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A comprehensive care plan that reduces readmissions after acute exacerbations of COPD

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Abstract

Background: "Transitions of care" have been the focus of readmission reduction strategies for acute exacerbations of Chronic Obstructive Pulmonary Disease (AECOPD). Wake Forest Baptist Medical Center (WFBMC) implemented a comprehensive care plan for AECOPD admissions in 2014 that also seeks to improve the diagnosis/treatment of COPD, strives for the optimal management of co-morbidities, and emphasizes hospice/palliative care in appropriate patients.

Methods: A retrospective, electronic health record (EHR) based, observational cohort study was used to evaluate AECOPD admissions between 5/12/2014 to 6/28/2016. An existing AECOPD registry was used to determine care plan status, readmissions were identified from the EHR, and mortality information was obtained from the state of North Carolina. Propensity weighted, multiple logistic regression was used to compare the care plan (n = 597) versus usual care (n = 677) on readmission and mortality outcomes after covariate adjustment.

Results: Enrollment in the care plan was associated with a reduced odds of 30-day all-cause readmission (OR 0.84, 95% CI 0.71–0.99), 30-day mortality (OR 0.63, 95% CI 0.44–0.88), and the composite endpoint of 30-day, all-cause readmissions and mortality (OR 0.78, 95% CI 0.67–0.92). The plan also reduced AECOPD-specific readmissions at 90 days (OR 0.78, 95% CI 0.63–0.96).

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Summary conflict of interest statements for each author

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Appendix A. Supplementary data

Supplementary data related to this article can be found at http://dx.doi.org/10.1016/j.rmed.2018.06.014.

Conclusion: A comprehensive care plan for patients hospitalized for AECOPD reduced the odds of all-cause readmission, mortality, and AECOPD specific readmission risk. This exploratory study reinforces the use of the AECOPD Care Plan at WFBMC. Future research should focus on a randomized, pragmatic clinical trial to further evaluate the impact of this plan on clinical outcomes.

Keywords

Readmission; Chronic obstructive pulmonary disease; Respiratory therapy; Electronic health records

1. Introduction

As part of the Affordable Care Act (ACA) the Center for Medicare and Medicaid Services (CMS) instituted a penalty for excess readmissions after a (Hospital Readmission Reduction Program – HRRP) hospitalization for an acute exacerbation of COPD (AECOPD) [1]. Many hospital systems have instituted AECOPD hospital management programs in response to that penalty, but few hospital management programs, to date, have shown significant improvement in both readmission rate and mortality. Some have demonstrated harm, with no reduced readmissions at the cost of increased mortality [2]. Most interventions demonstrate improvements in readmissions at 1 year but not at 30 days [3].

Existing COPD readmission reduction programs have been criticized for not adequately addressing co-morbidities and not emphasizing appropriate palliative services. Since many COPD patients suffer from concomitant vascular disease, heart failure, and chronic kidney disease [4–6], programs that focus solely on COPD management may be inadequate. Recurrent AECOPD admissions can also indicate end-stage lung disease where hospital readmissions may not be in the best interest of the patient. Previous research has shown that many end-stage patients have not received adequate counseling regarding the poor prognosis and lack of treatment options available for end-stage COPD [7].

In response to the ACA HRRP, Wake Forest Baptist Medical Center (WFBMC) initiated a comprehensive AECOPD care plan on May 12, 2014. The plan includes 1) transitions of care, 2) diagnosis and treatment of COPD and 3) its common co-morbidities as well as 4) hospice and palliative services. The current study evaluated the efficacy of this program using a retrospective design with the use of propensity scores to emulate aspects of a randomized trial comparison between AECOPD admissions where patients received the Care Plan vs AECOPD admissions receiving usual care.

2. Methods

2.1. Study design

This was a retrospective, observational analysis of all AECOPD index admissions occurring between May 12, 2014 through June 28, 2016, with inpatient/observation status and length of stay equal to or greater than one day among patients aged 40 years or older. These admissions were classified into two groups for comparison: the Experimental Group – AECOPD index admissions treated according to the AECOPD care plan, and the Control

Group – AECOPD index admissions receiving usual care. AECOPD admissions and covariate data were extracted from the Electronic Health Record (EHR) (Epic Systems - Verona, WI) data warehouse (Clarity) and matched to an AECOPD registry maintained at WFBMC to determine which classification of care the admission received. Epic System software was installed throughout the medical center in October of 2012. Mortality data were supplemented with data from the NC State Center for Health Statistics that tracks all deaths that occur within state. The protocol was reviewed and approved by the Wake Forest School of Medicine's Institutional Review Board.

