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Impact of a Post-Discharge Integrated Disease Management Program on COPD Hospital Readmissions

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BACKGROUND: Readmission following a hospitalization for COPD is associated with significant health-care expenditure. METHODS: A multicomponent COPD post-discharge integrated disease management program was implemented at the Cleveland Clinic to improve the care of patients with COPD and reduce readmissions. This retrospective study reports our experience with the program. Groups of subjects who were exposed to different components of the program were compared regarding their readmission rates. Multivariate logistic regression analysis was performed to build predictive models for 30- and 90-d readmission. RESULTS: One hundred sixty subjects completed a 90-d follow-up, of which, 67 attended the exacerbation clinic, 16 subjects received care coordination, 51 subjects completed both, and 26 subjects did not participate in any component despite referral. Thirty- and 90-d readmission rates for the entire group were 18.1 and 46.2%, respectively. Thirty- and 90-d readmission rates for the individual groups were: exacerbation clinic, 11.9 and 35.8%; care coordination, 25.0 and 50.0%; both, 19.6 and 41.2%; and neither, 26.9 and 80.8%, respectively. The model with the best predictive ability for 30-d readmission risk included the number of hospitalizations within the previous year and use of noninvasive ventilation (C statistic of 0.84). The model for 90-d readmission risk included receiving any component of the post-discharge integrated disease management program, the number of hospitalizations, and primary care physician visits within the previous year (C statistic of 0.87). CONCLUSIONS: Receiving any component of a post-discharge integrated disease management program was associated with reduced 90-d readmission rate. Previous health-care utilization and lung function impairment were strong predictors of readmission. *Key words: COPD; integrated disease management; care coordination; readmissions; post-discharge clinic.* [Respir Care 0;0(0):1–•. © 0 Daedalus Enterprises]

Introduction

Readmission of patients with COPD remains a vexing problem, with great morbidity for patients and challenges for health-care organizations in the context of bundled payment. COPD-related costs in the United States have been estimated at approximately $73 billion/y,[1] with most expenditures due to hospital care.[2] COPD is also the third leading disease condition associated with hospital readmissions within 30 d of hospital discharge.[3] Consequently, the Centers for Medicare and Medicaid Services have tar-

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geted COPD as a disease for which payment is withheld for readmission within 30 d.

Taken together, integrated disease management interventions improve quality of life and functional capacity and reduce hospital admissions for patients with COPD.[4] However, which interventions should be included in an integrated disease management program remains unclear.

With the purpose of decreasing readmissions and improving the care of patients after COPD exacerbations, we established a multicomponent post-discharge integrated disease management program at the Cleveland Clinic. The intervention consisted of 2 parts: a multidisciplinary outpatient follow-up in the exacerbation clinic within 5–7 d of discharge and a care coordination program. This study presents a retrospective analysis of the 30- and 90-d readmission rates after initiation of the post-discharge integrated disease management program and of the specific components of the program that were associated with reduced rates of readmission.

QUICK LOOK

Current knowledge

COPD readmissions represent a significant burden to health-care expenditure and patient morbidity. Integrated disease management systems have been shown to improve quality of life and reduce hospital readmission rates. Given the heterogeneity of interventions reported in previous literature, it remains unclear which specific interventions have been the most beneficial.

What this paper contributes to our knowledge

The establishment of a multicomponent post-discharge integrated disease management program consisting of a follow-up clinic appointment with a pulmonologist and/or care coordination was associated with a reduction in 90-d readmissions. Our data demonstrate that enrolling in any component of the program was beneficial. Prior health-care utilization and lung function impairment were found to be predictors for hospital readmission.

