Annals of Internal Medicine | Improving Patient Care

Quality of Care for Patients Hospitalized for Acute Exacerbations of Chronic Obstructive Pulmonary Disease

Peter K. Lindenauer, MD, MSc; Penelope Pekow, PhD; Shan Gao, MS; Allison S. Crawford, BA; Benjamin Gutierrez, PhD; and Evan M. Benjamin, MD

Background: Acute exacerbation of chronic obstructive pulmonary disease (COPD) is 1 of the 10 leading causes of hospitalization among adults in the United States.

Objective: To evaluate the quality of care provided to patients hospitalized for acute exacerbations of COPD and to determine whether hospital or patient characteristics influence treatment.

Design: Retrospective cohort study.

Setting: 360 hospitals throughout the United States.

Patients: 69 820 patients hospitalized for acute exacerbations of COPD.

Measurements: Adherence to diagnosis and treatment recommendations contained in guidelines produced by the American College of Physicians and the American College of Chest Physicians; analyses of associations between hospital and patient characteristics and composite measures of performance.

Results: Of the 69 820 patients, 66 276 (95%) underwent chest radiography, 63 715 (91%) received supplemental oxygen, 67 515 (97%) received bronchodilators, 59 240 (85%) received systemic steroids, and 59 053 (85%) were given antibiotics. In total, 45 800 (66%) received this entire set of recommended care processes. Numerous participants received tests or treatments that were not beneficial: 16 607 (24%) were treated with methylxanthine bronchodilators, 10 051 (14%) had sputum testing, 8354 (12%) underwent acute spirometry, 4299 (6%) had chest physiotherapy, and 1409 (2%) were treated with mucolytic medications. Overall, 31 519 patients (45%) received at least 1 of these nonrecommended care elements, and 22 929 (33%) received ideal care, defined as all of the recommended care processes and none of the nonrecommended ones. Individual hospital performance varied widely; whereas older patients and women were more likely to receive ideal care than their counterparts, a higher annual volume of admissions for COPD was not associated with improved hospital performance.

Limitations: The study used administrative data, not chart review, and was limited to the inpatient management of COPD.

Conclusions: The quality of care for patients hospitalized for acute exacerbations of COPD may be improved by increasing the use of systemic corticosteroid and antibiotic therapy, decreasing the use of unnecessary and potentially harmful treatments, and reducing variation in practice across hospitals.

Ann Intern Med. 2006;144:894-903. www.annals.org
For author affiliations, see end of text.

Chronic obstructive pulmonary disease (COPD) affects approximately 16 million adults, accounts for more than $18 billion in annual health care costs, and is the fourth leading cause of death in the United States (1, 2). In 2002, approximately 620 000 persons were hospitalized for acute exacerbation of COPD, making this 1 of the 10 leading causes of hospitalization among U.S. adults (3).

In 1987, the American Thoracic Society became the first organization to produce clinical practice guidelines for the management of COPD (4). The number of standards has grown steadily since then, and various national and international organizations now produce guidelines (5–11). The American College of Physicians and the American College of Chest Physicians have coproduced evidence-based guidelines recommending that patients with acute exacerbations of COPD undergo a diagnostic evaluation that includes chest radiography and arterial blood gas analysis, followed by treatment with supplemental oxygen; anticholinergic bronchodilators; short-acting β_2-agonists; systemic corticosteroids; antibiotics; and, in some circumstances, noninvasive positive-pressure ventilation. These guidelines identify spirometry, mucolytic agents, sputum examinations, methylxanthine bronchodilators, and chest physiotherapy to be of uncertain or no benefit, with the latter 2 treatments being potentially harmful (5).

While the attention of policymakers, regulatory agencies, and the federal government has focused on measuring and improving quality of care for patients with pneumonia (12–17), remarkably little is known about the management of patients with acute exacerbations of COPD. General information about the quality of care for patients with COPD is lacking, and it is unknown whether regional differences in treatment exist or whether there is a positive relationship between hospital volume and quality of care for patients with COPD (such relationships are well documented for some surgical procedures and medical condi-

See also:

Print
Editors' Notes 895

Web-Only
Conversion of figure and tables into slides

Improving Patient Care is a special section within *Annals* supported in part by the U.S. Department of Health and Human Services (HHS) Agency for Healthcare Research and Quality (AHRQ). The opinions expressed in this article are those of the authors and do not represent the position or endorsement of AHRQ or HHS.

tions [18]). Similarly, it is unclear whether disparities that have been observed between sexes and among ethnic groups across a wide variety of conditions and treatment settings are found in the management of patients with acute exacerbations of COPD (19). Consequently, we evaluated the quality of care provided to patients hospitalized for acute exacerbations of COPD by measuring adherence to current guideline recommendations and examining the impact of hospital and patient characteristics on composite measures of performance.

Context

Evidence-based guidelines for the care of patients with chronic obstructive pulmonary disease (COPD) recommend explicit criteria for appropriate management of the disease. These guidelines identify tests and treatments of uncertain benefit as well as those that are potentially harmful. The degree of adherence to these guidelines is unknown.

Contribution

By surveying 360 hospitals, these investigators found that use of ideal care varied from 10% at some hospitals to greater than 60% at others.

Cautions

Administrative data were used instead of medical chart review to determine adherence to guidelines.

Implications

Despite well-accepted criteria for care of acute exacerbations of COPD, guideline adherence remains poor.

—The Editors

METHODS

Setting and Participants

We conducted a retrospective cohort study using data from 360 hospitals that participate in Perspective (Premier Inc., Charlotte, North Carolina), a database developed for measuring quality and health care utilization. Participating hospitals represent all regions of the United States, are predominantly small to medium-sized nonteaching facilities, and serve mostly urban patient populations. In addition to the information available in the standard hospital discharge file, Perspective contains a date-stamped log of all billed items (including medications and laboratory, diagnostic, and therapeutic services) at the individual patient level.