2.2. Identification of AECOPD

The comprehensive care plan for AECOPD at WFBMC includes a daily, manual review of inpatient charts by specially trained respiratory therapist "navigators" (RTNs) to look for signs of possible AECOPD (details below). The retrospective nature of ICD coding and the limited personnel to attend to every single AECOPD admission leaves a number of AECOPD admissions unattended, creating circumstance under which we can retrospectively compare both conditions. For the purposes of this study, the identification of AECOPD admissions were determined solely by primary and secondary admission ICD codes corresponding to the Agency for Healthcare Research and Quality AECOPD ICD-9-CM code criteria [8] (Table 1). Given that only ICD-9-CM codes definitions were available during the study period, the study team mapped these to corresponding ICD-10-CM codes according to equivalence mappings created by the Centers for Medicare and Medicaid Services [9].

2.3. Inclusion criteria

- Age at admission ≥ 40 years
- Inpatient or Observation hospital admission lasting > 1 day
- Diagnoses code(s) meeting AHRQ criteria for AECOPD (see Table 1)

The description of our AECOPD care plan and usual care is provided in the online supplement.

2.4. Outcomes

Medicare's use of the 30-day readmission outcome to assign reimbursement penalties under the HRRP program has come under scrutiny. For example; Drs. Joynt and Jha [10] have pointed out that death constitutes a competing risk with readmission rates. In other words, patients who die have no chance for readmission. Hospitals with a high post-discharge mortality will have an artificially low readmission rate. Therefore, the authors chose a composite endpoint of 30-day readmission and mortality as a primary outcome. Additional study outcomes included 30 and 90-day all-cause readmission, ICD-code classified AECOPD readmission, and mortality. Readmission was defined as an inpatient or observational hospitalization occurring within 30 or 90 days of index discharge date. Markers of adherence to the pathway included percent of pathway patients seen in the outpatient clinic within 14 days of discharge and percent of patient enrolled in pulmonary rehabilitation within 90 days of discharge.

2.5. Covariates

Variables were captured with respect to occurrence in the EHR prior to the index discharge date. These included demographics such as age, gender, and race. Smoking status was categorized as past or current smoker vs nonsmoker. Measures of comorbid conditions included the Charlson Comorbidity Index (CCI) [11], glomerular filtration rate (GFR) [12], and body mass index (BMI). Socioeconomic status was estimated by merging geocoded patient address at time of index to block level median income, which is publicly available through the U.S. Census bureau's American Community Survey [13]. Measures of health care utilization included total number of admissions during the year prior to index and length of stay (days) of index admission. Lung function was assessed via most recent pulmonary function test occurring prior to discharge date and was categorized as follows: missing, obstructed, restricted, or normal. Independent variables used in conjunction with the aforementioned covariates in determining probability of treatment (propensity specification) are listed in Table 2 [14]. Restricted cubic splines with three knots were applied to continuous variables (age, CCI, BMI, GFR, previous admissions, and median income) to account for potential non-linear relationships [15].

2.6. Statistical analysis

Data cleaning and analysis was performed in R Studio version 3.3.0 [16]. The MICE package in R was used to impute missing data using chained equations to create 10 complete data set [17]. In the absence of an ability to randomize subjects into treatment and control groups, a propensity score can be estimated from existing data to assess treatment effects on an outcome of interest by distributing covariates evenly between treatment and control groups thus reducing confounding effects/systematic differences between the groups [18,19]. In this study, inverse probability of treatment weighting (IPTW) was used in conjunction with a logistic regression model as the method for incorporating the propensity of treatment assignment into the analysis. IPTW was re-calculated for each imputed dataset, logistic regression models were fit to each outcome, and the coefficients were pooled to derive the final odds ratios. The Variance Inflation Factor (VIF) was calculated for each independent variable to assess multicollinearity [20]. Adequate propensity model specification was assessed by standardized mean difference of covariates [21,22]. The authors chose to use IPTW as the method for applying propensity scores to the regression model but had concerns about inadequate confidence interval coverage of the true treatment effect due to possible clustering. Clustering was unavoidable due to repeat hospitalizations by the same patients. As noted by Hernan [23] and Washam [24], the simple inclusion of weights in a regression equation also increases within-subject correlation. Therefore, a robust variance estimator using the Huber-White method was incorporated in the model to help insure adequate Confidence Interval coverage of the true treatment effect [25]. This method is supported by a simulation study performed by Austin [26] which showed that IPTW with robust variance estimates outperformed other propensity score methods such as matching and covariate adjustments.

