HHS Public Access

Author manuscript

CHEST Pulm. Author manuscript; available in PMC 2024 April 19.

Published in final edited form as:

CHEST Pulm. 2024 March ; 2(1): . doi:10.1016/j.chpulm.2023.100017.

Guideline Alignment and Medication Concordance in COPD

Meredith A. Case, MD, MHS,
Eric P. Boorman, PhD,
Elizabeth Ruvalcaba, MSPH,
Michael T. Vest, DO,
Nadia N. Hansel, MD, MPH,
Nirupama Putcha, MD, MHS,
Michelle N. Eakin, PhD

Division of Pulmonary and Critical Care Medicine (M. A. C., e. P. B., E. R., N. N. H., N. P., and M. N. E.), Johns Hopkins University School of Medicine, Baltimore, MD; and the Division of Pulmonary and Critical Care Medicine (M. T. V.), Christiana Care Health System, Wilmington, DE.

Abstract

BACKGROUND: Provider adherence to clinical treatment guidelines in COPD is low. However, for patients to receive guideline-aligned care, providers not only must prescribe guideline-aligned care, but also must communicate that regimen successfully to patients to ensure medication concordance. The rate of medication concordance between patients and providers and its impact on clinical management is unknown in COPD.

RESEARCH QUESTION: To examine rates of guideline alignment and medication concordance and to identify patient-level factors that place patients at risk for these types of poor disease management outcomes.

STUDY DESIGN AND METHODS: This study was a secondary data analysis of the Medication Adherence Research in COPD study (2017–2023). Participants were categorized into 2017 Global Initiative for Chronic Obstructive Lung Disease (GOLD) stage. Medication regimens were classified as aligned or nonaligned with 2017 GOLD guidelines. Nonaligned regimens were stratified further into overuse and underuse categories. Medication concordance between provider-reported and participant-reported regimens was determined. Factors associated with guideline alignment and medication concordance were evaluated using logistic regression.

CORRESPONDENCE TO: Michelle N. Eakin; meakin1@jhmi.edu.

Authors contributions: M. A. C. designed the data analysis plan, conducted data analysis, and wrote the original draft of the manuscript. E. P. B. contributed to data cleaning and data analysis and manuscript revision. E. R. made substantial contributions to study implementation and data acquisition and cleaning and revising the manuscript. M. T. V. contributed to data acquisition and made substantial contributions to interpretation of the data and revising the manuscript critically for important intellectual content. N. N. H. and N. P. made substantial contributions to interpretation of the data and revising the manuscript critically for important intellectual content. M. N. E. led trial design and implementation, development of data analysis plan, interpretation of data, and editing and revising the manuscript. All authors had full access to the full data in the study and accept responsibility to submit for publication. The corresponding author had final responsibility for the decision to submit the manuscript for publication.

Role of sponsors: The sponsor had no role in the design of the study, the collection and analysis of the data, or the preparation of the manuscript.

Additional information: The e-Figures and e-Table are available online under “Supplemental Data.”

RESULTS: Of 191 participants, 51% of provider-reported regimens were guideline aligned, with 86% of nonaligned regimens reflecting overuse with an inhaled corticosteroid (ICS). Thirty-eight percent of participants reported different regimens than their providers, of which > 80% reflected participants not reporting medications their providers reported prescribing. Participants did not report long-acting muscarinic antagonists and long-acting beta-agonists at similar rates as ICSs. Greater symptom burden and absence of a pulmonologist on the care team were associated with both guideline misalignment and medication discordance. Cognitive impairment and Black race additionally were associated with medication discordance.

INTERPRETATION: Guideline misalignment and medication discordance were common and were driven by overuse of ICSs and unreported medications, respectively. The patient-level factors associated with medication discordance highlight the importance of improving patient-provider communication to improve clinical management in COPD.

Keywords

COPD; GOLD guidelines; guideline adherence; medication concordance; medication agreement; medication understanding

Despite widespread acceptance of clinical treatment guidelines for COPD, provider adherence to these guidelines remains low.[1] The most commonly cited treatment guidelines are published by the Global Initiative for Chronic Obstructive Lung Disease (GOLD), a project established in 1997 to create evidence-based guidelines for the prevention, diagnosis, and management of COPD. These guidelines offer specific recommendations for the selection of pharmacologic therapy in COPD based on categories of disease severity.[2] Although providers report awareness of these guidelines and general agreement with their recommendations,[3] prior studies have described rates of alignment between prescribing patterns and treatment guidelines of approximately 50%.[1,4–6]

Patients not receiving guideline-aligned care may be at increased risk of poor health outcomes and may be exposed to unnecessary harm. Undertreatment, which for patients with disease severity worse than GOLD stage A involves absence of a long-acting muscarinic antagonist (LAMA), long-acting beta-agonist (LABA), or both, has been associated with worse symptom control[7] and, for patients with a history of exacerbations, carries an additional risk of future exacerbations.[8,9] Overtreatment, which usually involves prescription of an inhaled corticosteroid (ICS) for patients with GOLD stage B disease, has been associated with an increased risk of pneumonia as well as poor glucose control and risk of fractures.[10–13] In addition, overtreatment may complicate patients' medication regimens unnecessarily and may worsen issues of medication adherence, which for patients with COPD has been shown to be poor.[9]

Therefore, improving alignment with guidelines has important implications for improving health outcomes.

For patients to receive guideline-aligned care, providers not only must prescribe guideline-aligned treatment, but also must communicate with patients in a way that ensures medication concordance, or agreement between patients and providers about the medication

regimen. Although little is known about rates of patient-provider medication concordance in COPD, medication concordance in other chronic diseases has been shown to be poor.[14–16] Moreover, patients with COPD face barriers to medication concordance beyond their peers because of disproportionately high rates of cognitive impairment, depression and anxiety, and comorbid disease.[17–19] In addition, patients with COPD have been shown to have unique health beliefs about medications that may impair their ability to engage with their treatment plan.[20] Understanding rates of medication concordance in COPD and the association of patient-level factors with medication concordance may help to identify patients who need additional support to understand the medication regimen.