Patients were included in our analysis if they were 40 years of age and older, had a principal diagnosis of COPD or a principal diagnosis of respiratory failure paired with a secondary diagnosis of COPD, and were discharged between 1 January 2001 and 31 December 2001. International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) codes were used to assess diagnostic information. Patients were excluded if they had a secondary diagnosis of pneumonia. The All Patient Refined–Diagnosis-Related Group classification system, version 15.0 (3M Corp., Minneapolis, Minnesota), was used to exclude patients if they were assigned to a diagnosis-related group other than COPD or one consistent with a hospitalization for COPD, such as respiratory failure. The institutional review board at Baystate Medical Center approved the study, and the need for written informed consent was waived.

Data Elements

In addition to age, sex, and ethnicity, we recorded the presence of congestive heart failure, valvular heart disease, pulmonary circulation disorders, peripheral vascular disorders, hypertension, paralysis and other neurologic disorders, diabetes, hypothyroidism, renal failure, liver disease, chronic peptic ulcer disease, HIV and AIDS, lymphoma, metastatic cancer, solid tumor without metastasis, rheumatoid arthritis and collagen vascular diseases, coagulation deficiency, obesity, weight loss, fluid and electrolyte disorders, blood loss anemia, deficiency anemias, alcohol abuse, drug abuse, psychoses, and depression. On the basis of work by Elixhauser and colleagues (20), we assessed comorbid conditions using Healthcare Cost and Utilization Project Comorbidity Software, version 3.1 (Agency for Healthcare Research and Quality, Rockville, Maryland). We obtained data regarding in-hospital mortality; length of stay; and disease-specific, pulmonary-specific, and overall readmission rates at 14 and 30 days from the Perspective discharge file. In addition to information related to the admission, we noted each hospital's bed size, annual number of admissions for acute exacerbations of COPD, teaching status, geographic region, and whether the institution served an urban or rural population.

Adherence to Guideline Recommendations

Using guidelines produced collaboratively by the American College of Physicians and the American College of Chest Physicians (5), we developed a set of performance measures that could be used to evaluate quality of care. On the basis of recommendations contained in these guidelines, we categorized the following diagnostic evaluations and treatments as beneficial: chest radiography, arterial blood gas analysis, supplemental oxygen, inhaled anticholinergic bronchodilators, inhaled short-acting β_2-agonists, systemic corticosteroids, antibiotics, and noninvasive positive-pressure ventilation. Antibiotic regimens were classified as providing broad- or narrow-spectrum coverage. Narrow-spectrum coverage was defined as treatment with first-generation penicillins, first-generation cephalosporins, macrolides, tetracyclines, sulfonamides, vancomycin, or clindamycin. Broad-spectrum coverage was defined as treatment with second- or later-generation cephalosporins, antistaphylococcal penicillins, aminopenicillins, antipseudomonal penicillins, fluoroquinolones, carbapenems, monobactams, aminoglycosides, aztreonam, or combina-

Table 1. **Baseline Characteristics of Patients***

Characteristic	Patients (*n* = 69 820)
Median age (interquartile range), *y*	70 (61–78)
Sex, *n* (%)	
Female	40 371 (58)
Male	29 449 (42)
Ethnicity, *n* (%)	
White	53 163 (76)
Black	6425 (9)
Hispanic	1850 (3)
Other	8382 (12)
Comorbid condition, *n* (%)	
Hypertension	28 715 (41)
Diabetes	15 235 (22)
Fluid and electrolyte disorders	12 477 (18)
Solid tumor without metastasis	7392 (11)
Depression	7046 (10)
Deficiency anemias	6866 (10)
Hypothyroidism	6134 (9)
Obesity	5078 (7)
Peripheral vascular disease	4074 (6)
Other neurologic disorders	4088 (6)
Primary diagnosis, *n* (%)	
COPD	60 611 (87)
Respiratory failure	9209 (13)
Readmission within 14 d, *n* (%)†	
COPD	2382 (3.4)
Respiratory illness	3438 (4.9)
Any disease	7759 (11.1)
Readmission within 30 d, *n* (%)†	
COPD	3588 (5.1)
Respiratory illness	5437 (7.8)
Any disease	11 993 (17.2)
Length of stay (interquartile range), *d*	4 (3–7)
Deaths, *n* (%)	2854 (4.1)

* COPD = chronic obstructive pulmonary disease.
† Reflects percentage of 66 966 survivors only.

tion therapy that included 2 or more narrow-spectrum agents. In addition, we categorized the following management strategies as having uncertain or no benefit and possibly causing harm: sputum examinations, acute spirometry, mucolytic agents, chest physiotherapy, and methylxanthine bronchodilators. Acute spirometry was defined as spirometry performed before the day of discharge. Adherence to these measures was assessed by using a combination of pharmacy billing data and records of other diagnostic and therapeutic services rendered during the hospitalization.

Statistical Analysis

Summary statistics at both the patient and the hospital level were constructed by using frequencies and proportions for categorical data and by using means, standard deviations, medians, and interquartile ranges for continuous variables. By applying the Institute for Healthcare Improvement's (21) concept of the "bundle," a "collection of processes needed to effectively care for patients with a particular condition," we classified patients as receiving *recommended care* if they received all of the following diagnostic tests and treatments: chest radiography, supplemental oxygen, bronchodilator therapy, systemic corticosteroid therapy, and antibiotic treatment. The authors of the American College of Physicians and American College of Chest Physicians guideline viewed arterial blood gas analysis as helpful; however, given insufficient evidence demonstrating a benefit, the guideline stopped short of giving this test a full recommendation. Consequently, arterial blood gas analysis was not included in the *recommended care* bundle. Patients were identified as receiving *nonrecommended care* if they received any of the following: sputum examination, acute spirometry, therapy with methylxanthine bronchodilator or mucolytic agents, or chest physiotherapy. Patients were considered to have received *ideal care* if they received all 5 recommended care elements and none of the nonrecommended ones.