3. Results

A total of 1274 AECOPD index admissions were identified within the study period. All had at least one previously documented COPD ICD code in the medical record at any time preceding index although this was not a stipulation for inclusion, and 94.3% (74) had primary or secondary Medicare insurance coverage at time of admission. Among 1274 index admissions 18.2% (232) experienced readmission or mortality within 30-days of discharge. Specifically, 51 (4.0%) died, 195 (15.3%) were readmitted for any reason, and 76 (6.0%) were readmitted for AECOPD within 30 days.

3.1. Demographics of AECOPD care plan and usual care admissions

Cohort characteristics are summarized in Table 3. Univariate analysis indicates admissions enrolled in the AECOPD care plan were predominantly Caucasian and male compared to those receiving usual care. Care plan admissions had a lower median income and BMI, a greater prevalence of co-morbidities (CHF and diabetes), a larger number of previous admissions, and a longer length of stay (LOS). Physiologic confirmation of a COPD diagnosis with spirometry was uncommon in both groups. However, admissions enrolled in the AECOPD care plan were more likely to have spirometric confirmation of their COPD diagnosis than those undergoing the usual care; 43.7% in the care plan compared to 18.2% in the usual care and more likely to have spirometry documentation in general (Table 3). Patients enrolled in the AECOPD care plan were also more likely to have a smoking history. Finally for each class of COPD related inhalers, the care plan patients were more likely to have these medications listed on their discharge summary (Table 3).

3.2. Covariate balance between groups

Table 4 displays the standardized mean differences between the treatment and usual care groups for each covariate. Prior to the implementation of the propensity weighting, numerous covariates exceeded 10%, which has been used as a threshold under which imbalance may be considered negligible in the literature although there is currently no definitive standard [27–29]. After IPTW, all covariates were found to have an unadjusted standard difference below 10%, indicating good balance between groups and adequate specification of the propensity model. The VIF was less than 6 for all independent variables, which indicates that there is no evidence of substantial multicollinearity.

3.3. Post discharge follow-up and participation in COPD clinic and pulmonary rehabilitation in the care plan compared to usual care group

Admissions enrolled in the AECOPD care plan had a higher rate (43.9% versus 9.7%) of completing pulmonary clinic visits within 14 days of discharge than patients who received usual care (AOR 5.94, 95% CI 5.07–6.97). Similarly, 8.7% of intervention patients presented for pulmonary rehabilitation within 90 days of discharge versus 3% in the usual care group. Both groups had very low attendance (~2%) at pulmonary rehabilitation within 30 days. As shown in Table 5, the adjusted odds of pulmonary rehab clinic attendance among the care plan patients was higher at 90 days (OR 1.49, 95% CI 1.13–1.97) but not 30 days (OR 0.72, 95% CI 0.45–1.15).

Telephone follow up within 48 h of discharge is not conducted by the respiratory navigators in usual care, but was successfully completed in 449/597 (75%) of the care plan patients.

3.4. Efficacy of AECOPD care plan on 30-day all-cause readmission, 30-day-mortality, and 90-day COPD specific readmission risk

In the propensity weighted regression analysis, the admission group that received the AECOPD care plan had a 16% (OR 0.84, 95% CI 0.71–0.99) lower odds of 30-day all-cause readmission, a 37% (OR 0.63, 95% CI 0.44–0.88) lower odds of 30-day mortality, and 22% (OR 0.78, 95% CI 0.67–0.92) lower odds of 30-day mortality or readmission (Table 5). Additionally, the odds AECOPD-specific readmissions was 22% lower (OR 0.78, 95% CI 0.63–0.96) at 90 days, but not statistically significant for the 30 day time point.

4. Discussion

The results of this exploratory study provide optimism in the ability of a comprehensive AECOPD care plan at reducing adverse events. This is one of the first AECOPD care plans that was associated with a reduction in all-cause readmissions at 30 days. The authors acknowledge that only a randomized controlled trial can adequately account for unmeasured differences between treatment and control groups. However, the robust propensity methods utilized in this project should give more credibility to these results compared with a traditional, non-weighted, regression analysis.

The 16% reduction in all-cause readmission rates seems reasonable given that the overall rate of avoidable readmissions is estimated to be 23% [30]. The reduction is significantly less than the 37% observed in a Spanish randomized trial evaluating an integrated COPD care plan [31]. However, the study by Casas included tailored individual care plans, an educational program, and a sophisticated web-based call center.

