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Original Study

Hospital Care of Older Patients With COPD: Adherence to International Guidelines for Use of Inhaled Bronchodilators and Corticosteroids

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A B S T R A C T

Keywords:

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Objectives: We aimed to analyze the prevalence and impact of COPD in older patients hospitalized in internal medicine or geriatric wards, and to investigate adherence to the Global Initiative for Chronic Obstructive Lung Disease (GOLD) guidelines, associated clinical factors, and outcomes.

Design: Data were obtained from REgistro POLiterapie SIMI (REPOSI), a prospective multicenter observational registry that enrolls inpatients aged ≥ 65 years.

Setting and Participants: Older hospitalized patients enrolled from 2008 to 2016 with a diagnosis of COPD.

Measures: We evaluated adherence to the 2018 GOLD guidelines at admission and discharge, by examining the prescription of inhaled bronchodilators and corticosteroids in COPD patients. We also evaluated the occurrence of outcomes and its association with COPD and guideline adherence.

Results: At hospital admission, COPD was diagnosed in 1302 (21.5%) of 6046 registered patients. COPD patients were older, with more impaired clinical and functional status and multiple comorbidities. Overall, 34.3% of COPD patients at admission and 35.6% at discharge were adherent to the GOLD guidelines. Polypharmacy (≥ 5 drugs) at admission [odds ratio (OR): 3.28, 95% confidence interval (CI): 2.24–4.81], a history of acute COPD exacerbation (OR: 2.65, 95% CI: 1.44–4.88) at admission, smoking habit (OR: 1.45, 95% CI: 1.08–1.94), and polypharmacy at discharge (OR: 6.76, 95% CI: 4.15–11.0) were associated with adherence to guidelines. COPD was independently associated with the risk of cardiovascular and respiratory death and rehospitalization occurrence compared to patients without COPD during follow-up. Adherence to guidelines was inversely associated with the occurrence of death from all causes (OR: 0.12, 95% CI: 0.02–0.90).

Conclusions/Implications: COPD was common in older patients acutely hospitalized, showing an impaired functional and clinical status. Prescriptions for older COPD patients were often not adherent to GOLD guidelines. Poor adherence to guidelines was associated with a worse clinical status. There is a need to

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improve adherence to guidelines in treating COPD patients, with the ultimate goal of reducing clinical events.

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Chronic obstructive pulmonary disease (COPD) is one of the most prevalent health conditions in terms of prevalence, incidence, and mortality.¹ In 2010, global COPD prevalence was estimated at 11.7%, affecting 384 million people.¹ Prevalence increases with age, with projections estimated to further increase as a result of the progressive ageing of the global population.^{1,2} In older people, COPD is often accompanied by multiple comorbidities.³ Moreover, COPD is associated with an increased risk of death, with 3 million deaths being reported globally every year.¹

The Global Initiative for Chronic Obstructive Lung Disease (GOLD) guidelines provide recommendations for drug treatment based on inhaled agents, with the goal to reduce symptoms, frequency, and severity of exacerbations, and to improve exercise tolerance and overall health status.¹ However, GOLD guidelines are often not followed, with a high rate of poor adherence to recommendations^{4,5} even though adherence has been associated with a reduction of health care resources use.⁴

Aims for this study were as follows: (1) to report COPD prevalence in the frame of a registry of older multimorbid patients acutely hospitalized in internal medicine and geriatric wards in Italy; (2) to analyze the use of drugs specific for COPD (inhaled bronchodilators and corticosteroids) and evaluate physicians' adherence to GOLD guidelines recommendations about pharmacologic prescription and the associated clinical factors; (3) to investigate the association of COPD with major clinical outcomes throughout the posthospital follow-up observation period; and (4) to evaluate the association between adherence to guidelines' recommendations and major clinical outcomes. In order to achieve these aims, we performed an analysis of hospitalized patients with COPD in the REgistro POLiterapie SIMI (REPOSI) registry.

Methods

REPOSI, a multicenter collaborative observational registry jointly held by Italian Society of Internal Medicine (SIMI), IRCCS Ca' Granda Maggiore Policlinico Hospital Foundation, and Mario Negri Institute of Pharmacological Research IRCCS. It is based on the participation of a representative network of internal medicine and geriatric wards in Italy. Full details about register design and specific aims have been reported elsewhere.⁵ Briefly, REPOSI was held for 3 nonconsecutive years (2008, 2010, 2012) and then annually from 2014 onwards. In each of these years, in a period of 4 weeks on a quarterly basis (ie, February, June, September, and December), consecutive patients older than 65 years and acutely admitted to participating wards were included in the register. The study protocol was first approved by the Ethics Committee of Ca' Granda Maggiore Policlinico Hospital Foundation and then by the Institutional Review Board of each enrolling site. REPOSI was conducted according to Good Clinical Practice recommendations and the Declaration of Helsinki. Concomitant diagnoses made at hospital admission were coded according to the International Classification of Diseases–9th Edition (ICD-9) system. Medication use at admission and discharge was assessed according to the Anatomic Therapeutic Chemical (ATC) Classification System.

