International Journal of Chronic Obstructive Pulmonary Disease Dovepress
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ORIGINAL RESEARCH

The Impact of the Pay-for-Performance Program on the Outcome of COPD Patients in Taiwan After One Year

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Objective: To investigate the impact of a multidisciplinary intervention on the clinical outcomes of patients with COPD.

Methods: This study retrospectively extracted the data of patients enrolled in the national pay-for-performance (P4P) program for COPD in four hospitals. Only COPD patients who received regular follow-up for at least one year in the P4P program between September 2018 and December 2020 were included.

Results: A total of 1081 patients were included in this study. Among them, 424 (39.2%), 287 (26.5%), 179 (16.6%), and 191 (17.7%) patients were classified as COPD Groups A, B, C, and D, respectively. Dual therapy with long-acting β2-agonist (LABA)/long-acting muscarinic antagonist (LAMA) was the most used inhaled bronchodilator at baseline (n = 477, 44.1%) patients, followed by LAMA monotherapy (n = 195, 18.0%), triple therapy with inhaled corticosteroid (ICS)/LABA/LAMA (n = 184, 17.0%), and ICS/LABA combination (n = 165, 15.3%). After one year of intervention, 374 (34.6%) and 323 (29.9%) patients had their pre- and post-bronchodilator-forced expiratory volume in one second (FEV1) increase of more than 100 mL. Both the COPD Assessment Test (CAT) and modified British Medical Research Council (mMRC) scores had a mean change of −2.2 ± 5.5 and −0.3 ± 0.9, respectively. The improvement in pulmonary function and symptom score were observed across four groups. The decreased number of exacerbations was only observed in Groups C and D, and not in Groups A and B.

Conclusion: This real-world study demonstrated that the intervention in the P4P program could help improve the clinical outcome of COPD patients. It also showed us a different view on the use of dual therapy, which has a lower cost in Taiwan.

Keywords: chronic obstructive pulmonary disease, COPD, dual therapy, Disease-Specific Care – Chronic Obstructive Pulmonary Disease, DSC-COPD, certification program, Joint Commission of Taiwan, pay-for-performance, quality-improvement

Introduction

Chronic obstructive pulmonary disease (COPD) is a common airway disease characterized by persistent respiratory symptoms and airflow limitation. In contrast to other diseases, ie, cardiovascular disease, coronary artery disease, and stroke, which showed decreasing burden with time, the prevalence of COPD remains high and has been continuously a major health problem and an economic burden globally.[1,2] In 2015, 2.6% of the global disability-adjusted life year (DALY) was caused by COPD and 3.2 million people were estimated to die of COPD worldwide.[2] In Taiwan, there was no exception. The average annual prevalence of COPD in Taiwan, based on the National Health Insurance medical reimbursement claims from 1996 to 2002, was 2.48%, with a rate up to 8.83% in those older than 70 years of age.[3] A study of the impact of COPD in the Asia-Pacific region—the Epidemiology and Impact of COPD (EPIC) Asia

Received: 20 November 2021
Accepted: 11 April 2022
Published: 21 April 2022

population-based survey—used telephone or face-to-face interviews in 6,000 residents of the Asia-Pacific and detected a prevalence rate of 9.5% in 207 Taiwanese patients.[4] In 2019, chronic lower respiratory disease ranked as the seventh cause of death in Taiwan, with a mortality rate of 26.7 per 100,000 population. Additionally, the in-hospital mortality rate for COPD patients requiring hospitalization remained 4% and the 1-year mortality rate was as high as 22%.[3]

To improve the clinical outcome of patients with COPD in Taiwan, the Bureau of National Health Insurance (NHI) and Joint Commission of Taiwan (JCT) implemented a Pay for Performance (P4P) program for COPD (Disease-Specific Care – Chronic Obstructive Pulmonary Disease (DSC-COPD)) in April 2017.[5] DSC-COPD certification program provides financial incentives to motivate the participation of physicians to establish patient-centered care within their service and to enhance the value of patient monitoring and management. A preliminary study showed that the implementation of the DSC-COPD certification program could help reduce 14-day readmission rates (37.5%), emergency department visit rate (31.3%), intensive care unit (ICU) admission rate (48.1%), and increase pulmonary rehabilitation rate (49.7%).[5] To provide more detailed data, the present study was conducted to investigate the impact of this multidisciplinary intervention on the clinical outcomes of patients with COPD in Taiwan.