There are a couple of reasons why the current plan may have appeared to perform better than previous COPD specific care plans. First, emphasis was placed on appropriate diagnostic testing. It is recommended that COPD be diagnosed by spirometry, performed when a patient’s health status is stable [32]. However, as many as 78% of patients hospitalized for AECOPD fail to have spirometry that confirms the diagnosis [33]. Bedside spirometry results, obtained after the patients were stabilized, were used to guide medical therapy and for diagnostic confirmation. We had shown earlier that bedside spirometry accurately predicts outpatient airflow obstruction [34].

In the absence of spirometry to confirm a diagnosis of COPD, ICD codes are often used as a substitute in studies evaluating the efficacy of AECOPD care plans. This study confirms the work of others [33,35–40] that ICD coding is an imperfect substitute for spirometric confirmation of airflow obstruction. Wu et al. [40] illustrate how often an ICD code for COPD is either unsupported or shown to be incorrect by spirometric testing. Only 56% of patients coded as AECOPD had spirometry results showing airway obstruction while 32% were indeterminate or missing upon discharge. Our current study, shows confirmation of obstruction in 30.1% of admissions with a larger proportion of missing values (65%). In addition, ICD codes are determined near or after hospital discharge making it especially

difficult to definitely determine whether an admission is for AECOPD at the point of inpatient care.

Second, we focused on the optimal management of comorbid conditions such as heart failure. Heart failure is particularly relevant for patients with COPD given that respiratory symptoms associated with both conditions may mimic one another while the specific treatments are markedly different. In a Canadian study, patients with COPD had 3.84 times (odds ratio CI: 3.56–4.14) greater prevalence of congestive heart failure compared to control patients, while the risk ratio for cardiovascular mortality was 2.07 (CI: 1.82–2.36) and all cause mortality was 2.82 (CI: 2.61–3.05) in COPD patients [41].

Third, we also emphasized palliative care discussions. End stage COPD is associated with frequent hospitalizations and increased dependence on mechanical ventilation, but an alarmingly small percentage of these patients have had frank discussions with their providers about prognosis and palliative care. Only 20% report receiving adequate information regarding prognosis and disease management from their physicians [7].

Fourth, the intervention group placed emphasis on outpatient follow-up arrangements in pulmonary clinics which, as previously reported in the results (Table 5), resulted in a much greater attendance to these visits. The delay and poor completion of outpatient pulmonary rehabilitation may help to explain the decrease in AECOPD specific readmissions at 90 days but not 30 days.

Shah had demonstrated in a large national study to delineate the Medicare population a third of COPD readmissions occur by day 7, 61% of readmissions occur by day 15, and the median time to readmission is 12 days [42]. Not attending follow-up visit with a pulmonologist has been associated with increased risk of rehospitalization within 90 days of discharge [43]. Therefore it is important that patients are seen in clinic for follow up within 14-days, and pulmonary rehabilitation within three months.

It is often not feasible to randomize patients when the aforementioned definitions are unattainable. The current study followed the widely accepted AHRQ definition for AECOPD. Another challenge to determining efficacy of a COPD hospital management program is the complex interaction between readmission and death. The HRRP program has been criticized for excluding deaths as an adverse outcome, which seemingly rewards mortality within 30 days. Since the risk of readmission and death are likely correlated the authors chose to examine a composite outcome of death +30day readmission instead of utilizing competing risk regression.

Shah and colleagues had published a review that highlights the discrepancies among the various definitions of AECOPD, and the effect of these discrepancies on outcomes in studies analyzing efficacy of AECOPD care programs [44]. This review outlines the challenges of identifying patients for a care plan while they are still hospitalized and explains why our RTNs were only able to identify 60% of hospitalized patients eventually coded as AECOPD. The RTNs also identified additional admissions that underwent the care plan, but were not ultimately coded as AECOPD and were thus excluded from analysis because no comparable control cases could be extracted from the EHR.

Our study has limitations. Our intervention was an integrative care plan, so we are unable to determine the magnitude of specific components on respective outcomes. A prospective randomized design would have required prehospitalization spirometry which is a rarity among patients or knowledge of ICD code admitted for AECOPD.

Furthermore, limiting enrollment to only those with prehospitalization spirometry would introduce its own bias based on differences in the population of patients with prehospital spirometry and those without, thus evaluating a skewed population. Although the use of ICD codes will likely over- and under-diagnose AECOPD, this choice has the additional benefit that ICD codes are used by CMS to apply reimbursement penalties for excess readmissions under the HRRP program.