Methods

The Cleveland Clinic Main Campus Hospital is a tertiary care academic medical center with 1,400 beds. In April 2014, a COPD exacerbation clinic was established to provide multidisciplinary out-patient follow-up for patients within 1 week of discharge from the Main Campus Hospital. A study protocol was approved by the Cleveland Clinic institutional review board (approval 15-454), and informed consent was waived. During the 1-h exacerbation clinic visit, the subject was seen by a mid-level provider, a physician, and an educator. The evaluation is standardized and includes a detailed history, medication reconciliation, review of systems, physical examination, spirometry, and 6-min walk test. Subjects also receive education on inhaler technique utilizing the teach-back method, smoking cessation counseling, pulmonary rehabilitation referral, vaccinations, and referral to relevant specialty clinics when significant comorbidities are identified that require additional attention.

In July 2014, the program was expanded to include the closer attention of a care coordinator. The care coordinator, a registered respiratory therapist, visited each subject during the hospitalization and, using a structured interview to assess health status and needs, made weekly telephone calls after discharge for up to 30 d. When worsening respiratory status or other clinical needs were identified from these telephone interviews, the subject's primary physician was notified for intervention. Subjects were also given a COPD care coordination card, which included the coordinator's contact information.

The asynchronous introduction of different elements of the post-discharge integrated disease management follow-up program and subjects' preferences for participation permitted an analysis of the impact of the program's individual components (ie, the exacerbation clinic and the care coordination). In this context, 4 groups were evaluated: subjects who attended the exacerbation clinic only, subjects who received the care coordination only, subjects who received both components, and subjects who received neither despite being referred.

Candidate variables for association with readmission were selected based on review of previous literature related to COPD exacerbation[5-8] and investigator judgment. Data were collected regarding demographic variables, socioeconomic status, prior health-care utilization, pulmonary function test results, comorbidities, smoking status, domiciliary oxygen use, and prior history use of noninvasive ventilation in the acute setting.

Statistical Analysis

The study variables were described using sample means with SD or proportions as appropriate. The study group was divided into 2 groups based upon the outcome of 30 or 90-d readmission. Categorical variables were compared using the Pearson chi-square test or Fisher exact test, whereas continuous variables were compared using the 2-sample independent *t* test. To build a multivariate logistic regression model, univariate logistic regression was first performed for each of the variables.[9] A complete list of the variables for univariate logistic regression analysis is provided in e-Tables 1 and 2 (see the supplementary

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materials at http://www.rcjournal.com). The predictive variables significant at $P < .10$ on univariate analysis were identified as potential predictor variables and then entered into a multivariate model. Correlation analysis was conducted to avoid multi-collinearity. A stepwise variable selection procedure was performed to select a significant subset of predictors. Two multivariate models were created for 30- and 90-d readmissions separately, and regression equations were constructed with the significant predictors, respectively. Pairwise comparisons were conducted to detect any differences among the different components of the program based on the final models. Receiver operating characteristic curves were constructed to compare the predictive capabilities of 30- and 90-d readmissions. Kaplan–Meier survival analysis and Cox proportional hazard regression analysis were also performed for the time from the clinic visit to 30- and 90-d readmission, respectively. The model-building strategy for the multivariate Cox regression was the same as that for the multivariate logistic regression. The proportional hazard assumption was evaluated, and regression equations were constructed with the significant predictors. All analyses were performed by using SAS 9.4 for Linux (SAS, Cary, North Carolina). Values of $P < .05$ (2-tailed) were considered statistically significant.

Results

A total of 185 ambulatory patients were referred to the program over a 1-y period. Twenty-one patients were excluded from the analysis because they were readmitted before their exacerbation clinic appointment and therefore did not have an opportunity to complete the clinic visit. An additional 4 patients were excluded because they opted to receive local medical care and did not return to the Cleveland Clinic system. In total, 160 subjects completed 90-d follow-up and were included in the analysis.

Baseline characteristics for all groups combined are displayed in Table 1. The mean age was 65.9 ± 10.0 y with mean post-bronchodilator FEV_1 percent of predicted of 50 ± 20%; 52.5% were female, and 71.9% were African American. Within the year before the index admission, study subjects had been hospitalized on average 2.8 ± 3.0 times, attended 1.7 ± 2.4 pulmonary out-patient visits, and had 3.0 ± 3.1 primary care physician visits.