We examined the association of patient age (differentiating patients who were 40 to 64 years of age, 65 to 74 years of age, and ≥75 years of age), sex, and ethnicity with the provision of recommended and ideal care by using chi-square statistics. The Mantel–Haenszel chi-square test was used to adjust for hospital, and hospital-adjusted relative risks for receiving recommended and ideal care were computed. In addition, Kruskal–Wallis analysis of variance was used to determine if hospital region, teaching status, and the annual number of patients admitted with COPD were associated with hospital rates of delivery of recommended and ideal care. All analyses were performed with SAS statistical software, version 9.1 (SAS Institute, Cary, North Carolina).

Role of the Funding Source

No funding was received for this study.

RESULTS

A total of 80 412 patients who were 40 years of age and older had a diagnosis of COPD during the study period, including 65 625 who had a principal diagnosis of COPD and 14 787 who had a principal diagnosis of respiratory failure and a secondary diagnosis of COPD. From this initial group, we excluded 9119 patients who had a secondary diagnosis of pneumonia, 1445 patients who were assigned to a diagnosis-related group that was not consistent with a hospitalization for COPD, 29 patients whose admission was coded as being related to childbirth, and 1 patient because of unknown sex. Of 69 820 patients remaining for analysis (median age, 70 years), 58% were women and 76% were white (**Table 1**). Hypertension, diabetes, and fluid and electrolyte disorders were the most commonly recorded comorbid conditions. The median length of stay was 4 days, and 1 of 4 patients was hospitalized for 1 week or longer. Overall, 2854 (4.1%) patients

died during the hospitalization. Total readmission rates at 14 and 30 days were 11.1% and 17.2%, respectively, and COPD was the principal diagnosis for approximately one third of these readmissions.

Approximately half of the participating hospitals were located in the South, 63% operated 300 beds or fewer, 90% were nonteaching facilities, and 75% were located in urban areas (**Table 2**). The annual number of patients receiving care at participating hospitals for exacerbations of COPD ranged from 1 to 994. Across balanced quartiles of volume, the median annual number of COPD cases was 56, 122, 234, and 379.

Adherence to Guideline Recommendations

Overall, 66 276 (95%) patients underwent chest radiography, 44 726 (64%) had at least 1 arterial blood gas analysis, 63 715 (91%) received supplemental oxygen, and 67 515 (97%) were treated with bronchodilators. Of those receiving bronchodilator therapy, 27 827 (40%) received short-acting β_2-agonists by metered-dose inhaler, 14 010 (20%) received an anticholinergic bronchodilator by metered-dose inhaler, and 66 492 (95%) received a bronchodilator by nebulizer (**Table 3**). A total of 59 240 patients (85%) were treated with systemic corticosteroids, including 54 092 (78%) who received corticosteroids intravenously and 5148 (7%) who were treated with oral corticosteroids exclusively. Antibiotic therapy was administered to 59 053 (85%) patients, and fluoroquinolone monotherapy was the most commonly used treatment. Approximately 11% of patients received narrow-spectrum coverage. Overall, 45 800 patients (66%) received all 5 management strategies in the recommended care bundle: chest radiography; supplemental oxygen; and therapy with bronchodilators, systemic corticosteroids, and antibiotics. Numerous patients received measures considered to be of uncertain or no benefit: A total of 16 607 (24%) patients received methylxanthine bronchodilator therapy, 10 051 (14%) had sputum examinations, 8354 (12%) underwent acute spirometry, 4299 (6%) received chest physiotherapy, and 1409 (2%) were treated with mucolytic medications. Overall, 31 519 (45%) patients received at least 1 of these nonrecommended strategies. Finally, 22 929 (33%) patients received all 5 of the recommended care elements and none of the nonrecommended ones (ideal care).

Variation in Performance across Hospitals and among Patients

Adherence to both individual and composite measures of performance varied widely among hospitals. We generally observed greater variation in the use of nonbeneficial

Table 2. **Characteristics and Outcomes of Hospitals Participating in the Study**

Variable	Hospitals, *n (%)*	Patients, *n (%)*	Mean Mortality Rate (SD), %	Mean 30-Day Readmission Rate (SD), %	Mean Length of Stay (SD), *d*
Overall	360	69 820	4.4	16.9	5.3
Hospital region					
Midwest	77 (21)	15 662 (22)	3.9 (2.5)	17.1 (5.7)	5.0 (0.7)
Northeast	41 (11)	7402 (11)	4.7 (3.0)	16.0 (7.4)	6.0 (1.2)
South	184 (51)	39 837 (57)	4.5 (5.7)	16.5 (5.4)	5.4 (0.8)
West	58 (16)	6919 (10)	4.5 (3.8)	18.2 (7.3)	5.1 (0.9)
Teaching status					
Nonteaching	324 (90)	60 409 (87)	4.4 (4.8)	16.6 (6.1)	5.4 (0.9)
Teaching	36 (10)	9411 (13)	4.3 (2.0)	19.3 (4.5)	5.3 (0.6)
Staffed beds					
6–100	68 (19)	4970 (7)	3.9 (3.7)	14.8 (6.9)	4.6 (1.1)
101–200	88 (24)	13 893 (20)	5.0 (8.2)	15.1 (6.5)	5.1 (0.8)
201–300	73 (20)	14 686 (21)	4.1 (2.3)	17.3 (4.8)	5.5 (0.9)
301–500	91 (25)	23 538 (34)	4.4 (2.0)	18.7 (5.3)	5.5 (0.9)
≥501	40 (11)	12 733 (18)	4.4 (1.9)	19.2 (5.0)	5.5 (0.6)
Population served					
Rural	90 (25)	13 301 (19)	3.7 (3.1)	15.7 (6.3)	5.3 (1.0)
Urban	270 (75)	56 519 (81)	4.6 (5.0)	17.3 (5.9)	5.4 (0.9)
Quartile of annual admissions for chronic obstructive pulmonary disease (median)*					
1 (56)	90 (25)	4271 (6)	5.3 (8.5)	15.4 (8.4)	4.9 (1.4)
2 (122)	91 (25)	10 973 (16)	4.1 (2.7)	16.3 (5.6)	5.1 (0.9)
3 (234)	90 (25)	20 033 (29)	4.2 (1.7)	17.4 (3.8)	5.4 (0.9)
4 (379)	89 (25)	34 543 (49)	3.9 (1.6)	18.4 (5.1)	5.5 (0.7)