For this analysis, we enlisted all the 6046 patients enrolled from 2008 to 2016. In order to evaluate the overall prevalence of COPD, we considered all patients identified by ICD-9 codes 491.xx and 492.xx at the time of hospital admission. To further evaluate baseline clinical

characteristics, ICD-9 codes reported in the [Supplementary Materials](#) were used.

A low-income occupation was defined on the basis of patients' self-reported activity. Polypharmacy was defined by the contemporary chronic use of 5 or more drugs.⁵ Comorbidities were evaluated using the Cumulative Illness Rating Scale severity index and comorbidity index.^{6,7} Cognitive status was evaluated using the Short Blessed Test;⁸ the presence of depression was assessed using the Geriatric Depression Scale,⁹ and functional status with the Barthel index.¹⁰ The Cumulative Illness Rating Scale severity index, Short Blessed Test score, Geriatric Depression Scale score, and Barthel index were collected only from 2010 onwards, so they were available for only 4714 REPOSI patients (80%).

Pharmacologic Treatments and Adherence to GOLD Guidelines Recommendations

In order to assess the use of inhaled bronchodilators and corticosteroids (ICS), we used the following ATC codes: (1) long-acting β_2 -agonists (LABA): R03ACxx; (2) long-acting muscarinic antagonists (LAMA): R03BBxx; (3) ICS: R03BAxx; (4) LABA + ICS: R03AK06-R03AK12; and (5) LABA + LAMA: R03AL03-R03AL06. All other pharmacologic agents were defined according to the reference codes.

With reference to 2018 GOLD international guidelines,¹ adherence to recommendations was evaluated both at hospital admission and discharge. Adherence to GOLD guidelines was defined according to diagnosis and previous history of exacerbation as follows: (1) for patients with a diagnosis of COPD and no history of acute exacerbation in the 6 months prior to current admission or admission due to acute exacerbation, adherence to guidelines was defined as the use of at least 1 LABA or 1 LAMA; (2) for patients with a diagnosis of COPD and a history of acute exacerbation in the previous 6 months or admission due to acute exacerbation, adherence to guidelines was defined as the use of at least 1 LABA or 1 LAMA plus 1 ICS.

Follow-Up and Outcome Definition

Follow-up data were collected at 3 and/or 12 months after hospital discharge through telephone interview or, for patients no longer alive, from the next of kin. In the first year of REPOSI (2008) the follow-up observation was not planned, but a follow-up phase was planned from 2010 onward. Hence, the total number of patients who had at least 1 follow-up observation was 4714 (80%). For those who died, each investigator/attending physician collected information about death circumstances and evaluated the final cause of death. On the basis of such information, causes of death were classified as follows: death from all causes, cardiovascular (CV) death, and respiratory death. Besides the causes of death, data on rehospitalization were collected and considered among the outcomes. Finally, we also considered 2 composite outcomes: rehospitalization/respiratory death and rehospitalization/death from all causes.

Statistical Analysis

Continuous variables were reported as medians and interquartile ranges, and differences between groups were evaluated according to the Mann-Whitney *U* test. Categorical variables were reported as counts and percentages, and differences between groups were