This study used an existing cohort of patients with COPD to examine rates at which providers prescribe GOLD guideline-aligned treatment, rates of patient-provider medication concordance, and the interplay between guideline alignment and medication concordance. We further examined how patient-level factors are associated with both guideline alignment and medication concordance to identify patients at higher risk of these types of poor disease management.

Study Design and Methods

Study Cohort

Medication Adherence Research in COPD Patients (MARC) was a multicenter cohort study conducted between Johns Hopkins Medicine (Baltimore, Maryland) and ChristianaCare (Wilmington, Delaware) from 2017 through 2023 of participants aged ≥ 40 years who received a physician diagnosis of COPD and who were prescribed a long-term daily medication for COPD. Participants were recruited from among former clinical research participants and patient volunteers. All participants provided written informed consent. Institutional review boards at Johns Hopkins Medicine (Identifier: IRB00091482) and ChristianaCare (Identifier: IRB00000479) approved the protocol. The analytical cohort for this study is limited to MARC participants with GOLD stage B, C, or D disease according to 2017 GOLD categorization to ensure that all participants had an indication for a long-term daily medication.

Procedures

At the baseline visit, participants completed self-report surveys on demographics, clinical characteristics, recent exacerbations, prescribed medication regimens, and prescribing provider (s). Exacerbations were defined as any respiratory flare-up requiring the use of antibiotics, systemic corticosteroids, or both or health care use in the prior 12 months. Evaluation included spirometry using pulmonary function testing machines in accordance with American Thoracic Society and European Respiratory Society technical standards.[21] Measurements collected included the modified Medical Research Council dyspnea scale score,[22] COPD Assessment Test (CAT),[23] Montreal Cognitive Assessment-Blind,[24] and Beliefs About Medicines Questionnaire, which measures strength of beliefs in the necessity of medications and concerns about their use.[25] Because of limitations during the COVID-19 pandemic, participants enrolled from 2020 onward completed spirometry assessment remotely using a lung function monitor. Participants were coached through a minimum

of three efforts by research coordinators who had completed the National Institute for Occupational Safety and Health training in spirometry.

Prescribing providers were contacted to provide the patient's medication regimen. Both patient-reported and provider-reported regimens were categorized into therapeutic classes of LAMA, LABA, and ICS. Alignment of both regimens with 2017 GOLD recommendations was determined, and nonaligned regimens were stratified into underuse and overuse categories (Table 1). Medication concordance was defined as agreement in all therapeutic classes reported by patients and providers.

Statistical Analysis

Descriptive statistics were generated to characterize participant sample. Differences in guideline alignment and medication concordance status by GOLD group were assessed via χ^2 tests using the Fisher exact test to account for low frequency counts. Medication concordance by therapeutic class was determined using a kappa statistic.

The association of patient-level factors at baseline with guideline alignment and medication concordance at baseline was evaluated using logistic regression. Logistic regression models controlling for (1) age, (2) sex, and (3) race were fit for the following additional variables: (4) insurance status, (5) educational attainment, (6) smoking status, (7) CAT score, (8) modified Medical Research Council dyspnea scale score, (9) exacerbation history, (10) comorbidity count,[26] (11) Montreal Cognitive Assessment-Blind score, (12) GOLD stage, and (13) presence of a pulmonologist on the care team. Models for guideline alignment additionally were fit for (14) self-reported history of asthma to control for comorbid asthma in the prescription of inhaled corticosteroids. Models for medication concordance additionally were fit for (15) Beliefs About Medicines Questionnaire scores. Results of the univariable and multivariable logistic regressions are presented as OR and adjusted ORs (aORs), respectively, with corresponding 95% CIs and *P* values. Statistical significance was defined as $P < .05$. Analyses were performed using Stata version 17.1 software (StataCorp).

Results

Participant Characteristics

As shown in e-Figure 1, 191 participants with complete data on provider-reported regimens and GOLD stage B, C, and D disease were included in this analysis, of whom 188 patients also had complete data on patient-reported regimens. Of these 191 participants, the average age was 68.4 years, 44% were male, 71% were White, and 29% were currently smoked with a median of 39 pack-years of smoking (Table 2). At baseline, 58.6% of participants (n = 112) were classified with GOLD stage B disease, 2.1% of participants (n = 4) were classified with GOLD stage C disease, and 39.3% of participants (n = 75) were classified with GOLD stage D disease. Self-reported history of asthma ranged from 36% in the GOLD stage B group to 50% in the GOLD stage C group.

Provider-Reported Medication Regimens

Complete data on provider-reported medication regimens is presented in e-Table 1. The most prevalent regimen was triple therapy with ICSs, LABAs, and LAMAs (44% [n = 84]), followed by ICSs and LABAs (27% [n = 51]) and LABAs and LAMAs (14% [n = 27]). These distributions were relatively consistent across GOLD stage groups, with the exception of the GOLD stage C group, which was an outlier given the overall low number of participants (n = 4).

Alignment With 2017 GOLD Guidelines

Overall, 51.3% of provider-reported regimens were in alignment with 2017 GOLD guidelines. The proportion of aligned regimens increased as GOLD group worsened in severity ($P < .001$), with 22.3% of regimens (n = 25) in alignment for participants in the GOLD stage B group, 75.0% (n = 3) in the GOLD stage C group, and 93.3% (n = 70) in the GOLD stage D group (Fig 1).Rates of alignment by year of enrollment into MARC from 2017 through 2021 did not differ significantly.