Specific clinical interventions performed during the exacerbation clinic visit included: changes to pharmacotherapy (38%), administration of vaccines (15%), smoking cessation counseling (10%), oxygen prescription initiation or adjustment (4%), instruction regarding tracheobronchial clearance techniques (4%), pulmonary hypertension assessment (2.5%), and provision of home bi-level positive airway pressure instructions (2.5%). Referrals to various subspecialties were made, including to psychiatry (8%)

Table 1. Subject Baseline Characteristics for All Groups Combined

Characteristics	Values
Age, mean ± SD y	65.9 ± 10.0
Sex, *n* (%)	
Male	76 (47.5)
Female	84 (52.5)
Race, *n* (%)	
African American	115 (71.9)
Caucasian	43 (26.9)
Other	2 (1.3)
Income, mean ± SD $ US	30,973 ± 18,549
BMI, mean ± SD kg/m^2	28.0 ± 9.0
Current smoker, *n* (%)	52 (32.5)
Prednisone use, *n* (%)	
Chronic	25 (15.6)
Intermittent	110 (68.8)
None	25 (15.6)
Supplemental oxygen use, *n* (%)	101 (63.1)
NIV use, *n* (%)	49 (30.6)
Post-bronchodilator FEV_1, mean ± SD L	1.1 ± 0.6
Post-bronchodilator FEV_1, mean ± SD % predicted	50 ± 20
Post-bronchodilator FVC, mean ± SD % predicted	70 ± 20
D_{LCO}, mean ± SD % predicted	40 ± 20
No. of hospitalizations in previous year, mean ± SD	2.8 ± 3.0
No. of pulmonary clinic visits in previous year, mean ± SD	1.7 ± 2.4
No. of PCP clinic visits in previous year, mean ± SD	3.0 ± 3.1
Cancer, *n* (%)	29 (18.1)
Anxiety, *n* (%)	27 (16.9)
Cirrhosis, *n* (%)	2 (1.3)
Atrial fibrillation/atrial flutter, *n* (%)	34 (21.3)
Diabetes mellitus, *n* (%)	58 (36.3)
Diabetes with neuropathy, *n* (%)	15 (9.4)
Pulmonary fibrosis, *n* (%)	2 (1.3)
Coronary artery disease, *n* (%)	45 (28.1)
Congestive heart failure, *n* (%)	48 (30.0)
Gastroesophageal reflux disease, *n* (%)	45 (28.1)
Peptic ulcer disease, *n* (%)	11 (6.9)
Hypertension, *n* (%)	107 (66.9)
Hyperlipidemia, *n* (%)	73 (45.6)
Chronic renal disease, *n* (%)	31 (19.4)
Cor pulmonale, *n* (%)	22 (13.8)
Asthma, *n* (%)	38 (23.8)
Obstructive sleep apnea, *n* (%)	42 (26.3)

N = 160.
BMI = body mass index
NIV = noninvasive ventilation
D_{LCO} = diffusing capacity of the lung for carbon monoxide
PCP = primary care physician

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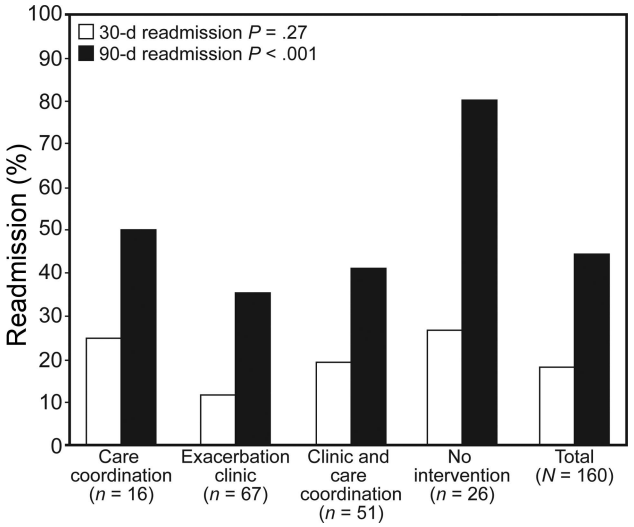

Fig. 1. Thirty- and 90-d readmission rates for different components of the COPD care coordination program. *P* values use the Fisher exact test, comparing any intervention with no intervention.