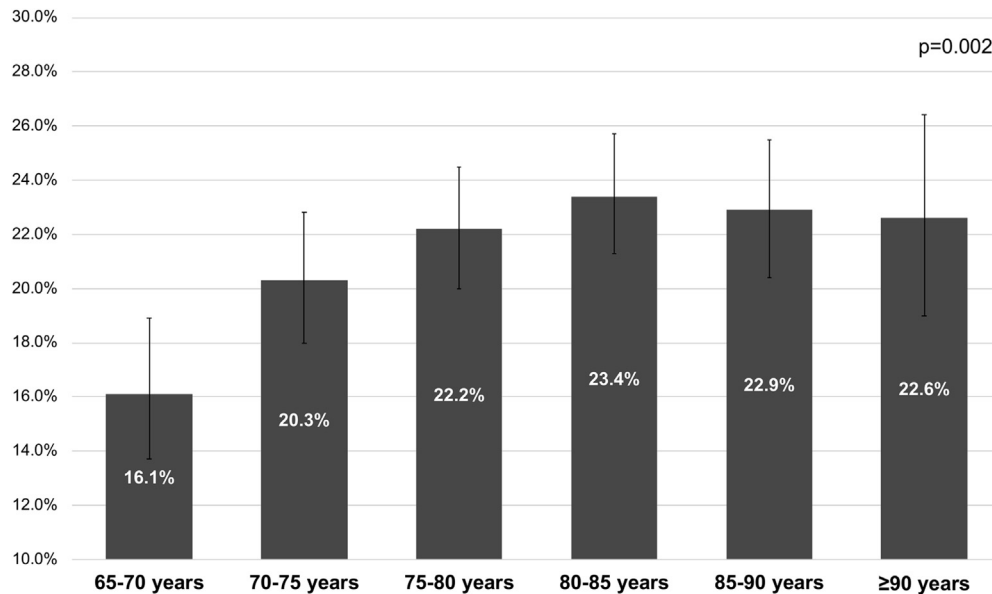


Fig. 1. COPD prevalence among hospital admissions aged 65 years and older, by age strata.

evaluated with a chi-square test. In order to identify factors associated with adherence to guidelines recommendations, a logistic regression analysis was performed. According to differences at baseline, covariates have been tested with univariate regression and, if associated with a $P < .10$, were included in the multivariate model.

A logistic regression analysis, to evaluate the association between adherence to guideline recommendations and clinical outcomes, was performed using both univariate and multivariate regression models. The multivariate model was adjusted for the following items: age, sex, Short Blessed Test score, Geriatric Depression Scale, Barthel index, low income, smoking habit, alcohol habit, hypertension, hypercholesterolemia, heart failure, coronary artery disease, peripheral artery disease, stroke/transient ischemic attack, atrial fibrillation, diabetes mellitus, chronic kidney disease, cancer, use of any LABA at discharge, use of any LAMA at discharge, and use of any ICS at discharge. A 2-sided P value $< .05$ was considered to be statistically significant. All analyses were performed using SPSS v. 25.0 (IBM Corp, Armonk, NY).

Results

From 2008 to 2016, a total of 6046 patients were enlisted in REPOSI, and 1302 (21.5%) had a diagnosis of COPD at admission. Of the patients with a diagnosis of COPD, 113 (8.7%) were admitted with COPD as the primary diagnosis, whereas 146 (11.2%) were admitted with a primary diagnosis of dyspnea. Prevalence of COPD progressively increased according to increasing age ($P = .002$) (Figure 1). Baseline characteristics according to COPD diagnosis are reported in Table 1. Compared to those without COPD, patients with COPD were older ($P < .001$) and more frequently men ($P < .001$). They were more depressed ($P = .003$) and with impaired cognitive function ($P = .001$). Moreover, they were less educated and more likely to have low-income work. According to the Barthel index, they had a more impaired functional status (median [interquartile range]: 88 [60-100] vs 95 [77-100] for COPD vs non-COPD, $P < .001$); also, they had more comorbidities and a more severe clinical status (both $P < .001$). Prevalence of smoking and alcohol habits were higher in COPD than in non-COPD patients (both $P < .001$). COPD patients reported more frequent polypharmacy (73.3% vs 55.6%, $P < .001$) and were more often treated with any of the non-COPD medications examined (Supplementary Table S1).

Pharmacologic Treatment and Therapeutic Appropriateness

The proportion of patients treated with inhaled bronchodilators (both LABA and LAMA) and ICS was low (Supplementary Table S2). At admission, 23.1% of them were treated with at least 1 LABA and 24.2% were treated with at least 1 LAMA. Regarding the association of