* Quartile 1, 1 to 81 patients; quartile 2, 82 to 167 patients; quartile 3, 168 to 274 patients; quartile 4, 275 to 994 patients. Numbers in parentheses are median annual numbers of chronic obstructive pulmonary disease cases.

treatments than beneficial ones (**Figure**). For example, use of methylxanthine bronchodilator therapy varied by more than 25% across hospitals at the 25th and 75th percentiles, whereas antibiotic and corticosteroid use varied less (**Table 3**). Among the recommended measures, arterial blood gas analysis and the administration of short-acting β_2-agonists and anticholinergic bronchodilators by metered-dose inhaler varied greatly among hospitals. Paralleling the individual recommended measures, performance of the recommended care bundle varied less among hospitals than did ideal care, for which we observed a 20% absolute difference in performance across hospitals spanning the interquartile range. Overall, ideal care was provided to fewer than 10% of patients at some hospitals and to greater than 60% at the best performers (**Figure**).

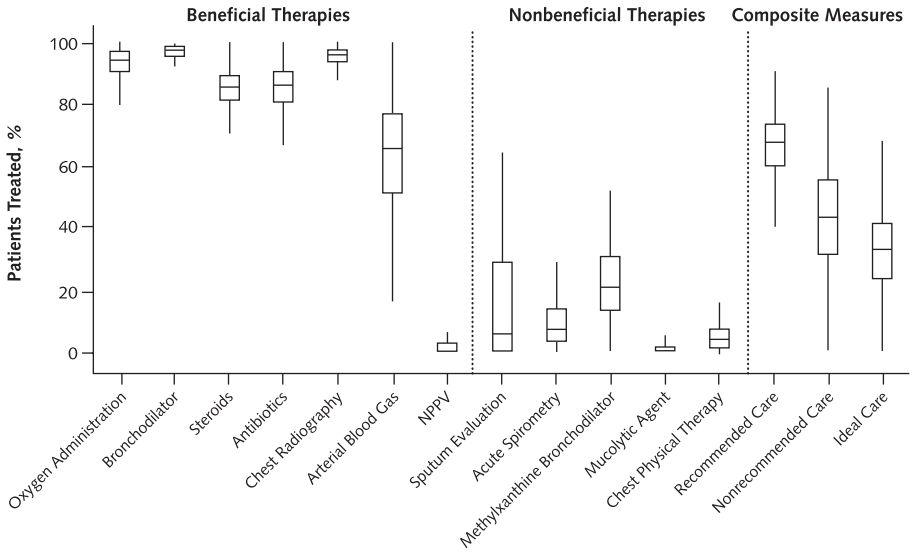
In the analyses focused on hospital characteristics, we found that teaching institutions and those located in the Northeast were less likely to perform all of the therapies in the recommended care bundle, but annual hospital COPD case volume was not associated with performance (**Tables 4** and **5**). Rates of nonrecommended care varied from 38% in the West to 47% in the South; however, neither teaching status nor annual volume was associated with this composite measure. When compared with other regions of the country, hospitals located in the West had the highest rates of ideal care, but neither teaching status nor the hospital's

Table 3. **Management of Patients with Acute Exacerbations of Chronic Obstructive Pulmonary Disease**

Treatment	Patients, *n* (%)	Median Hospital Performance (Interquartile Range), %
Beneficial measures		
Chest radiography	66 276 (94.9)	96.4 (93.9–97.8)
Arterial blood gas analysis	44 726 (64.1)	65.4 (52.0–77.0)
Oxygen administration	63 715 (91.3)	94.5 (90.1–97.1)
Bronchodilator therapy		
Any bronchodilator therapy	67 515 (96.7)	97.6 (96.2–98.5)
Short-acting β_2-agonist therapy (metered-dose inhaler)	27 827 (39.9)	39.0 (27.2–51.9)
Anticholinergic bronchodilator therapy (metered-dose inhaler)	14 010 (20.1)	13.4 (7.0–23.0)
Nebulized bronchodilator therapy	66 492 (95.2)	96.4 (94.9–97.8)
Systemic corticosteroid therapy		
Any corticosteroid therapy	59 240 (84.9)	85.9 (81.5–89.3)
Intravenous regimen (with or without oral regimen)	54 092 (77.5)	80.7 (74.5–84.1)
Oral regimen only	5148 (7.4)	5.0 (3.1–7.8)
Antibiotic therapy		
Any antibiotic therapy	59 053 (84.6)	86.1 (81.0–90.5)
Narrow-spectrum coverage*	7341 (10.5)	9.1 (5.3–13.2)
Broad-spectrum coverage†	51 712 (74.1)	76.7 (69.6–83.5)
Quinolone only	23 030 (33.0)	33.6 (23.0–43.8)
Macrolide only	4687 (6.7)	5.3 (2.8–8.3)
Third-generation cephalosporins only	4539 (6.5)	4.8 (2.5–8.9)
Macrolides and third-generation cephalosporins	4191 (6.0)	4.7 (1.8–8.2)
Quinolones and third-generation cephalosporins	3288 (4.7)	4.0 (1.8–6.7)
Macrolides and quinolones	1872 (2.7)	2.4 (1.1–3.6)
Other combinations	17 446 (25.0)	22.3 (17.5–28.3)
Noninvasive positive-pressure ventilation	1827 (2.6)	0.0 (0.0–3.0)
Nonbeneficial measures		
Sputum testing	10 051 (14.4)	5.5 (0.0–29.0)
Acute spirometry	8354 (12.0)	7.7 (3.4–14.2)
Methylxanthine bronchodilator therapy	16 607 (23.8)	20.7 (13.6–30.8)
Mucolytic therapy	1409 (2.0)	0.2 (0.0–2.1)
Chest physiotherapy	4299 (6.2)	4.1 (1.6–7.7)
Composite measures of performance		
Recommended care‡	45 800 (65.6)	67.6 (60.1–74.0)
Nonrecommended care§	31 519 (45.1)	43.6 (31.7–55.8)
Ideal care ‖	22 929 (32.8)	33.1 (23.1–41.7)