Of the nonaligned regimens, 86.0% (n = 80) reflected overuse of pharmacotherapy. In GOLD stage B and C groups, all cases of overuse, by definition, involved prescription of an ICS that was not recommended. Of these cases, 59% (n = 47) involved triple-therapy regimens with ICSs, LAMAs, and LABAs, 38% (n = 30) involved ICSs and LABAs, and 4% (n = 3) involved ICS monotherapy.

Medication Concordance

Kappa statistics for medication concordance between provider-reported and patient-reported medication regimens by inhaler class ranged from 0.33 (LABA) to 0.66 (LAMA) (Table 3). Overall, 38% of participants (n = 71) reported a different regimen than their provider. Of these discordant regimens, 83% (n = 59) reflected participants not reporting at least one of the prescribed inhaler classes. Of these patients, 40% (n = 23) reported not taking one medication, 56% (n = 33) reported not taking two medications, and 5% (n = 3) reported not taking three medications. The number of unreported medications stratified by the number of medications prescribed is presented in e-Figure 2. Of the total number of unreported medications, 40% (n = 39) were LABAs, 40% (n = 39) were ICSs, and 20% (n = 20) were LAMAs. Overall, 29% of participants prescribed a LABA, LAMA, or both and 27% of participants prescribed an ICS reported not taking those medications. Although less common, 9% of participants (n = 17) reported taking at least one additional inhaler class beyond what their provider reported. These added inhaler classes were roughly evenly distributed among the three classes (36% ICS, 36% LAMA, 28% LABA).

Interplay Between Guideline Alignment and Medication Concordance

Of the 38% of participants (n = 71) who reported a discordant medication regimen, only 15% (n = 11) reported discrepancies that brought them into alignment with GOLD guidelines, with the remainder either not changing the alignment (63% [n = 45]) or bringing them out of alignment (21% [n = 15]). Most participants being brought into alignment (n = 10) were in the GOLD stage B group because these participants did not report an ICS, which is considered overuse for that group.

Overall rates of medication concordance did not differ significantly either by GOLD group or by category of guideline alignment. However, participants prescribed overuse regimens reported not taking medications at higher rates than participants prescribed guideline-aligned regimens, with 36% of participants (n = 29) in the overuse category not reporting at least one medication as compared with 28% of participants (n = 27) prescribed guideline-aligned regimens, although this difference was not statistically significant.

Factors Associated With Alignment and Concordance

The results from logistic regression models are presented in Table 4. In a multivariable model of factors associated with guideline alignment, having GOLD stage D disease was positively associated significantly with guideline alignment (aOR, 352.9; 95% CI, 20.3–6138.2; $P < .001$). Higher CAT score was associated significantly with guideline nonalignment (aOR, 0.88; 95% CI, 0.80–0.97; $P < .01$), suggesting that participants reporting greater symptom burden were more likely to be prescribed nonaligned regimens. Having a pulmonologist on the care team also was associated significantly with guideline alignment (aOR, 3.04; 95% CI, 1.03–8.92; $P < .05$).

In a multivariable model of factors associated with medication concordance, higher CAT score was found to be associated significantly with medication discordance (aOR, 0.92; 95% CI, 0.86–0.99; $P < .05$), even after controlling for GOLD group. In addition, Montreal Cognitive Assessment-Blind score was associated significantly with medication concordance (aOR, 1.21; 95% CI, 1.02–1.44; $P < .05$), indicating that patients with cognitive impairment are less likely to be concordant with their providers. Beliefs About Medicines Questionnaire Necessity score was on the border of statistical significance (aOR, 0.90; 95% CI, 0.81–1.00; $P = .51$), potentially suggesting that patients who hold stronger beliefs about the necessity of medications are more likely to be concordant with their providers. Black race also was associated negatively with medication concordance (aOR, 0.35; 95% CI, 0.13–0.97; $P < .05$). Being treated by a pulmonologist was associated with medication concordance (aOR, 4.76; 95% CI, 1.86–12.2; $P < .001$).

Discussion

In this analysis, > 50% of provider-reported medication regimens were not in alignment with GOLD guidelines in effect at the time of the study. More than 85% of nonaligned regimens reflected overuse of medications, primarily driven by use of ICSs for patients at low risk of exacerbations. Underuse was driven primarily by absence of any long-acting inhaler. These findings demonstrate continued poor provider uptake of clinical treatment guidelines in COPD.

In an assessment of medication concordance, nearly 40% of participants were found to report a different medication regimen than their provider, and kappa statistics by therapeutic class ranged from low to moderate. Although a small proportion of instances of medication discordance brought patients into guideline alignment, most medication discrepancies represented participants not reporting at least one guideline-recommended medication. Less than 10% of participants reported more medications than their provider, likely representing additional prescriptions from sources other than the provider primarily managing the COPD,

for example, urgent care or ED physicians. These results demonstrate that medication discordance is common in COPD and is characterized primarily by patients not reporting guideline-recommended medications that their providers reported prescribing.

Having GOLD stage D disease was associated significantly with guideline alignment after controlling for other factors, which is consistent with prior research demonstrating that rates of guideline alignment increase by GOLD stage severity.[1,27] This finding reflects the fact that > 70% of participants in all three GOLD stage groups were receiving ICS-containing double therapy or triple therapy, which for patients with GOLD stage B disease is considered overuse, whereas for patients with GOLD stage D disease is considered guideline-aligned treatment. Higher CAT scores also were found to be associated significantly with guideline nonalignment even after controlling for GOLD stage group, raising the possibility that providers may escalate therapy beyond guideline recommendations by adding an ICS for patients who remain highly symptomatic with fewer medications. However, participants who were prescribed overuse regimens also were found not to report medications at higher rates than participants prescribed guideline-aligned regimens, although this difference was not statistically significant. In addition, participants were found to not report a LAMA, LABA, or both as frequently as an ICS. Taken together, these findings raise concern that patients whose treatment is escalated because of a high symptom burden may not take all medications prescribed and are just as likely not to report an aligned LAMA, LABA, or both as compared with a nonaligned ICS. Being cared for by a pulmonologist also was associated significantly with guideline alignment, suggesting that specialists may be more familiar with guidelines or may be more likely to adopt them into their practice.