Table 1
Baseline Characteristics According to a Diagnosis of COPD at Admission

	Non-COPD (n = 4744)	COPD (n = 1302)	P
Age, y	79 [72-84]	80 [75-85]	<.001
Age classes			<.001
65-70 y	693 (14.6)	135 (10.4)	
70-80 y	1883 (39.7)	509 (39.1)	
≥80 y	2168 (45.7)	658 (50.5)	
Male sex	2129 (44.9)	794 (61.0)	<.001
BMI (n = 4202)	25.3 [22.8-28.4]	25.7 [22.6-28.9]	.066
GDS (n = 3931*)	1 [0-2]	1 [0-2]	.003
SBT (n = 4233*)	6 [2-13]	8 [2-14]	.001
Education, y (n = 5523)	5 [5-9]	5 [5-8]	.011
Low-income work (n = 5605)	3380 (77.0)	976 (80.3)	.016
Barthel index (n = 4611*)	95 [77-100]	88 [60-100]	<.001
CIRS IC (n = 4646*)	3 [2-4]	4 [2-5]	<.001
CIRS IS (n = 4646*)	1.61 [1.38-1.85]	1.77 [1.54-2.00]	<.001
Smoking habit (n = 4588)	1401 (39.3)	685 (67.0)	<.001
Alcohol habit (n = 4561)	1408 (39.7)	513 (50.6)	<.001
Polypharmacy (n = 5985)	2605 (55.6)	950 (73.3)	<.001
Hypertension	3412 (71.9)	974 (74.8)	.039
Hypercholesterolemia	343 (7.2)	82 (6.3)	.244
Heart failure	628 (13.2)	308 (23.7)	<.001
CAD	931 (19.6)	377 (29.0)	<.001
PAD	143 (3.0)	72 (5.5)	<.001
Stroke/TIA	456 (9.6)	149 (11.4)	.051
Atrial fibrillation	968 (20.4)	347 (26.7)	<.001
Diabetes mellitus	1283 (27.0)	382 (29.3)	.101
CKD	893 (18.8)	329 (25.3)	<.001
Cancer	680 (14.3)	153 (11.8)	.017

BMI, body mass index; CAD, coronary artery disease; CKD, chronic kidney disease; CIRS, Cumulative Index Rating Scale; GDS, Geriatric Depression Scale; IC, Index of Comorbidity; IQR, interquartile range; IS, Index of Severity; PAD, peripheral artery disease; SBT, Short Blessed Test; TIA, transient ischemic attack.
Values are median [IQR] or n (%).

*Collected from 2010 onwards in 4714 patients.

different agents, 21.5% of patients were treated with 1 LABA and 1 ICS. Similar figures were found at discharge (Supplementary Table S2).

Regarding adherence to guideline recommendations, 34.3% of patients were adherent to guidelines on admission, whereas 35.6% were adherent to guidelines at discharge. In evaluating the adherence to guideline recommendations across the various study years, we found no difference across the years both at admission ($P = .985$) and at discharge ($P = .853$). At admission, cases treated in adherence to guidelines were similar to those not adherent (Supplementary Table S3), except for being more frequently males ($P = .031$), smokers (72.3% vs 64.3%, $P = .01$), polypharmacy (85.2% vs 67.1%, $P < .001$), and with heart failure (27.4% vs 21.7%, $P = .023$). Furthermore, patients treated adherent to guidelines had more frequent acute exacerbations (6.7% vs 2.8%, $P = .001$), but no differences were found regarding hospital admissions for such exacerbations.

At discharge (Supplementary Table S4), patients treated adherent to guidelines were more frequently on polypharmacy ($P < .001$), had hypertension ($P = .001$), hypercholesterolemia ($P = .023$), heart failure ($P = .029$), and atrial fibrillation ($P = .049$), whereas no differences were found in terms of history of acute exacerbation or admission for acute exacerbation.

After univariate analysis (Supplementary Table S5), multivariate analysis found that polypharmacy [odds ratio (OR): 3.28, 95% confidence interval (CI): 2.24–4.81] and history of acute exacerbation (OR: 2.65, 95% CI: 1.44–4.88) were associated with treatment adherent to guidelines at admission. At discharge, smoking habit (OR: 1.45, 95% CI: 1.08–1.94) and polypharmacy (OR: 6.76, 95% CI: 4.15–11.0) were associated with treatment adherent to guidelines.

Outcomes and Regression Analyses

Follow-up data were available for 3324 patients (70.5%) of the 4714 who underwent follow-up evaluation. Examining outcome rates according to COPD diagnosis (Supplementary Figure S1), patients had a higher rate of CV deaths ($P = .023$), respiratory deaths (14.1% vs 10.3% in non-COPD, $P < .001$), and rehospitalization (19.0% vs 10.3%, $P = .003$). The rate of death from all causes was marginally higher in COPD patients ($P = .089$). Furthermore, the rate of the 2 composite outcomes was higher in these patients (Supplementary Figure S1).

During follow-up, logistic regression analysis (Table 2) showed that in comparison with non-COPD patients, COPD was associated with CV death (OR: 1.66, 95% CI: 1.04–2.67), respiratory death (OR: 2.14, 95% CI: 1.00–4.59), rehospitalization (OR: 1.50, 95% CI: 1.08–2.09), rehospitalization/respiratory death (OR: 1.60, 95% CI: 1.17–2.18), and rehospitalization/death from all causes (OR: 1.51, 95% CI: 1.17–1.95). Regarding death from all cause alone, a trend for an association was found (OR: 1.33, 95% CI: 0.98–1.81).