* Narrow-spectrum coverage indicates treatment with older penicillins, first-generation cephalosporins, macrolides, tetracyclines, sulfonamides, vancomycin, or clindamycin.
† Broad-spectrum coverage indicates treatment with second- and later-generation cephalosporins, antistaphylococcal penicillins, aminopenicillins, antipseudomonal penicillins, fluoroquinolones, carabapenems, monobactams, aminoglycosides, aztreonam, or combination therapy that includes 2 or more narrow-spectrum agents.
‡ Recommended care indicates receiving *all* of the following: chest radiography; supplemental oxygen; and therapy with bronchodilators, systemic corticosteroids, and antibiotics.
§ Nonrecommended care indicates receiving 1 or more of the following: chest physiotherapy, acute spirometry, sputum test, or therapy with a methylxanthine bronchodilator or mucolytic agent.
‖ Ideal care indicates receiving all of the recommended therapies (chest radiography, supplemental oxygen, therapy with bronchodilators, systemic corticosteroids, and antibiotics) and none of the nonbeneficial therapies (chest physiotherapy, acute spirometry, sputum test, or therapy with a methylxanthine bronchodilator or mucolytic agent).

Figure. **Performance data for the 360 hospitals that participated in the study.**



The line in the middle of each box represents the median performance rate for individual and composite measures across hospital(s), and the box extends to the interquartile range (IQR). The lines emerging from the box extend to the adjacent values. The upper adjacent value is defined as the largest data point less than or equal to the 75th percentile plus 1.5 times the IQR. The lower adjacent value is defined as the smallest data point greater than or equal to the 25th percentile minus 1.5 times the IQR. *Recommended care* indicates receiving all of the following: chest radiography; supplemental oxygen; and therapy with bronchodilators, systemic corticosteroids, and antibiotics. *Nonrecommended care* indicates receiving 1 or more of the following: chest physiotherapy, acute spirometry, methylxanthine bronchodilator therapy; mucolytic therapy, or a sputum test. *Ideal care* indicates receiving all of the recommended care elements (chest radiography; supplemental oxygen; and therapy with bronchodilators, systemic corticosteroids, and antibiotics) and none of the nonbeneficial measures (chest physiotherapy, acute spirometry, sputum test, or therapy with methylxanthine bronchodilators or mucolytic agents). NPPV = noninvasive positive-pressure ventilation.

annual COPD case volume was a predictor of performance.

In the analysis focused on the effect of patient characteristics, we observed that patients who were 75 years of age and older were less likely than younger patients to receive the complete bundle of recommended therapies, but sex was not associated with performance (**Table 4**). Black patients were less likely to receive recommended care than white and Hispanic patients (unadjusted relative risk, 0.88 [95% CI, 0.86 to 0.90]); however, this difference virtually disappeared after adjusting for hospital performance (**Table 4**). Patients who were 75 years of age and older, women, and Hispanic patients were less likely than other groups to receive nonrecommended care. Consequently, patients older than 75 years of age (adjusted relative risk, 1.10 [CI, 1.08 to 1.13]) and women (adjusted relative risk, 1.09 [CI, 1.06 to 1.11]) were most likely to receive ideal care. As observed in the analysis focused on recommended care, black patients were less likely to receive ideal care (unadjusted relative risk, 0.84 [CI, 0.81 to 0.88]), but this difference did not persist after adjusting for the hospitals where black patients received treatment.

DISCUSSION

In this study of nearly 70 000 patients who were hospitalized for acute exacerbations of COPD, we identified widespread opportunities to improve quality of care and to reduce costs by addressing problems of underuse, overuse, and misuse of resources and by reducing variations in practice across institutions. Fifteen percent of hospitalized patients did not receive systemic corticosteroid therapy, and as many as 15% may have benefited from antibiotic therapy but did not receive it. Conversely, approximately 1 in 4 patients were treated with methylxanthine bronchodilators, and 10% to 15% received potentially unnecessary sputum examinations and acute spirometry. Overall, 66% of patients received the entire recommended care bundle and only 33% received ideal care. Quality of care was found to vary widely across hospitals; however, this variation was generally unexplained by hospital characteristics, such as region, teaching status, or the annual number of admissions for COPD exacerbations. On the other hand, older patients and women were somewhat more likely to receive ideal care than their counterparts. Although black patients were less likely to receive care consistent with guideline recommendations, this finding was explained by poorer performance at the hospitals where they obtained care.

Although the treatment of patients hospitalized for pneumonia has been a primary focus of national efforts to measure and improve quality for more than a decade (12–17, 22), acute exacerbations of COPD have received disproportionately less attention. The quality of pneumonia

Table 4. **Association of Patient Characteristics with Recommended Care, Nonrecommended Care, and Ideal Care**