It is possible that some instances of overuse reflect patients who previously were categorized with GOLD stage D disease being escalated to an ICS-containing regimen for a history of exacerbations and later being recategorized as having GOLD stage B disease because of improvement in their condition as a result of that medication. However, the high rates of unreported medications among this group are at odds with this explanation. Moreover, this explanation does not apply to escalations to ICS-containing regimens for high symptom burden, because GOLD guidelines do not recommend escalation to ICSs for severe or persistent symptoms. Notably, history of asthma was not associated significantly with guideline alignment, suggesting that comorbid asthma also does not account for the observed overuse of ICSs.

For medication concordance, higher CAT score was associated significantly with medication discordance after controlling for other factors. This finding suggests either that patients who are more symptomatic are less confident in the ability of medications to relieve symptoms and as a result are discordant at higher rates, or that patients who do not adhere to the medication regimen as prescribed are more symptomatic as a result. However, given that this model controlled for strength of beliefs in the necessity of medication, the latter interpretation seems more likely.

Cognitive impairment was negatively associated significantly with medication concordance, which is consistent with prior research that patients with cognitive impairment are at higher

risk of nonadherence.[28] Stronger belief in the necessity of medication also was associated with medication concordance, although this finding was on the border of statistical significance ($P = .51$). Black race was associated negatively with medication concordance, whereas other demographic factors and socioeconomic indicators were not. Prior studies have suggested that this association may be mediated through worse communication by health care providers with patients from racial and ethnic minority groups[29] as well as lower trust in the health care system or in the positive effect of medications.[30] It is also possible that the other socioeconomic factors used in this study do not capture the ways in which Black and patients from racial and ethnic minority groups face systematic bias in health care. Having a pulmonologist on the care team was associated with medication concordance, suggesting that specialists may have more training or time to communicate with patients about inhaler regimens or may have access to an experienced multidisciplinary team that assists with communication.

These findings suggest that providers routinely should assess medication concordance, particularly before further escalation to nonaligned treatment regimens. Providers should pay specific attention to patient groups at risk of medication discordance and should explore underlying reasons for this discordance, such as confusion and medication beliefs. Our research is consistent with prior literature suggesting that improving communication between patients and providers is critical to addressing racial disparities in COPD and improving clinical management.[31] Although additional research is needed on the best strategies to improve this communication, future work should focus on interventions that have shown promise in other disease areas or care settings, such as using pictograms and involvement of the multidisciplinary team.[32–34] Additional research also should focus on identifying the reasons pulmonologists have higher rates of medication concordance to implement better those factors in the generalist setting.

The most recent GOLD guidelines published in 2023 collapse GOLD stages C and D into a new stage E defined by a history of frequent or severe exacerbations.[35] These recommendations remove ICSs entirely from the guidelines for initial pharmacotherapy and recommend escalation to an ICS-containing regimen for patients with persistent exacerbations, elevated blood eosinophil counts, or comorbid asthma. This further de-emphasis of the role of ICSs highlights the importance of understanding the drivers of overuse of this medication, particularly because recent research has shown that ICS overuse has increased over time.[36] Our findings also underscore the importance of ensuring medication concordance to address this problem because we must minimize the likelihood that patients drop a LAMA, LABA, or both rather than an ICS.

This study has several limitations. Like other similar studies, we were unable to account for confounding by indication. Exacerbation history was collected via self-report, which may be subject to information and recall bias. This study did not include data collection on blood eosinophil levels, which may have affected prescribing decisions. The participant sample was affected by the inclusion criteria for MARC, which stipulated a prescription for a long-term daily medication. Although this medication was not required to be an inhaler, this criterion likely affected our sample in ways that underestimated the rate of underuse. For this reason, the analytical cohort for this study was limited to GOLD stages B, C, and

D to ensure that all participants had an indication for a controller inhaler. The number of participants with GOLD stage C disease also was low (n = 4), which is consistent with other studies showing overall low prevalence of this disease category.[37] Additional research is needed to confirm our findings in a larger sample size, in a more generalizable population, and in a longitudinal analysis. Despite these limitations, the data collection performed within this cohort enables this study to be the first that we are aware of to estimate rates of medication concordance in COPD using both patient-reported and physician-reported regimens and to examine patient-level factors associated with medication concordance.

Interpretation

In conclusion, approximately one-half of provider-reported regimens were in alignment with clinical treatment guidelines, with most nonaligned regimens reflecting overuse. Nearly 40% of patients reported different medication regimens than their providers, which predominantly reflected patients dropping medications. Certain patient-level factors, including higher symptom burden, cognitive impairment, Black race, and not being managed by a pulmonologist, were associated with medication discordance. These findings highlight the importance of increasing provider adherence to clinical treatment guidelines and enhancing patient-provider communication about medication efficacy to improve clinical management in COPD.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Funding/Support

The MARC trial was supported by the National Heart, Lung, and Blood Institute [Grant R01HL128620]. M. A. C. was supported by the National Heart, Lung, and Blood Institute [Grants T32HL007534 and F32HL167418]. N. N. H. is supported by the COPD Foundation.

Financial/Nonfinancial Disclosures

The authors have reported to *CHEST* the following: N. N. H. reports receiving financial support from AstraZeneca and GlaxoSmithKline. None declared (M. A. C., E. P. B., E. R., M. T. V., N. P., M. N. E.).