Methods

Study Design

The COPD P4P program was started on April 1, 2017. Our P4P team member included pulmonologist, pharmacists, respiratory therapists, and healthcare administrator. According to the COPD P4P program guidelines, pulmonologist enrolled patients with symptoms of cough, dyspnea with and without sputum, history of risk factors' exposure, and COPD was confirmed using a lung function test (postbronchodilator FEV1/FVC <70%) during a 90-day period on an outpatient basis in the hospital. After enrolled, patients were suggested to maintain regular therapy and follow-up every 3 months with the same pulmonologist in the same hospital. Patients enrolled into P4P and received complete pharmacologic and nonpharmacologic intervention included physical exercise program designed to help patients with COPD, quitting smoking, coordinated and integration of COPD information on self-care and to prevent exacerbation. Pulmonologist evaluated the enrolled COPD patients and adjusted their treatment and management of drug therapy. In this study, we used severe exacerbation requiring hospitalization or emergency department visit as the definition of COPD exacerbation. The prior history of exacerbation was counted by patients and case managers.

This study retrospectively extracted data of COPD patients who participated in the national P4P program in four hospitals in Taiwan.[5] The P4P program aims to provide a comprehensive care system and create a trilateral win-win situation for patients, physicians, and insurers. Furthermore, the comprehensive care system was expected to improve the quality of health care, as well as reduce emergency department visits, ICU admission, and the cost burden of COPD. The hospitals/clinics that are enrolled in the P4P program could receive extra payments for case management, smoking cessation success, execution of pulmonary rehabilitation, medication adherence, and reduction in COPD-related emergency visits and hospitalizations. The Taiwan COPD Clinical Treatment Guideline was used to establish a unified standard for physicians and provide evidence-based analyses of individual agents commonly used in the treatment of COPD. Moreover, the Taiwan Society of Pulmonary and Critical Care Medicine (TSPCCM) was responsible for conducting training certification classes to improve the skills and knowledge of physicians, case managers, and respiratory therapists. Patients' decision aid and self-management tools are also provided by TSPCCM.

Study Participants

Only COPD patients who received regular follow-up for at least one year in the P4P program in the four hospitals, including Chi Mei Medical Center, Cardinal Tien Hospital, Chi Mei Medical Center Liouying branch, and Chi Mei Medical Center Chiali branch between September 2018 and December 2020 were included in this study. Patients without complete symptom scores in the COPD Assessment Test (CAT) and modified British Medical Research Council (mMRC) were excluded in the study as well as those with incomplete spirometry scores in the pre- and post-bronchodilator (BD) forced expiratory volume in one second (FEV_1) and forced vital capacity (FVC) at both pre- and post-intervention. After obtaining the ethical approval of the institutional review board, the clinical data of patients, including demographic

characteristics, signs and symptoms, results of initial and follow-up spirometry, number of exacerbation, and medications especially for inhaled bronchodilator, were retrospectively collected for analysis. To avoid confounding effect of changing inhaled bronchodilator, only patients used the same type of inhaled bronchodilator for one year were included in this study. Therefore, the inhaled bronchodilator used at baseline was kept in use for the follow-up one year. The study design complies with the Declaration of Helsinki ethical standards.