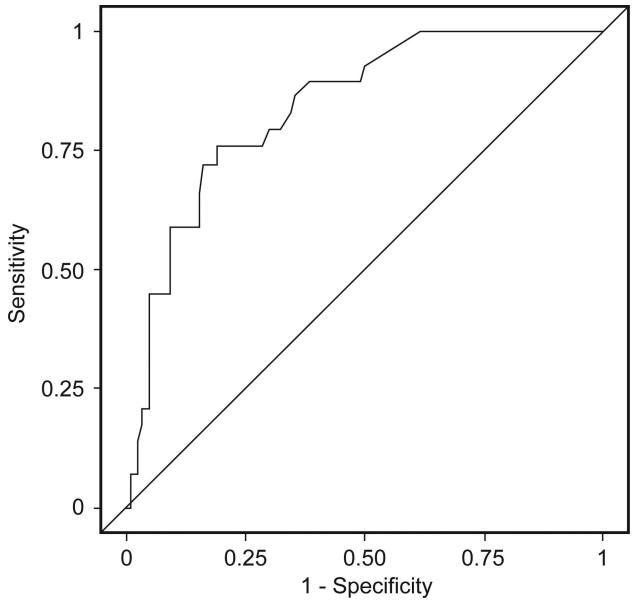

Fig. 2. Receiver operating characteristic curve for 30-d readmission. C statistic = 0.84, and area under the curve = 0.843.

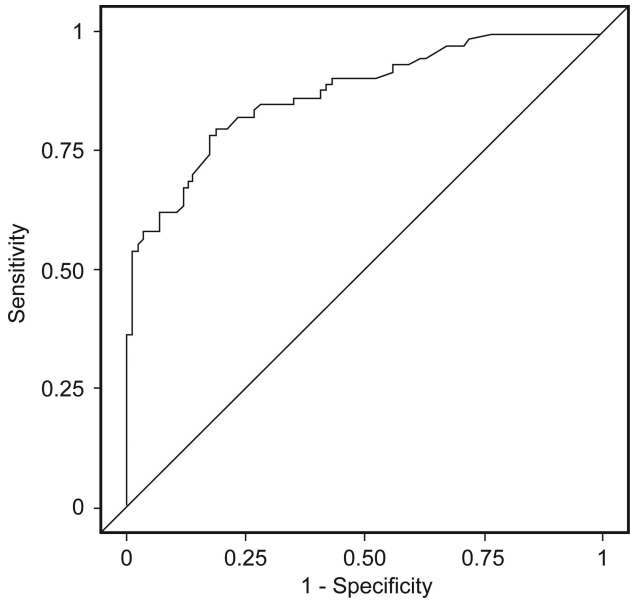

Fig. 3. Receiver operating characteristic curve for 90-d readmission. C statistic = 0.87, and area under the curve = 0.873.

and sleep medicine (8%). Also, 89% of subjects received referrals for pulmonary rehabilitation.

Thirty- and 90-d readmission rates for the 4 groups are displayed in Figure 1. For all 160 subjects, the total 30- and 90-d readmission rates were 18.1 and 46.2%, respectively. In the individual intervention groups, the 30- and 90-d readmission rates were: exacerbation clinic ($n = 67$), 11.9 and 35.8%; care coordination ($n = 16$), 25.0 and 50.0%; both ($n = 51$), 19.6 and 41.2%; neither ($n = 26$), 26.9 and 80.8%, respectively.

Univariate logistic regression analysis for 30- and 90-d readmission identified 12 and 16 variables as significant predictors of readmission, respectively (e-Tables 3 and 4). These variables were then used to create a multivariate model.