ABBREVIATIONS:

aOR	adjusted OR
CAT	COPD Assessment Test
GOLD	Global Initiative for Chronic Obstructive Lung Disease
ICS	inhaled corticosteroid
MARC	Medication Adherence Research in COPD Patients
LABA	long-acting beta-agonist
LAMA	long-acting muscarinic antagonist

References

1. Ghosh S, Anderson WH, Putcha N, et al. Alignment of inhaled chronic obstructive pulmonary disease therapies with published strategies. Analysis of the Global Initiative for Chronic Obstructive Lung Disease recommendations in SPIROMICS. Ann Am Thorac Soc. 2019;16 (2):200–208. [PubMed: 30216731]
2. Vogelmeier CF, Criner GJ, Martinez FJ, et al. Global Strategy for the Diagnosis, Management, and Prevention of Chronic Obstructive Lung Disease 2017 report. GOLD executive summary. Am J Respir Crit Care Med. 2017;195 (5):557–582. [PubMed: 28128970]
3. Perez X, Wisnivesky JP, Lurslurchachai L, Kleinman LC, Kronish IM. Barriers to adherence to COPD guidelines among primary care providers. Respir Med. 2012;106 (3):374–381. [PubMed: 22000501]
4. López-Campos JL, Abad Arranz M, Calero-Acuña C, et al. Guideline adherence in outpatient clinics for chronic obstructive pulmonary disease: results from a clinical audit. PLoS One. 2016;11 (3):e0151896, 1–13. [PubMed: 26985822]
5. Sharif R, Cuevas CR, Wang Y, Arora M, Sharma G. Guideline adherence in management of stable chronic obstructive pulmonary disease. Respir Med. 2013;107 (7):1046–1052. [PubMed: 23639271]
6. Sehl J, O'Doherty J, O'Connor R, O'Sullivan B, O'Regan A. Adherence to COPD management guidelines in general practice? A review of the literature. Ir J Med Sci. 2018;187 (2):403–407. [PubMed: 28735500]
7. Appleton S, Jones T, Poole P, et al. Ipratropium bromide versus long-acting beta-2 agonists for stable chronic obstructive pulmonary disease. Cochrane Database Syst Rev. 2006;3:CD006101, 1–47.
8. Decramer ML, Chapman KR, Dahl R, et al. Once-daily indacaterol versus tiotropium for patients with severe chronic obstructive pulmonary disease (INVIGORATE): a randomised, blinded, parallel-group study. Lancet Respir Med. 2013;1:524–533. [PubMed: 24461613]
9. Anthonisen NR, Connett JE, Enright PL, Manfreda J. Hospitalizations and mortality in the Lung Health Study. Am J Respir Crit Care Med. 2002;166:333–339. [PubMed: 12153966]
10. Crim C, Calverley PM, Anderson JA, et al. Pneumonia risk in COPD patients receiving inhaled corticosteroids alone or in combination: TORCH study results. Eur Respir J. 2009;34:641–647. [PubMed: 19443528]
11. Loke YK, Cavallazzi R, Singh S. Risk of fractures with inhaled corticosteroids in COPD: systematic review and meta-analysis of randomised controlled trials and observational studies. Thorax. 2011;66:699–708. [PubMed: 21602540]
12. Slatore CG, Bryson CL, Au DH. The association of inhaled corticosteroid use with serum glucose concentration in a large cohort. Am J Med. 2009;122:472–478. [PubMed: 19375557]
13. Spece LJ, Feemster LC. Aligning prescribing practices with chronic obstructive pulmonary disease guidelines: a Sisyphean struggle? Ann Am Thorac Soc. 2019;16 (2):187–188. [PubMed: 30707064]
14. Riekert KA, Butz AM, Eggleston PA, Huss K, Winkelstein M, Rand CS. Caregiver-physician medication concordance and undertreatment of asthma among inner-city children. Pediatrics. 2003;111 (3):e214–e220. [PubMed: 12612274]
15. Butz A, Sellers MD, Land C, Walker J, Tsoukleris M, Bollinger ME. Factors affecting primary care provider and caregiver concordance for pediatric asthma medications. J Asthma. 2009;46 (3):308–313. [PubMed: 19373641]
16. Redmond P, Grimes TC, McDonnell R, Boland F, Hughes C, Fahey T. Impact of medication reconciliation for improving transitions of care. Cochrane Database Syst Rev. 2018;8 (8):CD010791, 1–125. [PubMed: 30136718]
17. Schneider C, Jick SS, Bothner U, Meier CR. COPD and the risk of depression. Chest. 2010;137 (2):341–347. [PubMed: 19801582]
18. Fan VS, Meek PM. Anxiety, depression, and cognitive impairment in patients with chronic respiratory disease. Clin Chest Med. 2014;35 (2):399–409. [PubMed: 24874134]
19. Smith MC, Wrobel JP. Epidemiology and clinical impact of major comorbidities in patients with COPD. Int J Chron Obstruct Pulmon Dis. 2014;9:871–888. [PubMed: 25210449]