Variable	Recommended Care*					Nonrecommended Care†	
	Patients Treated, *n (%)*	Unadjusted Relative Risk (95% CI)	Chi-Square *P* Value	Mantel–Haenszel Hospital-Adjusted Relative Risk (95% CI)§	Mantel–Haenszel Chi-Square *P* Value§	Patients Treated, *n (%)*	Unadjusted Relative Risk (95% CI)
Age			<0.01		<0.01		
40–64 y	15 533 (67)	1.00		1.00		11 297 (49)	1.00
65–74 y	14 842 (68)	1.02 (1.00–1.03)		1.01 (0.99–1.02)		10 327 (47)	0.97 (0.95–0.99)
≥75 y	15 425 (62)	0.93 (0.92–0.94)		0.93 (0.91–0.94)		9895 (40)	0.82 (0.81–0.84)
Sex			0.04		0.22		
Male	19 189 (65)	1.00		1.00		13 840 (47)	1.00
Female	26 611 (66)	1.01 (1.00–1.02)		1.01 (1.00–1.02)		17 679 (44)	0.93 (0.92–0.95)
Ethnicity			<0.01		0.02		
White	35 406 (67)	1.00		1.00		24 219 (46)	1.00
Black	3749 (58)	0.88 (0.86–0.90)		0.97 (0.95–0.99)		2989 (47)	1.02 (0.99–1.05)
Hispanic	1144 (62)	0.93 (0.90–0.96)		0.97 (0.92–1.02)		753 (41)	0.89 (0.85–0.94)
Other‖	5501 (66)	0.99 (0.97–1.00)		1.01 (0.98–1.05)		3558 (42)	0.93 (0.91–0.96)

* Recommended care indicates receiving *all* of the following: chest radiography; supplemental oxygen; and therapy with bronchodilators, systemic corticosteroids, and antibiotics.
† Nonrecommended care indicates receiving 1 or more of the following: chest physiotherapy, acute spirometry, sputum test, or therapy with a methylxanthine bronchodilator or mucolytic agent.
‡ Ideal care indicates receiving all of the recommended therapies (chest radiography, supplemental oxygen, therapy with bronchodilators, systemic corticosteroids, and antibiotics) and none of the nonbeneficial therapies (chest physiotherapy, acute spirometry, sputum test, or therapy with a methylxanthine bronchodilator or mucolytic agent).
§ Mantel–Haenszel chi-square and relative risks are adjusted for hospital.
‖ Includes Asian/Pacific Islander, Native American, and other ethnicities.

care at thousands of hospitals in the United States is now publicly reported and available on the Internet (23), and an increasing number of hospitals are involved in "pay for performance" initiatives that tie their reimbursement to adherence to standardized pneumonia quality measures (24). Guidelines for the management of COPD have existed for nearly 20 years; however, little information has been available by which to assess their effectiveness. In this context, the large opportunities that we observed to improve COPD care support the notion that guidelines are a necessary but insufficient approach to quality improvement. The multidimensional approach taken toward improving pneumonia care may be required before COPD care can be viewed as highly reliable.

Bratzler and colleagues (25) reviewed the records of 409 patients hospitalized for acute exacerbations of COPD from 2000 to 2001 and documented similar opportunities to increase the use of antibiotic and corticosteroid therapy and to limit use of treatment with methylxanthine bronchodilators; however, the study was limited to Medicare beneficiaries in a single state and was not powered to examine variations in care between hospitals or among patients. Gibson and colleagues (26) studied 248 admissions for acute exacerbations of COPD at a single hospital in Australia and reported that 79% of patients received treatment with antibiotics and 82% received corticosteroid therapy. By providing a detailed analysis of practice at 360 hospitals throughout the United States, our results extend the findings of these earlier studies while shedding new light on opportunities to reduce large variations in practice between institutions and to improve care nationally.

The strengths of our study include its large size, its national scope, and the use of recommendations derived from recent evidence-based guidelines to produce a series of performance measures that were used to assess quality of care. Our examination of variation in quality across a range of patient and hospital characteristics provides new and valuable insights into the equity of care while running counter to prevailing ideas about the relationship between hospital volume and quality. Our observation that women and patients older than 75 years of age were more likely than their counterparts to receive ideal care was explained by the fact that these patients were less likely than their peers to receive nonrecommended measures. In fact, older patients were less likely to receive treatment in general—both recommended and nonrecommended measures, with the latter outweighing the former in the calculation of ideal care rates. Poor performance at the hospitals where black patients received care fully accounted for ethnic disparities in quality, a finding consistent with a recent analysis by Barnato and colleagues (27), who found that within-hospital analysis narrowed or erased disparities. This observation suggests that hospital-focused quality improvement efforts may offer the best chance for resolving ongoing differences in quality of treatment for patients with COPD (27).

Our study has several limitations. First, our data were obtained from administrative sources and not through a

Table 4—Continued

Nonrecommended Care†			Ideal Care‡				
Chi-Square *P* Value	Mantel–Haenszel Hospital-Adjusted Relative Risk (95% CI)§	Mantel–Haenszel Chi-Square *P* Value§	Patients Treated, *n (%)*	Unadjusted Relative Risk (95% CI)	Chi-Square *P* Value	Mantel–Haenszel Hospital-Adjusted Relative Risk (95% CI)§	Mantel–Haenszel Chi-Square *P* Value§
<0.01		<0.01			<0.01		<0.01
	1.00		7164 (31)	1.00		1.00	
	0.98 (0.96–1.00)		7224 (33)	1.07 (1.04–1.10)		1.05 (1.02–1.08)	
	0.83 (0.81–0.85)		8541 (35)	1.12 (1.09–1.15)		1.10 (1.08–1.13)	
<0.01		<0.01			<0.01		<0.01
	1.00		9156 (31)	1.00		1.00	
	0.94 (0.92–0.95)		13 773 (34)	1.10 (1.07–1.12)		1.09 (1.06–1.11)	
<0.01		<0.01			<0.01		0.68
	1.00		17 617 (33)	1.00		1.00	
	0.98 (0.95–1.01)		1791 (28)	0.84 (0.81–0.88)		0.98 (0.94–1.03)	
	0.91 (0.85–0.99)		614 (33)	1.00 (0.94–1.07)		1.02 (0.93–1.12)	
	1.03 (0.98–1.08)		2907 (35)	1.05 (1.01–1.08)		1.01 (0.95–1.08)	

Table 5. **Association of Hospital Characteristics with Recommended Care, Nonrecommended Care, and Ideal Care**