Unlike a true randomized trial, the propensity weighting method used in this study can only adjust for differences between the treatment groups of which we have knowledge. The authors chose a large number of independent variables from a diverse group of data domains (e.g. demographics, severity of illness, comorbidities, health care utilization, test results, medications, socio-economic status, and social history) in order to decrease the likelihood that an important unmeasured variable would confound the results. A randomized trial could also be designed in a manner that would allow evaluation of the individual components of the care plan as patient specific characteristics that might impact outcomes. The authors do not feel that estimating the impact of the individual components of the care plan would be appropriate with the current study design. The results would likely be biased due to significant multicollinearity between the components. In addition, the propensity-based balancing of covariates was based on the probability of being enrolled in the care-plan at large.

The current study describes a care plan for AECOPD that significantly reduced the risk for the composite endpoint of all cause 30-day readmission and mortality. The component variables, all cause 30-day readmission and 30-day mortality were also reduced. Finally, the results also have a statistically significant reduction in AECOPD specific readmissions within 90 days. In addition to describing the benefits of multimodal treatment of AECOPD, this study also highlights the issues involved in accurately identification of acute exacerbations of COPD and their role in care plan assignment. In addition to future research investigating the impact of the care plan in a prospective fashion in other health systems, future research should focus on interventions aimed at improving the accuracy and completeness of structured documentation of AECOPD in EHR systems.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

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Table 1

AECOPD case definition derived from AHRQ ICD-9-CM codes.

ICD-CM-9	ICD-CM-10 CMS General Equivalence Mapping	ICD-CM-9 Code Description
A Principle Diagnosis of one of the following:		
491.21	J44.1	Obstructive chronic bronchitis with (acute) exacerbation
491.22	J44.0	Obstructive chronic bronchitis with acute bronchitis
491.8	J41.8	Other chronic bronchitis
492.8	J43.9	Unspecified chronic bronchitis
491.9	J42	Other emphysema
493.2		Chronic obstructive asthma, unspecified
493.21	J44.0	Chronic obstructive asthma with status asthmaticus
493.22	J44.1	Chronic obstructive asthma with (acute) exacerbation
496	J44.9	Chronic airway obstruction, not elsewhere classified
OR		
A Principle Diagnosis of one Respiratory Failure:		
518.81	J96.00, J96.90	Acute respiratory failure
518.82	J80	Other pulmonary insufficiency, not elsewhere classified
518.84	J96.20	Acute and chronic respiratory failure
799.1	R09.2	Respiratory arrest
AND		
A Secondary Diagnosis of Acute Exacerbation of COPD:		
491.21	J44.1	Chronic obstructive asthma with status asthmaticus
491.22	J44.0	Obstructive chronic bronchitis with acute bronchitis
493.21	J44.0	Chronic obstructive asthma with status asthmaticus
493.22	J44.1	Chronic obstructive asthma with (acute) exacerbation

*AHRQ ICD-10-CM codes were not available at the time of analysis and were therefore mapped ICD-10-CM codes through CMS general equivalence mapping.

Table 2

Variables used in propensity specification.

Variables used only in propensity specification in addition to all predictors of final outcomes. These variables relate to how respiratory therapists decide to enroll and admission in care plan and/or relate to the outcomes of interest. These are all binary variables and are coded as present or absent in the EHR.
Conditions listed as a reason for index admission in the EHR
COPD indicated as reason for admission or active on problem list, cough, sputum, abnormal breathing, pneumobacterial infection, pulmonary embolism, pneumonia unspecified, pneumothorax, interstitial exacerbation
Possible COPD-related medications active in the EHR during index admission
Anticholinergics, beta adrenergic and anticholinergic combinations, inhaled steroids
Comorbid conditions by ICD-CM-9 and ICD-CM-10 code in the EHR at any time prior index discharge
ischemic heart disease, congestive heart failure, diabetes, chronic kidney disease, diabetes, and malignancy

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Table 3

Demographics of AECOPD admissions receiving the usual care vs the care plan.