Evaluating the association between treatment adherent to guideline recommendations and outcomes in COPD patients (Table 3), we found that even if at univariate association, adherence to guidelines was inversely associated with death from all causes, CV death, and rehospitalization/death from all causes; after multivariate adjustments, it was strongly inversely associated only with the occurrence of death from all causes (OR: 0.12, 95% CI: 0.02–0.90).

Discussion

In this study, we demonstrated a very high prevalence of COPD among older patients acutely hospitalized in internal medicine and geriatric wards. Furthermore, a large majority of the patients were not adherent to current GOLD guideline recommendations. Examining drug prescriptions, we found that clinical factors usually associated (in the general population as well as in COPD patients) with a worse clinical status (such as polypharmacy, a history of acute exacerbation, and smoking habit) were directly associated with adherence to

Table 2

Logistic Regression Analysis for the Association of Diagnosis of COPD at Admission on Study Outcomes

	Univariate		Multivariate*	
	OR (95% CI)	P	OR (95% CI)	P
Death from all causes	1.19 (0.97–1.44)	.089	1.33 (0.98–1.81)	.071
CV death	1.42 (1.05–1.91)	.023	1.66 (1.04–2.67)	.034
Respiratory death	2.39 (1.57–3.66)	<.001	2.14 (1.00–4.59)	.051
Rehospitalization	1.44 (1.13–1.83)	.004	1.50 (1.08–2.09)	.016
Rehospitalization/ respiratory death	1.65 (1.33–2.06)	<.001	1.60 (1.17–2.18)	.003
Rehospitalization/ any death	1.35 (1.14–1.61)	.001	1.51 (1.17–1.95)	.001

*Adjusted for age, sex, Short Blessed Test score, Geriatric Depression Scale score, Barthel Index, low income, smoking habit, alcohol habit, hypertension, hypercholesterolemia, heart failure, coronary artery disease, peripheral artery disease, stroke/transient ischemic attack, atrial fibrillation, diabetes mellitus, chronic kidney disease, cancer, use of any LABA at discharge, use of any LAMA at discharge, use of any ICS at discharge.

guidelines. We also demonstrated that COPD was associated with an increased risk of major clinical events. Furthermore, adherence to guideline recommendations was inversely associated with the occurrence of death from all causes.

It is well established that COPD prevalence increases significantly with age.² A previous systematic review and meta-analysis of 37 studies showed that pooled prevalence (95% CI) of COPD in patients ≥ 65 years was 14.2% (11.0%–18.0%).² Another more recent systematic review and meta-regression did show that increasing age is a strong predictor of COPD prevalence. A previous Italian survey performed in Internal Medicine wards found an overall prevalence of COPD of 18.1% in the context of a study cohort, including mainly older patients.¹¹ Our study demonstrates a higher prevalence than prior studies, which is consistent with the increasing estimates of COPD global prevalence.¹

A recent review found considerable variability among physicians' adherence to guideline recommendations, showing that the proportion of patients adequately prescribed ranged from 30% to 60%.¹² Data from a US cohort showed that appropriateness ranged from 30% to 45%.⁴ A previous Italian study, held in the context of specialized lung clinics, found that only 37.9% of COPD patients were treated according to GOLD recommendations even though they were managed by specialized physicians.¹³ This notwithstanding, other reports suggest that being treated by a specialist rather than by general practitioners is associated with a higher proportion of appropriate prescription.¹⁴ Furthermore, in the COPD context, patients' adherence to physicians' prescription was found to be consistently low across several

Table 3

Logistic Regression Analysis for Adherence to GOLD Guidelines (vs No Adherence) to Study Outcomes

	Univariate		Multivariate*	
	OR (95% CI)	P	OR (95% CI)	P
Death from all causes	0.37 (0.25–0.57)	<.001	0.12 (0.02–0.90)	.040
CV death	0.25 (0.11–0.52)	<.001	—	—
Respiratory death	0.90 (0.44–1.82)	.772	—	—
Rehospitalization	1.10 (0.71–1.69)	.662	—	—
Rehospitalization/ respiratory death	1.06 (0.72–1.56)	.768	—	—
Rehospitalization/ any death	0.53 (0.38–0.74)	<.001	—	—

*Adjusted for age, sex, Short Blessed Test score, Geriatric Depression Scale score, Barthel Index, low income, smoking habit, alcohol habit, hypertension, hypercholesterolemia, heart failure, coronary artery disease, peripheral artery disease, stroke/transient ischemic attack, atrial fibrillation, diabetes mellitus, chronic kidney disease, cancer, use of any LABA at discharge, use of any LAMA at discharge, use of any ICS at discharge.