20. Krauskopf K, Federman AD, Kale MS, et al. Chronic obstructive pulmonary disease illness and medication beliefs are associated with medication adherence. COPD. 2015;12 (2):151–164. [PubMed: 24960306]
21. Graham BL, Steenbruggen I, Miller MR, et al. Standardization of Spirometry 2019 Update. An official American Thoracic Society and European Respiratory Society technical statement. Am J Respir Crit Care Med. 2019;200 (8):e70–e88. [PubMed: 31613151]
22. Bestall JC, Paul EA, Garrod R, Garnham R, Jones PW, Wedzicha JA. Usefulness of the Medical Research Council (MRC) dyspnoea scale as a measure of disability in patients with chronic obstructive pulmonary disease. Thorax. 1999;54 (7):581–586. [PubMed: 10377201]
23. Jones PW, Harding G, Berry P, Wiklund I, Chen WH, Kline Leidy N. Development and first validation of the COPD Assessment Test. Eur Respir J. 2009;34 (3):648–654. [PubMed: 19720809]
24. Wittich W, Phillips N, Nasreddine ZS, Chertkow H. Sensitivity and specificity of the Montreal cognitive assessment modified for individuals who are visually impaired. J Vis Impair Blind. 2010;104: 360–368.
25. Horne R, Chapman SC, Parham R, Freemantle N, Forbes A, Cooper V. Understanding patients' adherence-related beliefs about medicines prescribed for long-term conditions: a meta-analytic review of the necessity-concerns framework. PLoS One. 2013;8 (12):e80633, 1–24. [PubMed: 24312488]
26. Putcha N, Puhan MA, Drummond MB, et al. A simplified score to quantify comorbidity in COPD. PLoS One. 2014;9 (12):e114438, 1–14. [PubMed: 25514500]
27. Gershon AS, Pequeno P, Alberga Machado A, et al. Factors associated with nonreceipt of recommended COPD medications: a population study. Chest. 2021;160 (5):1670–1680. [PubMed: 34144022]
28. Incalzi RA, Gemma A, Marra C, Capparella O, Fuso L, Carbonin P. Verbal memory impairment in COPD: its mechanisms and clinical relevance. Chest. 1997;112 (6):1506–1513. [PubMed: 9404746]
29. Diette GB, Rand C. The contributing role of health-care communication to health disparities for minority patients with asthma. Chest. 2007;132 (5 suppl): 802S–809S. [PubMed: 17998344]
30. Williams LK, Joseph CL, Peterson EL, et al. Patients with asthma who do not fill their inhaled corticosteroids: a study of primary nonadherence. J Allergy Clin Immunol. 2007;120 (5):1153–1159. [PubMed: 17936894]
31. Ejike CO, Dransfield MT, Hansel NN, et al. Chronic obstructive pulmonary disease in America's Black population. Am J Respir Crit Care Med. 2019;200 (4): 423–430. [PubMed: 30789750]
32. Sletvold H, Sagmo LAB, Torheim EA. Impact of pictograms on medication adherence: a systematic literature review. Patient Educ Couns. 2020;103 (6): 1095–1103. [PubMed: 31924384]
33. Hawkins LA, Firek CJ. Testing a novel pictorial medication sheet to improve adherence in veterans with heart failure and cognitive impairment. Heart Lung. 2014;43 (6):486–493. [PubMed: 24928185]
34. Mekonnen AB, McLachlan AJ, Brien JA. Effectiveness of pharmacist-led medication reconciliation programmes on clinical outcomes at hospital transitions: a systematic review and meta-analysis. BMJ Open. 2016;6 (2):e010003. 1–14.
35. Global Initiative for Chronic Obstructive Lung Disease Global Strategy for the Diagnosis, Management, and Prevention of Chronic Obstructive Lung Disease 2023 Report. Global Initiative for Chronic Obstructive Lung Disease website https://goldcopd.org/2023-gold-report-2/. Accessed March 4, 2023.
36. Duan KI, Donovan LM, Spece LJ, et al. Trends and Rural-Urban Differences in the Initial Prescription of Low-Value Inhaled Corticosteroids among U.S. Veterans with Chronic Obstructive Pulmonary Disease. Ann Am Thorac Soc. 2023;20 (5):668–676. [PubMed: 36867427]
37. Cabrera López C, Casanova Macario C, Marín Trigo JM, et al. Comparison of the 2017 and 2015 Global Initiative for Chronic Obstructive Lung Disease reports. Impact on grouping and outcomes. Am J Respir Crit Care Med. 2018;197 (4): 463–469. [PubMed: 29099607]