The final multivariate logistic regression model identified 2 predictor variables of 30-d readmission: number of prior hospitalizations (odds ratio [OR] 1.36 [95% CI 1.17–1.57]) and use of noninvasive ventilation (OR 3.07 [95% CI 1.19–7.91]). As shown in Figure 2, the model's C statistic was 0.84, suggesting excellent predictive accuracy (C statistic values of 0.8–0.9 indicate excellent discrimination[9]). The final multivariate logistic regression model for 90-d readmission identified 3 predictor variables: receiving any component of the post-discharge integrated disease management program (care coordination vs neither: OR 0.08, 95% CI 0.01–0.51; exacerbation clinic vs neither: OR 0.09, 95% CI 0.02–0.33; both versus neither: OR 0.11, 95% CI 0.03–0.43, number of primary care physician visits within the previous year OR 1.25, 95% CI 1.09–1.45, and number of hospitalizations within the previous year OR 1.90, 95% CI 1.48–2.43 with a C statistic of 0.87 (Fig. 3). Pairwise comparison did not demonstrate a significant difference between the individual program components (Table 2).

Cox proportional hazard analysis identified 4 predictor variables of 30-d readmission: percent of predicted post-bronchodilator FEV_1 with hazard ratio (HR) 0.09, 95% CI 0.01–0.69, number of hospitalizations within the previous year (HR 1.27, 95% CI 1.17–1.38), diabetes mellitus (HR 2.28, 95% CI 1.12–4.65), and peptic ulcer disease (HR 3.15, 95% CI 1.15–8.63). Four predictors were identified

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Table 2. Pairwise Comparison of Each Component of the Intervention Group

Component	*P*
Care coordination vs no intervention	.007
Exacerbation clinic vs no intervention	<.001
Clinic and care coordination vs no intervention	.002
Care coordination vs clinic and care coordination	.70
Clinic and care coordination vs exacerbation clinic	.64
Care coordination vs exacerbation clinic	.93

for 90-d readmission: receiving any component of the post-discharge integrated disease management program (care coordination: HR 0.39, 95% CI 0.17–0.89; exacerbation clinic: HR 0.25, 95% CI 0.14–0.44; both: HR 0.33, 95% CI 0.17–0.67), number of hospitalizations in the previous year (HR 1.20, 95% CI 1.13–1.27), number of primary care physician visits within the previous year (HR 1.12, 95% CI 1.02–1.22), and hypertension (HR 2.15, 95% CI 1.24–3.73). After adjusting for explanatory variables, the probability of being readmitted within 90 d was significantly lower when receiving any program component compared with receiving no intervention ($P < .05$) (Fig. 4).

Discussion

In this retrospective analysis of a post-discharge integrated disease management program, enrolling in any component of the program was associated with reduced 90-d readmission. Our data are consistent with previous reports that demonstrate that integrated care confers greater benefit for mid-term than for short-term outcomes.[10]

Our study extends current knowledge about integrated care management by suggesting specific components that confer benefit in averting readmission for COPD. Although a meta-analysis that included 26 randomized, controlled trials involving 2,997 subjects concluded that post-discharge integrated disease management programs resulted in an improvement in quality of life and functional status and a reduction in the number of hospital admissions over a 3–12-month period when compared with controls,[4] the significant heterogeneity of integrated management interventions throughout the various studies precluded ascertaining which specific interventions were effective. In our study, we found that receiving any component of the post-discharge integrated disease management program was associated with lower 90-d readmission than receiving no intervention, with no difference among those receiving care coordination alone, attending the exacerbation clinic alone, or receiving both components (Fig. 4). Our findings agree with prior observations that early pulmonary follow-up after COPD exacerbations can avert readmissions. For instance, in a retrospective cohort study, Gavish et al[11] reported that not attending the follow-up visit with a pulmonologist within 1 month of discharge was associated with an increased risk of 90-d readmission. The benefit of early post-discharge follow-up is also supported for other disease states. Hernandez et al[12] reported a lower risk of 30-d readmission for subjects with heart failure when follow-up occurred within 7 d of discharge. Similar results were also seen with early follow-up after high risk surgery[13] and with sickle cell disease.[14] Unfortunately, not all patients can attend an early follow-up appointment despite the demonstrated benefits. In this context, Gavish et al[11] identified distant residence as a risk factor for 90-d readmission. In our study, subjects who received only care coordination without a clinic visit had lower 90-d readmission rates, suggesting that patients who are unable to make an out-patient follow-up visit still experience benefit, perhaps because the care coordinator helped to craft an individualized post-discharge clinical plan.