cohorts.^{15–17} This low compliance to physician's prescription in older patients could also be related to difficulties in properly using the inhalers due to physical limitations (ie, hands affected with osteoarthritis, tremor, or general weakness).^{18–20}

Our data, obtained in a cohort of multimorbid older people managed by internists and geriatricians, indicate that adherence to GOLD guidelines was rather poor.¹ Patients more likely to be adherent to guideline recommendations were those with a worse clinical condition, with more acute exacerbations and comorbidities. The importance of improving guidelines' knowledge and their implementation is strongly supported by our finding that adherence to guideline recommendations was associated with a lower risk of all-cause death. The high impact of COPD on major clinical outcomes (rehospitalization and mortality) has been already firmly established.¹ Our data are consistent with this finding in the context of older patients characterized by a significant burden of comorbidities, frequent polypharmacy, a poor clinical status, and reduced functional capacity.

On the basis of our data and currently available evidence, we believe that interventional educational programs are needed and likely to have a positive role in improving physicians' adherence to guideline recommendations.²¹ Furthermore, specific education interventions can also improve patient adherence to physicians' prescription.¹⁶

This study has limitations. First, being based on ICD-9 codes, we cannot exclude some bias related to coding mistakes and inaccurate diagnosis. Second, not being specifically designed and powered to detect differences in the subgroups considered, some data should be considered critically, particularly those stemming from small numbers. Third, lack of data about the assessment of severity of airflow limitation and specific COPD-related symptoms did not allow us to fully characterize the clinical profile of this study sample and thus provide a more accurate analysis on prescription appropriateness. In this respect, in the absence of symptoms assessment, we were unable to evaluate the GOLD clinical classification. Notwithstanding, even though we referred to the 2018 version to evaluate adherence to guideline recommendations even in earlier years, use of LABA and LAMA, as well as ICS in patients with history of exacerbations, was already recommended since the 2007 version for treatment of patients with COPD²²; hence, the definition we used allowed us to evaluate the prescription of the pharmacologic agents considered as the mainstay to treat this condition. Fourth, the analysis of the relationship between adherence to guidelines and occurrence of outcomes is based on a small sample of patients and needs to be considered as "hypotheses generating." Finally, being based on a cohort of acutely hospitalized and multimorbid older patients, the extension of these results to general COPD patients should be cautious.

Conclusions and Relevance

COPD is highly prevalent among older patients acutely hospitalized in internal medicine and geriatric wards and characterized by a poor clinical and impaired functional status. Older COPD hospitalized patients, particularly frailer patients, are often treated with a low level of adherence to GOLD guideline recommendations with a higher number of acute exacerbations and taking multiple medications. COPD is associated with an increased risk of major clinical events, whereas adherence to guidelines is associated with a reduced risk of death from all causes. Educational interventions are warranted to increase adherence to guidelines with the goal of improving patients' quality of life and reducing the impact of major clinical events.

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Supplementary Materials

ICD-9 CODES

Hypertension: 40*
 Hypercholesterolemia 272.0
 Heart failure: 428*
 Coronary artery disease: 411.1, 413*, 414.8, 414.9
 Peripheral artery disease 440.2*, 440.4*, 443.9*
 Stroke/TIA: 431*, 432*, 434.1*, 433.1*, 435*
 Atrial fibrillation: 427.31
 Diabetes: 250*
 Chronic kidney disease: 585*
 Cancer: 14*, 15*, 16*, 17*, 18*, 19*, 20*

Appendix

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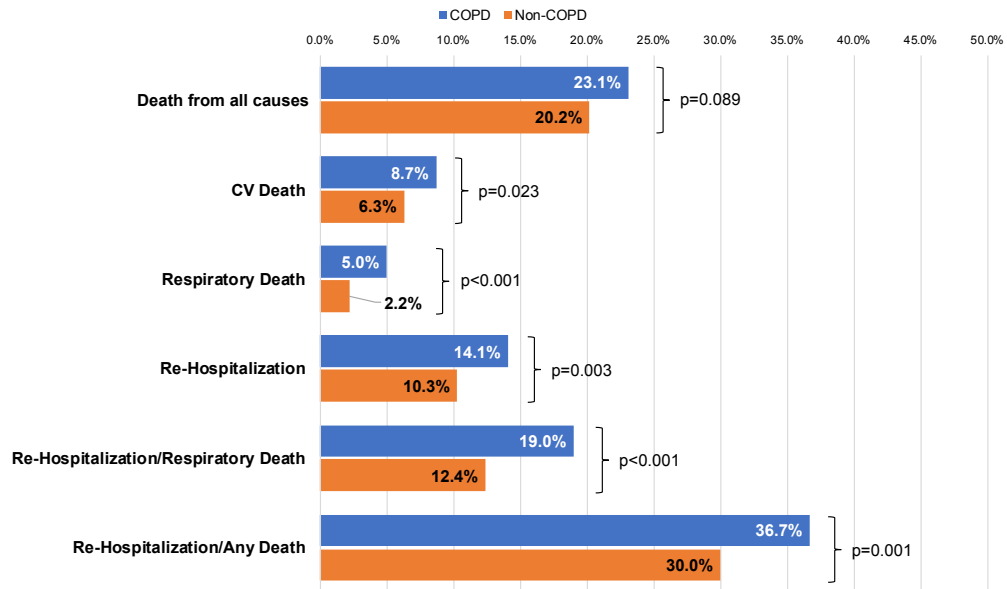
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Supplementary Figure S1. Distribution of outcomes according to the diagnosis of COPD at admission.