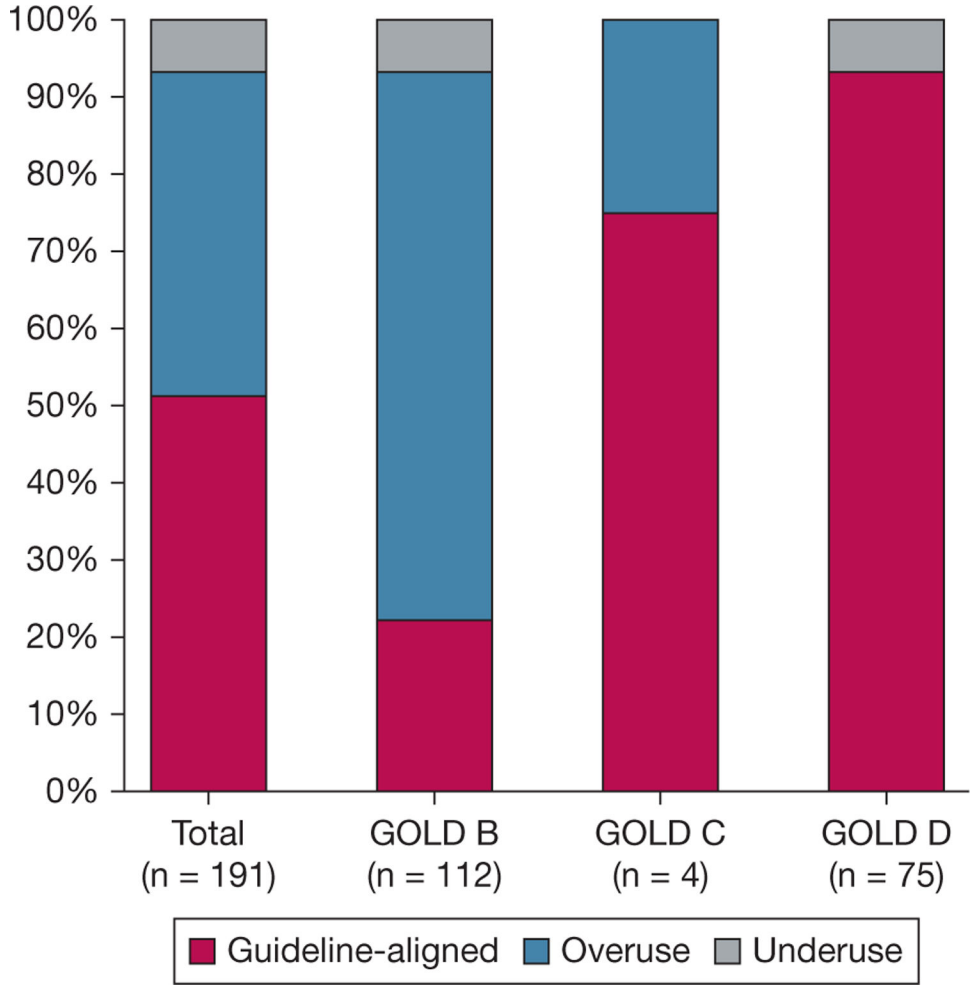

Figure 1 –.

Bar graph showing alignment of provider-reported regimens with 2017 GOLD guidelines by GOLD group. GOLD = Global Initiative for Chronic Obstructive Lung Disease.

TABLE 1]

Alignment of Medication Regimen With 2017 GOLD Recommendations

	Aligned Regimens		Nonaligned Regimens	
GOLD Stage	**First-Line Therapy**	**Second-Line Therapy**	**Underuse**	**Overuse**
A	SAMA or SABA	SAMA plus SABA or LAMA or LABA	N/A	ICS monotherapy or ICS plus LABA or ICS plus LAMA or ICS plus LAMA plus LABA
B	LAMA or LABA	LAMA plus LABA	No inhaler or ICS monotherapy	ICS plus LABA or ICS plus LAMA or ICS plus LAMA plus LABA
C	LAMA or LAMA plus LABA	ICS plus LABA	No inhaler or ICS monotherapy or LABA monotherapy	ICS plus LAMA or ICS plus LAMA plus LABA
D	LAMA plus LABA or ICS plus LAMA plus LABA	LAMA or ICS plus LABA	No inhaler or ICS monotherapy or LABA monotherapy	N/A

GOLD = Global Initiative for Chronic Obstructive Lung Disease; ICS = inhaled corticosteroid; LABA = long-acting beta-agonist; LAMA = long-acting muscarinic antagonist; SABA = short-acting beta-agonist; SAMA = short-acting muscarinic antagonist.

TABLE 2]

Baseline Patient Characteristics

Characteristic	Full Cohort	GOLD Stage		
		B	C	D
No. of patients	191	112 (58.6)	4 (2.1)	75 (39.3)
Age, y	68.4 ± 9.1	68.1 ± 9.3	76.6 ± 7.8	68.4 ± 8.8
At diagnosis	55.5 ± 12.5	55.9 ± 12.6	55 ± 8.7	55.0 ± 12.7
Male sex	83 (43.5)	53 (47.3)	4 (100)	26 (34.7)
Race				
White	135 (71.1)	81 (72.3)	4 (100)	50 (67.6)
Black	51 (26.8)	29 (25.9)	0	22 (29.7)
Other	4 (2.1)	2 (1.8)	0	2 (2.7)
Socioeconomic status				
Public insurance only	149 (78.8)	90 (81.8)	4 (100.0)	55 (73.3)
Highest education				
High school or less	58 (30.4)	33 (29.5)	1 (25)	24 (32.0)
Some college	59 (30.9)	33 (29.5)	0	26 (34.7)
College degree or more	74 (38.7)	46 (41.1)	3 (75)	25 (33.3)
Current tobacco user	53 (30.8)	31 (30.1)	2 (100)	22 (32.8)
Pack-years	39 (26–54)	39 (24–53)	40 (25–54)	39 (26–56)
FEV_1, % predicted (SD)[a]	55.2 (22.8)	55.6 (20.8)	61.2 (33.4)	54.1 (25.1)
Exacerbations in prior year				
None	95 (49.5)	95 (84.8)	0	0
1	39 (20.3)	17 (15.2)	0	22 (29.3)
≥ 2	57 (2.7)	0	4 (100)	53 (70.7)
CAT score[b]				
Median (IQR)	18 (13–23)	17 (12–23)	7 (6–8)	19 (16–24)
≥ 10	154 (81.5)	89 (80.2)	0	65 (87.8)
mMRC dyspnea scale score[c]				
Median (IQR)	2 (2–3)	2 (2–3)	1 (1–1)	2 (2–3)
≥ 2	158 (83.6)	92 (83.6)	0	66 (88.0)

Characteristic	Full Cohort	GOLD Stage		
		B	C	D
Comorbidity count				
Median (IQR)	3 (2–5)	3 (2–5)	4 (4–5)	3 (2–4)
≥ 3	125 (65.5)	74 (66.1)	4 (100)	47 (62.8)
MoCA-Blind score[d]				
Median (IQR)	18 (17–20)	18 (17–20)	18 (16–20)	18 (16–19)
≤ 17	71 (37.8)	42 (38.5)	2 (50)	27 (36.0)
BMQ score[e]				
Necessity scale	10 (6–13)	10 (6–13)	8 (6–11)	9 (6–11)
Concerns scale	17 (13–20)	17 (13–20)	17 (16–18)	17 (13–19)
History of asthma	70 (37.6)	40 (36.0)	2 (50.0)	28 (39.4)
Managed by pulmonologist	112 (58.6)	59 (52.7)	2 (50.0)	51 (68.0)

Data are presented as No. (%), No., mean ± SD, or median (interquartile range), unless otherwise indicated. BMQ = Beliefs About Medicines Questionnaire; CAT = COPD Assessment Test; GOLD = Global Initiative for Chronic Obstructive Lung Disease; IQR = interquartile range; mMRC = modified Medical Research Council; MoCA = Montreal Cognitive Assessment.