In contrast to the observations regarding 90-d readmission, no reduction in 30-d readmission rates was observed for subjects enrolled in the post-discharge integrated disease management program. Although our data do not permit a firm conclusion, we speculate that a shorter-term benefit may not have been observed because the impact of the intervention is cumulative, and a difference may not have been detectable until the second and third months post-discharge. For instance, some interventions that have been shown to reduce hospital admissions, such as pulmonary rehabilitation,[15] may not be available to patients within the first 30 d after discharge. In our program, although a pulmonary rehabilitation order was placed for 89% of the subjects, < 10% started the program within 30 d. Even if these patients were recruited within 30 d, it would have been unlikely for them to accrue the expected benefits within this short time frame. The general barriers to enrollment for others included access to transportation, patient refusal, work commitment, and having undergone pulmonary rehabilitation before (ie, no available reimbursement). In keeping with this low participation, Jones et al[16] reported that only 32% of eligible subjects were referred to pulmonary rehabilitation after COPD exacerbations, and only 9.6% actually completed the program. Improving access and adherence to pulmonary rehabilitation programs in the real-world practice setting may lead to overall reduced health-care utilization.

We found a strong association between the likelihood of 30- and 90-d readmission and previous health-care utilization. In keeping with prior observations, lung function impairment and past health-care utilization were strongly associated with 30- and 90-d readmissions. For example, in a study of 172 subjects admitted for acute COPD, the number of COPD admissions in the prior year was associated with a 42% increase in risk of 30-d readmission for each additional past hospitalization.[17] Similarly, Almagro

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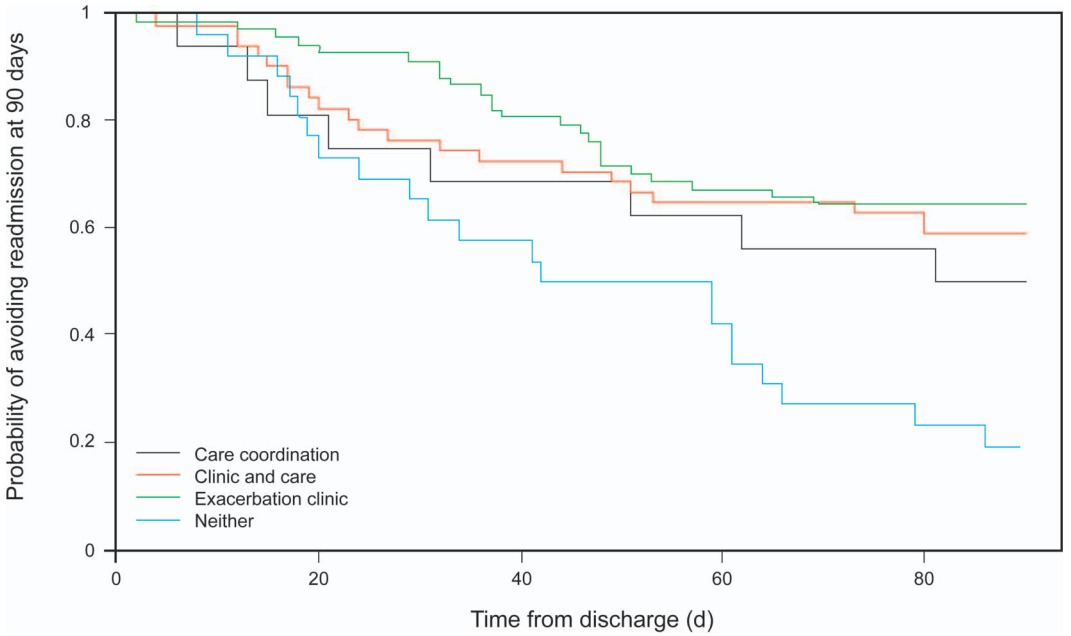