Supplementary Table S1

Distribution of Other Medications at Admission According to the Diagnosis or Not of COPD

	Non-COPD, n (%) (n = 4744)	COPD, n (%) (n = 1302)	<i>P</i>
PPI	2127 (44.8)	708 (54.4)	<.001
Antiplatelet drugs	1873 (39.5)	610 (46.9)	<.001
Calcium-channel blockers	973 (20.5)	278 (21.4)	.507
Diuretics	1856 (39.1)	738 (56.7)	<.001
Digoxin	264 (5.6)	135 (10.4)	<.001
ACE inhibitors	1417 (29.9)	392 (30.1)	.868
ARBs	1044 (22.0)	264 (20.3)	.179
Statins	1097 (23.1)	304 (23.3)	.865
Nonselective beta-blockers	475 (10.0)	93 (7.1)	.002
Selective beta-blockers	1079 (22.7)	244 (18.7)	.002
Any OAC	604 (12.7)	198 (15.2)	.020

ACE, angiotensin-converting enzyme; ARB, angiotensin receptor blockers; OAC, oral anticoagulant; PPI, proton-pump inhibitor.

Supplementary Table S2

Distribution of COPD Pharmacologic Treatments at Hospital Admission and Discharge

	Admission, n (%)	Discharge, n (%)
Any LABA	301 (23.1)	298 (22.9)
Any LAMA	315 (24.2)	358 (27.5)
LABA + ICS	280 (21.5)	270 (20.7)
LABA + LAMA	154 (11.8)	174 (13.4)
LABA + LAMA + ICS	144 (11.1)	161 (12.4)

Supplementary Table S3

Baseline Characteristics According to Adherence to GOLD Guidelines at Admission

	Nonappropriate (n = 856)	Appropriate (n = 446)	P
Age, y	80 [74-85]	80 [75-84]	.940
Age classes			.134
65-70 y	95 (11.1)	40 (9.0)	
70-80 y	319 (37.3)	190 (42.6)	
≥80 y	442 (51.6)	216 (48.4)	
Male sex	504 (58.9)	290 (65.0)	.031
BMI (n = 946)	25.7 [22.7-29.2]	25.8 [23.0-29.0]	.692
GDS (n = 878*)	1 [0-2]	2 [1-2]	.131
SBT (n = 926*)	9 [4-16]	8 [2-14]	.154
Education, y (n = 1190)	5 [5-8]	5 [5-8]	.724
Barthel Index (n = 1024*)	84 [51-98]	86 [56-98]	.242
CIRS IS (n = 1031*)	1.77 [1.54-2.00]	1.77 [1.61-2.00]	.333
CIRS IC (n = 1031*)	4 [2-5]	4 [2-5]	.507
Low-income work (n = 1216)	639 (79.7)	337 (81.4)	.474
Smoking habit (n = 1023)	437 (64.3)	248 (72.3)	.010
Alcohol habit (n = 1014)	338 (50.2)	175 (51.3)	.741
Polypharmacy (n = 1296)	570 (67.1)	380 (85.2)	<.001
Hypertension	644 (75.2)	330 (74.0)	.624
Hypercholesterolemia	54 (6.3)	28 (6.3)	.983
Heart failure	186 (21.7)	122 (27.4)	.023
CAD	255 (29.8)	122 (27.4)	.358
PAD	44 (5.1)	28 (6.3)	.394
Stroke/TIA	107 (12.5)	42 (9.4)	.097
Atrial fibrillation	226 (26.4)	121 (27.1)	.778
Diabetes mellitus	261 (30.5)	121 (27.1)	.206
CKD	217 (25.4)	112 (25.1)	.925
Cancer	103 (12.0)	50 (11.2)	.662
History of acute exacerbation	24 (2.8)	30 (6.7)	.001
Admission for acute exacerbation	65 (7.6)	36 (8.1)	.759

BMI, body mass index; CAD, coronary artery disease; CKD, chronic kidney disease; CIRS, Cumulative Index Rating Scale; GDS, Geriatric Depression Scale; IC, Index of Comorbidity; IQR, interquartile range; IS, Index of Severity; PAD, peripheral artery disease; SBT, Short Blessed Test; TIA, transient ischemic attack.

