projects—acute myocardial infarction, stroke, and atrial fibrillation. The relevance of those other projects lies in the fact that CHF and CAP may be confused initially on hospital admission because each presents with cough and shortness of breath. Consequently, improved care of patients with both CHF and CAP may account for the lower readmission rate. Before the intervention, a number of the readmissions in patients with CAP may actually have been for CHF.

Care of Patients with COPD

In July 2001, following the success of switch therapy for pneumonia, the investigators decided to apply switch therapy to COPD. The early-switch plan would include not only antibiotics but also corticosteroids. The pulmonary service line of the performance improvement department oversaw the process. The service line consisted of representatives from the relevant disciplines and included physicians, NPs, staff nurses, respiratory therapists, and others. The pulmonary division, the department of internal medicine’s executive committee, and the full department of internal medicine (in May 2001) approved the early-switch and early-discharge criteria. After physicians and nurses were educated regarding the COPD measures, switch therapy for COPD patients was instituted.

After reviewing charts of 37 patients with COPD for the first month of the project, antibiotics were switched in 54% of patients on a mean of 2.7 days, and corticosteroids were switched in 71% of the patients on a mean of 3.4 days. We showed that the LOS among patients discharged alive was reduced significantly compared with all other live patient discharges during the same periods, as shown in Table 3 (page 384). LOS and cost per case were analyzed by regression and analysis of variance (ANOVA; general linear models) to test for significance of time trends during the course of 33 months between January 2000 and October 2002. Linear regression indicated a significant steady decline in LOS, with adjustment for calendar-month seasonal effects \( p < .001 \). An ANOVA was performed to estimate a composite mean

Figure 1. Benchmarks from the state (and peer institutions in the state of New Jersey through the New Jersey Quality Improvement Organization for the CAP measures as shown in Table 1 for the period ending June 30, 2002, are as follows: CAP measure 1, 88.9% (89.4%), measure 2: 91.3% (90.2%), measure 3: 81.5% (83.7%), measure 4 (for the last quarter of 2001): 65.6% (63.2%), and measure 5: 72.2% (67.8%). CAP, community-acquired pneumonia.
LOS for each of the three calendar years, with adjustment for seasonal effects. The adjusted means are shown in Table 1. Whereas the 95% confidence interval (CI) for mean LOS in 2001 (95% CI: 5.35, 6.07) overlapped the confidence intervals for the mean LOS in 2000 (95% CI: 6.05, 6.80) and 2002 (95% CI: 4.76, 5.63), the decline in LOS during the three calendar years was statistically significant ($p < .001$). Transformation of the LOS to the log scale to reduce the impact of the longest stays did not alter the significance of these trends. In contrast, mean LOS did not decline for the all-inpatients group that excluded COPD patients (Table 1).

Although the average actual direct cost per case remained about the same for patients with COPD, the cost compared favorably to the net increase of $1,013 per case for all other inpatients in the same period (Table 1). Regression analysis of costs per case showed no significant time trend in direct costs or total costs per case (not shown), nor were calendar year (adjusted) mean costs significantly different.

Although concerns about patients being discharged too quickly were raised by Halm et al.,$^{18}$ our patients were discharged only when criteria were met and vital signs returned to normal. Furthermore, linear regression analysis of mortality, which was 2.5% among patients with COPD, showed no significant time trends ($p = .56$). Logistic regression results were essentially the same (no trend, $p = .45$).

To ensure continuity of care, reduce the readmission rate, improve disease self-management, educational protocols were implemented for patients with COPD. The protocols covered knowledge of disease process, purpose and procedures for treating and monitoring disease processes, medications (including side effects and drug interactions), smoking cessation counseling, diet, exercise guidelines, better breathing techniques, control of infections, importance of compliance, how to seek follow-up care, and important phone numbers for follow-up care.