Fig. 4. Kaplan–Meier survival curve for the different components of the COPD care coordination program for 90-d readmission. $P < .001$.

et al[8] demonstrated that the best predictor for COPD readmission was the number of hospitalizations within the previous year (OR 4.27, 95% CI 1.5–12).

In keeping with previous observations, lung function impairment was associated with 30-d readmission in our study. In the ECLIPSE study,[18] which assessed 2,138 COPD subjects, exacerbations of COPD were independently associated with worse lung function. Although the ECLIPSE study also identified gastroesophageal reflux disease as a predictor for future exacerbations of COPD, such an association with 30- and 90-d readmissions was not observed in our cohort. The incidence of gastroesophageal reflux disease (as ascertained from the medical record) was 27% in our population (comparable with ECLIPSE participants), and 78% of subjects were on anti-reflux therapy. Since treatment of gastroesophageal reflux disease has been associated with reduced exacerbation frequency,[19] it is plausible that any conferred risk for exacerbation was abrogated with the high rate of gastroesophageal reflux disease therapy in our cohort.

During the clinic visit, a change to pharmacotherapy compliant with Global Initiative for Chronic Obstructive Lung Disease (GOLD) guidelines[20] was made 38% of the time. We speculate that the apparently high frequency with which discharged subjects' regimens were changed may reflect an unawareness of treatment guidelines by the discharging physicians. A retrospective analysis of United States COPD and Medicare patients demonstrated that over two thirds of patients were not prescribed maintenance COPD pharmacotherapy per GOLD guidelines during a 1-y study.[21] Furthermore, a survey of primary care physicians by Foster et al[22] showed that only 55% were aware of COPD guidelines and only 25% would use such guidelines for decision making. Clearly, a benefit of follow-up clinics is the opportunity to optimize patients' drug regimens.

Several limitations of our study warrant comment. First, by virtue of its retrospective nature, our data are hypothesis-generating and require validation in a prospective, pragmatic clinic trial. Second, because the study was conducted in a single center, albeit large, the generalizability of our findings requires validation in other settings. As a matter of internal bias,[23] inclusion of only those subjects referred to the post-discharge integrated disease management raises the specter of selection bias in our sample. On the other hand, the readmission rates for the entire group were similar to those reported in the literature, suggesting that the groups were comparable in terms of susceptibility to the outcomes of interest.[1] It could also be argued that subjects who participated in the post-discharge integrated disease management program were more likely to be adherent to medical care than those who did not, hence biasing the results toward a favorable impact. Although we have accounted for some of the factors that have traditionally been related to adherence (eg, the presence of multiple comorbidities and socioeconomic status) in our multivariate analysis, the possible impact of subject nonadherence on the outcome is not entirely excluded.

Conclusions

To our knowledge, the establishment of a multidisciplinary COPD exacerbation clinic after discharge under

the direction of a pulmonologist is a novel intervention. Utilizing 2 different analytic approaches (absolute event rate and survival models), short-term improvement (ie, lower 30-d readmission rates) was not observed, whereas longer-term benefits were evident. In this regard, our findings suggest that the focus of Centers for Medicare and Medicaid Services reimbursement withholding might shift from a 30-d readmission to a 90-d readmission focus, where intervention can effect improvement. Overall, our findings suggest that the interventions of a post-discharge COPD follow-up clinic visit and care coordination by a respiratory therapist are feasible and, subject to further validation, effective.

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