Values are median [IQR] or n (%).

*Collected from 2010 onwards in 1042 patients.

Supplementary Table S4

Baseline Characteristics According to Adherence to GOLD Guidelines at Discharge

	Nonappropriate (n = 838)	Appropriate (n = 464)	P
Age, y	80 [75-85]	80 [75-85]	.838
Age classes			.496
65-70 y	93 (11.1)	42 (9.1)	
70-80 y	323 (38.5)	186 (40.1)	
≥80 y	422 (50.4)	236 (50.9)	
Male sex	509 (60.7)	285 (61.4)	.809
BMI (n = 946)	25.6 [22.8-29.3]	26.1 [22.8-28.9]	.333
GDS (n = 878*)	1 [0-2]	1 [1-2]	.115
SBT (n = 926*)	8 [2-16]	8 [4-14]	.776
Education, y (n = 1190)	5 [5-8]	5 [5-8]	.930
Barthel Index (n = 735*)	83 [51-99]	85 [62-95]	.641
CIRS IS (n = 888*)	1.77 [1.61-2.00]	1.77 [1.54-2.08]	.820
CIRS IC (n = 888*)	4 [2-5]	4 [2-5]	.844
Low-income work (n = 1216)	617 (79.3)	359 (82.0)	.264
Smoking habit (n = 1023)	430 (65.1)	255 (70.4)	.080
Alcohol habit (n = 1014)	335 (51.1)	178 (49.7)	.682
Polypharmacy (n = 1231)	545 (71.1)	431 (92.9)	<.001
Hypertension	516 (63.4)	338 (72.8)	.001
Hypercholesterolemia	38 (4.7)	36 (7.8)	.023
Heart failure	195 (24.0)	137 (29.5)	.029
CAD	210 (25.8)	120 (25.9)	.980
PAD	34 (4.2)	26 (5.6)	.246
Stroke/TIA	91 (11.2)	53 (11.4)	.895
Atrial fibrillation	196 (24.1)	135 (29.1)	.049
Diabetes mellitus	214 (26.3)	130 (28.0)	.503
CKD	197 (24.2)	119 (25.6)	.565
Cancer	107 (13.1)	74 (15.9)	.167
History of acute exacerbation	30 (3.6)	24 (5.2)	.168
Admission for acute exacerbation	58 (6.9)	43 (9.3)	.130

BMI, body mass index; CAD, coronary artery disease; CKD, chronic kidney disease; CIRS, Cumulative Index Rating Scale; GDS, Geriatric Depression Scale; IC, Index of Comorbidity; IQR, interquartile range; IS, Index of Severity; PAD, peripheral artery disease; SBT, Short Blessed Test; TIA, transient ischemic attack.

Values are median [IQR] or n (%).

*Collected from 2010 onwards in 1042 patients.

Supplementary Table S5

Univariate Logistic Regression Analysis of Treatment According to Adherence to GOLD Guidelines at Admission and at Discharge

	OR (95% CI)	P
Admission		
Male sex	1.30 (1.02-1.65)	.031
GDS	1.07 (0.96-1.20)	.213
SBT	0.98 (0.97-1.00)	.061
Smoking habit	1.45 (1.09-1.93)	.010
Polypharmacy	2.83 (2.10-3.81)	<.001
Heart failure	1.36 (1.04-1.77)	.024
Stroke/TIA	0.73 (0.50-1.06)	.098
History of acute exacerbation	2.50 (1.44-4.33)	.001
Discharge		
GDS	1.08 (0.97-1.21)	.156
Smoking habit	1.28 (0.97-1.69)	.080
Polypharmacy	5.32 (3.61-7.93)	<.001
Hypertension	1.55 (1.21-1.99)	.001
Hypercholesterolemia	1.72 (1.07-2.75)	.024
Heart failure	1.33 (1.03-1.72)	.029
Atrial fibrillation	1.29 (1.00-1.67)	.049
Cancer	1.25 (0.91-1.73)	.168
History of acute exacerbation	1.47 (0.85-2.54)	.170
Admission for acute exacerbation	1.37 (0.91-2.07)	.131

GDS, Geriatric Depression Scale; SBT, Short Blessed Test; TIA, transient ischemic attack.