Variable	Recommended Care*		Nonrecommended Care†		Ideal Care‡	
	Mean Patients Treated ± SE, %	Kruskal–Wallis *P* Value	Mean Patients Treated ± SE, %	Kruskal–Wallis *P* Value	Mean Patients Treated ± SE, *(%)*	Kruskal–Wallis *P* Value
All hospitals	64.5 ± 0.64		43.8 ± 0.88		32.7 ± 0.68	
Region		0.01		<0.01		<0.01
Midwest	64.7 ± 1.7		40.4 ± 1.8		35.5 ± 1.6	
Northeast	58.2 ± 2.5		43.2 ± 2.8		29.2 ± 2.0	
South	66.0 ± 0.71		47.2 ± 1.2		31.0 ± 0.86	
West	64.1 ± 1.3		38.1 ± 2.4		36.7 ± 1.8	
Teaching status		<0.01		0.11		0.19
Nonteaching	65.7 ± 0.62		44.3 ± 0.93		33.0 ± 0.72	
Teaching	54.0 ± 2.6		39.6 ± 2.7		29.9 ± 2.2	
Quartile of annual admissions for chronic obstructive pulmonary disease§		0.31		0.25		0.86
1	63.3 ± 1.3		42.3 ± 2.1		32.2 ± 1.6	
2	64.0 ± 1.5		41.9 ± 1.7		33.7 ± 1.4	
3	65.1 ± 1.2		44.9 ± 1.5		32.4 ± 1.2	
4	65.8 ± 1.1		46.2 ± 1.8		32.4 ± 1.3	

* Recommended care indicates receiving *all* of the following: chest radiography; supplemental oxygen; and therapy with bronchodilators, systemic corticosteroids, and antibiotics.
† Nonrecommended care indicates receiving 1 or more of the following: chest physiotherapy, acute spirometry, sputum test, or therapy with a methylxanthine bronchodilator or mucolytic agent.
‡ Ideal care indicates receiving all of the recommended therapies (chest radiography; supplemental oxygen; therapy with bronchodilators, systemic corticosteroids, and antibiotics) and none of the nonbeneficial therapies (chest physiotherapy, acute spirometry, sputum test, or therapy with a methylxanthine bronchodilator or mucolytic agent).
§ Quartile 1, 1 to 81 patients; quartile 2, 82 to 167 patients; quartile 3, 168 to 274 patients; quartile 4, 275 to 994 patients.

review of medical charts. This limited our ability to identify "ideal" candidates for supplemental oxygen because we were unable to determine which patients were hypoxic or hypercarbic and therefore appropriate candidates for this therapy. Second, we could not assess change in sputum volume or purulence, factors that are used to determine the need for antibiotics; however, we felt that hospital admission was a reasonable proxy for the moderate-to-severe exacerbations for which antibiotic administration has been shown to improve outcomes. Furthermore, our reliance on administrative data should not have affected our estimates of the appropriate use of chest radiography or corticosteroid or bronchodilator therapy because there are few contraindications to these measures and almost all hospitalized patients are thought to benefit from their use. Third, if diagnoses or services provided to patients were not specifically documented and charged, we would have failed to detect their occurrence. This prevented us from being able to differentiate β_2-agonists from anticholinergic bronchodilators when such medications were administered by nebulizer. Furthermore, patients treated with medications brought from home would not typically be billed for the drugs themselves, and this may explain why we did not observe universal administration of bronchodilators. Fourth, the hospitals that participated in this study were generally representative of acute care hospitals across the United States; however, given the relatively small percentage of large academic medical centers and small rural hospitals, our results may be less generalizable to these care settings. Fifth, the study was restricted to patients whose COPD exacerbations resulted in hospital admission. Our findings should not be used to make generalizations about the quality of care for COPD exacerbations managed in the outpatient setting.

The quality of care provided to patients hospitalized for acute exacerbations of COPD can be improved through greater adherence to treatment recommendations found in current guidelines. Although large variations in care are known to exist at the hospital level, additional research is needed to determine whether hospitals that achieve greater adherence to recommended and ideal care measures can expect improved risk-adjusted outcomes.

From Baystate Medical Center and Tufts University School of Medicine, Springfield, Massachusetts; University of Massachusetts–Amherst, Amherst, Massachusetts; and Premier Healthcare Informatics, Charlotte, North Carolina.

Acknowledgments: The authors thank Michael Rothberg, MD, MPH, and Dale Bratzler, DO, MPH, for their comments on an earlier version of this manuscript.

Grant Support: None.

Potential Financial Conflicts of Interest: None disclosed.

Requests for Single Reprints: Peter K. Lindenauer, MD, MSc, Division of Healthcare Quality, Baystate Medical Center, 759 Chestnut Street, P-5928, Springfield, MA 01199; e-mail, Peter.Lindenauer@bhs.org.

Current author addresses are available at www.annals.org.

References

1. **Snow V, Lascher S, Mottur-Pilson C.** Evidence base for management of acute exacerbations of chronic obstructive pulmonary disease. Joint Expert Panel on Chronic Obstructive Pulmonary Disease of the American College of Chest Physicians and the American College of Physicians–American Society of Internal Medicine. Ann Intern Med. 2001;134:595-9. [PMID: 11281744]

2. **Hoyert DL, Kung HC, Smith BL.** Deaths: Preliminary Data for 2003. National Vital Statistics Reports. Volume 53, No. 15. Hyattsville, MD: National Center for Health Statistics; 2005.

3. **Agency for Healthcare Research and Quality.** HCUPnet: Healthcare Cost and Utilization Project. Accessed at www.ahrq.gov/HCUPnet on 16 December 2005.