Admission Characteristics	Usual Care N = 677 (%)	Care Plan N = 597 (%)	*p*-value	Missing data n (% total N)
Age (median, IQR)	63 (55,72)	64 (56,71)	0.390	
Female	403 (59.5)	314 (52.6)	0.013	
Race			<0.001	
Black or African American or Other	128 (18.9)	179 (30)		
White or Caucasian	549 (81.1)	418 (70)		
Body Mass Index	29.5 (23.6,37.2)	27.3 (22.1,33.9)	0.413	3 (< 1%)
Smoking (previous or current)	572 (84.5)	553 (92.6)	**< 0.001**	
Length of stay – days	3 (2,4)	3 (2,5)	**< 0.001**	
Charlson Comorbidity Index	4 (2,6)	4 (2,6)	0.767	
Admissions in previous year	0 (0,1)	1 (0,2)	**< 0.001**	
Glomerular Filtration Rate	95.5 (88.4103.2)	97.6 (89.7105.3)	0.110	95 (7.5%)
Median Income	37545 (28496,48574)	36471 (27292,49384)	**< 0.001**	144 (11.3%)
Spirometry - Categorization of PFT			**< 0.001**	
Missing	511 (75.5)	323 (54.1)		
Normal	14 (2.1)	5 (0.8)		
Obstructed	123 (18.2)	261 (43.7)		
Restricted	29 (4.3)	8 (1.3)		
Comorbidities				
Ischemic heart disease	307 (45.3)	260 (43.6)	0.520	
Congestive heart failure	279 (41.2)	285 (47.7)	**0.019**	
Diabetes	261 (38.6)	191 (32)	**0.015**	
Chronic kidney disease	158 (23.3)	168 (28.1)	0.050	
Malignancy	158 (23.3)	152 (25.5)	0.378	
Discharge Inhalers				
Anticholinergics	482 (71.2)	543 (91)	< 0.001	
Long-acting beta-agonist	514 (75.9)	555 (93)	< 0.001	
Inhaled-steroids	562 (83)	560 (93.8)	< 0.001	
Short-acting beta-agonist	614 (90.7)	584 (97.8)	< 0.001	

Median (interquartile range) and Wilcoxon Rank-Sum test reported for continuous variables. Number (percentage) and Chi-squared test reported for categorical variables. GFR units in mL/min/1.73 m^2. BMI units in kg/m^2. Individual comorbidities described, but not included as covariates in model.

Table 4

Balance statistics in relation to observed treatment variable (care plan and usual care) before and after weighting by IPTW. Standard Difference with largest absolute value among the 10 imputed data sets is reported for all predictors. Balance was assessed with respect to a threshold of 10% (0.10).

Covariate	Variable Type	Unadjusted Standardized Difference	Adjusted Standardized Difference
Gender (female)	Categorical	0.069	0.012
Race (Black/African American or Other)	Categorical	0.111	0.001
Age	Continuous	0.007	0.015
Smoking (previous or current)	Categorical	0.081	0.006
Body Mass Index	Continuous	0.280	0.038
Charlson Comorbidity Index	Continuous	0.031	0.003
Glomerular Filtration Rate	Continuous	0.139	0.019
Income (log-transformed)	Continuous	0.122	0.028
Total admission in past year	Continuous	0.426	0.046
Length of Stay – days	Continuous	0.203	0.051
Lung Function (missing)	Categorical	0.214	0.007
Lung Function (normal)	Categorical	0.012	0.002
Lung Function (obstructed)	Categorical	0.256	0.005
Lung Function (restricted)	Categorical	0.029	0.009

Table 5

Outcomes for admissions exposed to the AECOPD care plan vs usual care.

Outcomes	Adjusted[a] Odds Ratio (95% CI)	p-value
30 day follow up period		
AECOPD readmission	0.97 (0.72–1.30)	0.8320
All-cause readmission	**0.84 (0.71–0.99)**	**0.0434**
Mortality	**0.63 (0.44–0.88)**	**0.0071**
Mortality + all-cause readmission	**0.78 (0.67–0.92)**	**0.0025**
90 day follow up period		
AECOPD readmission	**0.78 (0.63–0.96)**	**0.0200**
All-cause readmission	0.96 (0.85–1.09)	0.5607
Mortality	0.92 (0.71–1.19)	0.5181
Mortality + all-cause readmission	0.96 (0.85–1.09)	0.5546
Follow up care		
Pulmonary outpatient clinic within 14 days	**5.94 (5.07–6.97)**	**< 0.0001**
Pulmonary rehab clinic within 30 days	0.72 (0.45–1.15)	0.1653
Pulmonary rehab clinic within 90 days	**1.49 (1.13–1.97)**	**0.0045**

[a]Models adjusted for gender, race, age, smoking status (ever or never), log-transformed income), CCI, number admissions in prior year, BMI, GFR, length of stay and lung function and weighted with IPTW.