**Discussion**

In these before-and-after studies, we augmented physician care by assigning an NP to work with physicians providing care for patients with CAP.$^{13}$ The use of NPs in the inpatient setting is a recent phenomenon. NPs had been employed to monitor and treat outpatients with urinary tract infections.$^{19}$ In a case-controlled study with cluster randomization, Marrie et al. reported effective use of nurses as case managers for CAP.$^{2}$ Meehan et al. also showed an improvement in compliance with performance measures in a multifaceted approach involving performance data feedback, dissemination of an evidence-based critical pathway, and sharing of implementation experiences among Connecticut hospitals participating in a QI project.$^{11}$

For an NP intervention to be successful, the performance measures to be monitored and implemented should be valid and be readily accepted by the medical staff. The validity of the CAP performance measures was documented by Rhew et al.,$^{20}$ who reviewed recommendations for indicator assessment by Eddy,$^{21}$ Hofer et al.,$^{22}$...
and McGlynn and confirmed that the measures met the five criteria he proposed. Other measures, such as the importance of hemodynamic monitoring, checking for lower extremity edema, and smoking cessation counseling, also meet those criteria but were not used in our studies.

Comparison with National Benchmarks

We found that use of an NP could significantly improve compliance with the CMS performance measures for CAP. The change in the system of management for CAP patients resulted in >90% compliance with all CMS measures, except for the pneumococcal vaccine screen (84%). National benchmarking for 1997–1999 showed the following median rates of compliance in the United States:

- 85% (range 38%–92%) for antibiotic timing
- 79% (range 55%–85%) for appropriate antibiotic treatment
- 82% (range 67%–93%) for timing of drawing blood cultures
- 14% (6%–38%) for influenza vaccine screening or administration
- 11% (4%–22%) for pneumococcal vaccine screening or administration

Jencks et al. expressed concern that state levels of compliance with these measures was inadequate and estimated that improvement would be likely to save hundreds to thousands of lives annually.

The largest improvement occurred in screening for and giving pneumococcal vaccine. Others have reported a lack of improvement with a clinical pathway to improve hospital-based pneumococcal vaccination rates. Our success is most likely due to the NPs’ diligence in following up on the CMS’s fifth CAP measure.

CAP Cost Reduction

Reductions in the cost of care for CAP are likely to occur when the percentage of low-risk patients admitted to the hospital is reduced, the percentage of patients inappropriately admitted to an intensive care unit is limited, and the percentage of patients discharged is encouraged when patients are switched to oral therapy and meet criteria for discharge. Battleman et al. recently confirmed the link between those indicators and reductions in resource utilization.

Successful implementation of CAP guidelines can have a significant impact on reducing the cost of care.
and decreasing the length of stay. Cost analyses are difficult to compare, however, because of differences in factors included in each analysis, such as geographic region, year of calculation, and considerations included in the sensitivity analyses. Englert et al. reduced CAP costs $435 by reviewing clinical practice profiles with each physician.26 Ramirez et al., who included reduction in LOS, decrease in drug costs, and avoidance of line sepsis in their cost analysis, estimated cost saving from early switch therapy at $937 per patient.27 The majority of savings usually come from reductions in LOS.21–23,28,29 From a societal point of view, pneumonia also incurs significant indirect costs from disability and work absenteeism that may not be included in the analysis.30

LOS Reduction

Halm et al., who demonstrated that clinical stability occurred within three to seven days and that when it occurred, subsequent clinical deterioration was rare,31 supported Ramirez et al.’s approach to early switch and early-discharge plans.25 Rhew et al., who performed a meta-analysis of controlled studies on early-switch and discharge strategies, found a reduction in mean LOS of 3 days (95% CI, -4.90 to -1.19 days),32 with no significant differences in outcomes between the intervention and the control groups.