[a]Assessments before bronchodilator administration were used in these summary statistics because participants who completed spirometry remotely did not undergo testing after bronchodilator administration.

[b]Higher scores indicate greater symptom burden.

[c]Higher scores indicate greater dyspnea.

[d]Lower scores indicate greater cognitive impairment.

[e]Lower scores indicate stronger beliefs about the necessity of medications or higher concerns about their use.

TABLE 3]

Patient-Provider Medication Concordance by Therapeutic Class

Drug Class	Patient-Provider Concordance			Percent Positive Agreement	Kappa Statistic (95% CI)
ICS		Patient report (+)	Patient report (−)	69	0.42 (0.30–0.55)
	Provider report (+)	105	39		
	Provider report (−)	9	35		
LAMA		Patient report (+)	Patient report (−)	79	0.66 (0.55–0.77)
	Provider report (+)	108	20		
	Provider report (−)	9	51		
LABA		Patient report (+)	Patient report (−)	73	0.33 (0.19–0.47)
	Provider report (+)	122	39		
	Provider report (−)	7	20		

ICS = inhaled corticosteroid; LABA = long-acting beta-agonist; LAMA = long-acting muscarinic antagonist.

TABLE 4]

Factors Associated With Guideline Alignment and Medication Concordance

Variable	Guideline Alignment Models		Medication Concordance Models	
	OR (95% CI)	aOR (95% CI)	OR (95% CI)	aOR (95% CI)
Age	…	0.94 (0.87–1.00)	…	1.00 (0.95–1.06)
Male sex	…	2.71 (0.97–7.51)	…	0.78 (0.34–1.82)
Race[a]				
Black	…	0.41 (0.11–1.57)	…	0.35 (0.13–0.97)[b]
Other/missing	…	1.02 (0.03–41.8)	…	1.54 (0.13–18.8)
Public insurance[c]	0.84 (0.41–1.69)	1.38 (0.38–5.04)	1.16 (0.56–2.43)	1.66 (0.61–4.51)
Highest education[d]				
Some college	0.91 (0.44–1.90)	0.45 (0.12–1.64)	1.72 (0.77–3.83)	1.83 (0.62–5.40)
College or more	0.84 (0.41–1.73)	0.53 (0.13–2.09)	1.05 (0.49–2.24)	0.59 (0.20–1.73)
Current tobacco use[e]	1.20 (0.58–2.49)	1.09 (0.33–3.61)	0.87 (0.41–1.85)	1.51 (0.56–4.03)
Comorbidity count	1.04 (0.89–1.21)	1.24 (0.94–1.63)	1.02 (0.86–1.21)	1.08 (0.86–1.35)
CAT score[f]	1.00 (0.96–1.05)	0.88 (0.80–0.97)[g]	0.95 (0.91–0.99)[b]	0.92 (0.86–0.99)[b]
mMRC dyspnea scale score[h]	1.10 (0.82–1.48)	1.52 (0.91–2.53)	0.71 (0.51–0.98)[b]	0.67 (0.43–1.03)
Exacerbation history[i]	5.44 (3.39–8.72)[j]	0.56 (0.13–2.39)	0.83 (0.58–1.17)	0.94 (0.37–2.39)
History of asthma[k]	0.68 (0.37–1.26)	0.46 (0.14–1.56)	…	…
MoCA-Blind score[l]	0.98 (0.87–1.11)	1.05 (0.83–1.33)	1.18 (1.03–1.35)[b]	1.21 (1.02–1.44)[b]
GOLD stage[m]				
C	7.88 (0.73–85.08)	3.31 (0.05–230.1)	0.49 (0.06–3.81)	Omitted[n]
D	77.4 (24.5–244.4)[j]	352.9 (20.3–6138.2)[j]	0.89 (0.47–1.68)	0.77 (0.16–3.74)
BMQ score[o]				
Necessity	…	…	0.95 (0.88–1.03)	0.90 (0.81–1.00)
Concern	…	…	1.03 (0.95–1.11)	0.98 (0.88–1.09)
Pulmonologist[p]	2.41 (1.30–4.49)[g]	3.04 (1.03–8.92)[b]	2.94 (1.54–5.62)[j]	4.76 (1.86–12.2)[j]

aOR = adjusted OR; BMQ = Beliefs About Medicines Questionnaire; CAT = COPD Assessment Test; GOLD = Global Initiative for Chronic Obstructive Lung Disease; mMRC = modified Medical Research Council; MoCA = Montreal Cognitive Assessment.

[a] Reference group is White.

[b] $P < .05$.

[c] Reference group is private insurance.

[d] Reference group is high school or less.

[e] Reference group is no current tobacco use.

[f] Higher score indicates greater symptom burden.

[g] $P < .01$.

[h] Higher score indicates greater dyspnea.

[i] Defined as the number of exacerbations in the last year.

[j] $P < .001$.

[k] Reference group is no history of asthma.

[l] Lower score indicates greater cognitive impairment.

[m] Reference group is stage B.

[n] Omitted because of low variability (n = 4) contributing to perfect prediction failure.

[o] Lower score indicates stronger beliefs about the necessity of medications or higher concerns about their use.

[p] Defined as the presence of a pulmonologist on the patient's care team.