4. **American Thoracic Society.** Standards for the diagnosis and care of patients with chronic obstructive pulmonary disease (COPD) and asthma. This official statement of the American Thoracic Society was adopted by the ATS Board of Directors, November 1986. Am Rev Respir Dis. 1987;136:225-44. [PMID: 3605835]

5. **Bach PB, Brown C, Gelfand SE, McCrory DC,** Management of acute exacerbations of chronic obstructive pulmonary disease: a summary and appraisal of published evidence. American College of Physicians–American Society of Internal Medicine; American College of Chest Physicians. Ann Intern Med. 2001;134:600-20. [PMID: 11281745]

6. **McCrory DC, Brown C, Gelfand SE, Bach PB.** Management of acute exacerbations of COPD: a summary and appraisal of published evidence. Chest. 2001;119:1190-209. [PMID: 11296189]

7. **American Thoracic Society, European Respiratory Society.** Standards for the Diagnosis and Management of Patients with COPD. Accessed at www-test.thoracic.org/copd/ on 16 December 2005.

8. **O'Donnell DE, Aaron S, Bourbeau J, Hernandez P, Marciniuk D, Balter M, et al.** Canadian Thoracic Society recommendations for management of chronic obstructive pulmonary disease—2003. Can Respir J. 2003;10 Suppl A:11A-65A. [PMID: 12861361]

9. **National Collaborating Centre for Chronic Conditions.** Chronic obstructive pulmonary disease. National clinical guideline on management of chronic obstructive pulmonary disease in adults in primary and secondary care. Thorax. 2004;59 Suppl 1:1-232. [PMID: 15041752]

10. **Global Initiative for Chronic Obstructive Lung Disease.** Global strategy for the diagnosis, management and prevention of chronic obstructive pulmonary disease. Accessed at www.goldcopd.org on 16 December 2005.

11. **Agency for Healthcare Research and Quality.** Management of Acute Exacerbations of Chronic Obstructive Pulmonary Disease. Summary, Evidence Report/Technology Assessment No. 19. Rockville, MD: Agency for Healthcare Research and Quality; September 2000. AHRQ publication no. 00-E020.

12. **Meehan TP, Fine MJ, Krumholz HM, Scinto JD, Galusha DH, Mockalis JT, et al.** Quality of care, process, and outcomes in elderly patients with pneumonia. JAMA. 1997;278:2080-4. [PMID: 9403422]

13. **Fine JM, Fine MJ, Galusha D, Petrillo M, Meehan TP.** Patient and hospital characteristics associated with recommended processes of care for elderly patients hospitalized with pneumonia: results from the Medicare quality indicator system pneumonia module. Arch Intern Med. 2002;162:827-33. [PMID: 11926859]

14. **Meehan TP, Weingarten SR, Holmboe ES, Mathur D, Wang Y, Petrillo MK, et al.** A statewide initiative to improve the care of hospitalized pneumonia patients: The Connecticut Pneumonia Pathway Project. Am J Med. 2001;111:203-10. [PMID: 11530031]

15. **Meehan TP, Chua-Reyes JM, Tate J, Prestwood KM, Scinto JD, Petrillo MK, et al.** Process of care performance, patient characteristics, and outcomes in elderly patients hospitalized with community-acquired or nursing home-acquired pneumonia. Chest. 2000;117:1378-85. [PMID: 10807825]

16. **Jencks SF, Cuerdon T, Burwen DR, Fleming B, Houck PM, Kussmaul AE, et al.** Quality of medical care delivered to Medicare beneficiaries: a profile at state and national levels. JAMA. 2000;284:1670-6. [PMID: 11015797]

17. **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;164:637-44. [PMID: 15037492]

18. **Halm EA, Lee C, Chassin MR.** Is volume related to outcome in health care? A systematic review and methodologic critique of the literature. Ann Intern Med. 2002;137:511-20. [PMID: 12230353]

19. **Fiscella K, Franks P, Gold MR, Clancy CM.** Inequality in quality: addressing socioeconomic, racial, and ethnic disparities in health care. JAMA. 2000;283:2579-84. [PMID: 10815125]

20. **Elixhauser A, Steiner C, Harris DR, Coffey RM.** Comorbidity measures for use with administrative data. Med Care. 1998;36:8-27. [PMID: 9431328]

21. **Institute for Healthcare Improvement.** Bundle up for safety. Accessed at www.ihi.org/IHI/Topics/CriticalCare/IntensiveCare/ImprovementStories/BundleUpforSafety.htm on 16 December 2005.

22. **Joint Commission on Accreditation of Healthcare Organizations.** Specification Manual for National Hospital Quality Measures 2005. Accessed at www.jcaho.org/pms/core+measures/aligned_manual.htm on 16 December 2005.

23. **U.S. Department of Health and Human Services.** Hospital Compare: a quality tool for adults, including people with Medicare. Accessed at www.hospitalcompare.hhs.gov on 16 December 2005.

24. **Centers for Medicare and Medicaid Services.** Medicare pay for performance demonstration shows significant quality of care improvement at participating hospitals. Accessed at www.cms.hhs.gov/media/press/release.asp?Counter=1441 on 16 December 2005.

25. **Bratzler DW, Oehlert WH, McAdams LM, Leon J, Jiang H, Piatt D.** Management of acute exacerbations of chronic obstructive pulmonary disease in the elderly: physician practices in the community hospital setting. J Okla State Med Assoc. 2004;97:227-32. [PMID: 15346799]

26. **Gibson PG, Wlodarczyk JH, Wilson AJ, Sprogis A.** Severe exacerbation of chronic obstructive airways disease: health resource use in general practice and hospital. J Qual Clin Pract. 1998;18:125-33. [PMID: 9631350]

27. **Barnato AE, Lucas FL, Staiger D, Wennberg DE, Chandra A.** Hospital-level racial disparities in acute myocardial infarction treatment and outcomes. Med Care. 2005;43:308-19. [PMID: 15778634]

Current Author Addresses: Drs. Lindenauer, Pekow, and Benjamin: Division of Healthcare Quality, Baystate Medical Center, 759 Chestnut Street, P-5928, Springfield, MA 01199.
Ms. Gao and Ms. Crawford: 408 Arnold House, School of Public Health and Health Sciences, University of Massachusetts, 715 North Pleasant Street, Amherst, MA 01003-9304.
Dr. Gutierrez: Premier Healthcare Informatics, 2320 Cascade Pointe Boulevard, Charlotte, NC 28208.