A number of studies have shown that the implementation of guidelines requires significant changes in the processes of care to effect LOS reductions. Marrie et al. found a reduction of 1.7 bed-days per case when multiple care processes were altered. The switch to oral therapy occurred sooner in the intervention group.7 No adverse outcomes were noted in the intervention group. Multifaceted improvement approaches are clearly a good starting point, as shown in numerous studies.14

Although there is a concern that reducing LOS might result in an increase in readmissions or an increase in mortality when patients are treated for an insufficient period of time, we did not find an increase in readmission rates. Fine et al., who examined 30-day mortality rather than the rate of re-admissions as an outcome criterion,33 found no evidence for poorer outcome in organizations with the shorter-than-average LOS. Halm et al. recently pointed out that stability should be documented before discharge—in terms of temperature, blood pressure, pulse, respiratory rate, arterial oxygen, mental status, and demonstrated ability to eat and drink—to avoid readmission.18

We cannot rule out the possibility that the LOS reductions that we observed after our intervention may have been due in part to secular trends in LOS reduction or random variation; however, a reduction in LOS of 1.34 days during a one-year period is probably larger than a chance occurrence. (In comparison, the medical center’s overall LOS during the same periods decreased by only 0.13 days.) For COPD, we can rule out random variation.

Summary and Conclusions

In these before-and-after studies, the NP appeared to serve as the primary agent of change. The NP approach, which was first used at our medical center with telemetry, was extended effectively to improving care and reducing resource use for CAP and COPD. The NP was able to implement the criteria for early switch therapy from IV to oral antibiotics for CAP and to encourage discharge by prompting the physician to consider Ramirez et al.’s early discharge criteria.15 Significant reductions in LOS and increased revenue resulted without incurring an increase in readmissions for pneumonia. Preliminary results for the use of a similar approach for patients with COPD yielded comparable improvements.
In the past, most improvement efforts have focused on changing provider behavior; whereas less attention has been given to systematic changes in care delivery. Evidence indicates that systematic changes, such as standing orders, disease-specific order sets, and computerized physician order entry, are more likely to be effective than provider or patient education. We would like to add another systematic change for consideration—the use of a disease-oriented NP as a case manager. Acting in a prospective manner, the NP conveniently supplements the efforts of physicians and can partner with them to achieve excellent compliance with evidence-based measures. As Phillips and colleagues have stated, we need “a collaborative, integrated workforce aimed at improving the health care system of tomorrow. The country can ill afford doctors and nurses who ignore one another's capabilities and fail to maximize each other's contributions cost-effectively.” Such a collaboration should significantly aid in improving the six dimensions of health care performance—safety, effectiveness, patient-centeredness, timeliness, efficiency, and equity. Further studies should be done to document the effectiveness of the NP Concurrent Intervention Model. The work described in this article was supported in part by The Robert Wood Johnson Foundation's Grant #043306—Pursuing Perfection: Raising the Bar for Health Care Performance.

References


Peter A. Gross, M.D., is Chair, Department of Internal Medicine, Hackensack University Medical Center (HUMC), Hackensack, New Jersey, and Professor, University of Medicine and Dentistry of New Jersey—New Jersey Medical School (UMDNJ–NJMS), Newark, New Jersey. Linda Aho, R.N., A.P.N., is the Pulmonary Nurse Practitioner, Department of Patient Care, HUMC. Hormoz Ashyani, M.D., is the Director, Pulmonary Division, Department of Internal Medicine, and Jerome Levine, M.D., is Director, Infectious Disease, Department of Internal Medicine, HUMC, UMDNJ–NJMS. Margaret McGee, R.N., is Performance Improvement Coordinator, Department of Performance Improvement; Stephen Moran, R.N., is Decision Support Manager and Thomas Anton is Director, Budget and Reimbursement, Department of Finance; Joseph Feldman, M.D., is Chairman, Department of Emergency Trauma; and Arpi Kuyumjian, Pharm.D., is Clinical Pharmacy Coordinator—Infectious Disease Specialist, Department of Pharmacy, HUMC. Joan Skurnick, Ph.D., is Project Statistician, Department of Preventive Medicine, UMDNJ–NJMS. Please address requests for reprints to Peter A. Gross, M.D., pgross237@aol.com.