Statistical Analysis

Continuous variables were reported as the mean and standard deviation (SD). Categorical variables are presented as frequency counts with percentages. In addition, the differences in baseline characteristics and clinical variables were evaluated using Kruskal–Wallis test for continuous variables and Pearson's chi-squared test or Fisher's exact test for categorical variables. For estimating the post hoc analysis, the Dunn's test was used after the significant difference in Kruskal–Wallis test. All statistical analyses were conducted using the statistical package SPSS for Windows (Version 26.0, IBM Corp, Armonk, NY, USA); a p value of <0.05 was considered to show statistical significance.

Results

Study Subjects

Initially, 1,137 COPD patients with regular follow-up for more than 1 year were identified from the databases of the local P4P program. However, 56 patients did not have follow-up spirometry; thus, they were excluded. Finally, a total of 1081 patients were included in this study. Among them, 424 (39.2%) patients were classified as COPD Group A, 287 (26.5%) as Group B, 179 (16.6%) as Group C, and 191 (17.7%) as Group D. According to their baseline spirometry, most COPD patients were classified as GOLD grade 2 (51.6%), followed by grade 1 (24.2%) and grade 3 (21.3%). Only 31 (2.9%) patients were classified as GOLD grade 4. Group A and B patients belonged mostly in GOLD grades I and 2, while those in Groups C and D were under GOLD grades 3 and 4 (see Figure 1).

The demographic features and clinical characteristics of the patients at baseline are shown in Table 1. Overall, the mean age of the participants was 70.6 ± 9.9 years and 85.4% (n = 923) of them were males. Their mean body mass index was 24.2 ± 4.2 kg/m^2. A total of 110 (10.2%) patients had a family history of COPD and 74 (6.8%) had asthma. Hypertension was the most common co-morbidity (n = 449, 41.5%), followed by cardiovascular disease (n = 337, 31.2%) and diabetes mellitus (n = 195, 18.0%). Further, 864 patients had a smoking history and 556 patients had quit smoking. There was no significant difference in age, gender, allergy history, and smoking history between each group (all with $p>0.05$). In contrast, the frequency of family history of COPD, underlying diabetes mellitus and cardiovascular disease, baseline pulmonary function, symptomatic scores, and episodes of prior exacerbation varied across the groups (all with $p<0.05$). As shown in Figure 2, dual therapy with long-acting β2-agonist (LABA)/long-acting muscarinic antagonist (LAMA) was the most commonly used inhaled bronchodilator at baseline (n = 477, 44.1%), followed by LAMA monotherapy (n = 195, 18.0%), triple therapy with inhaled corticosteroid (ICS)/LABA/LAMA (n = 184, 17.0%), and

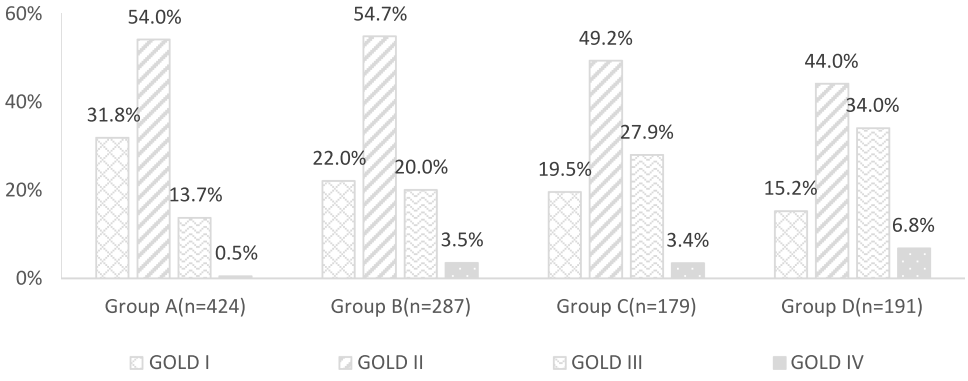

Figure 1 The distribution of 1081 patients with COPD according to GOLD grade.

https://doi.org/10.2147/COPD.S349468 DovePress

Table 1 The Demographic and Clinical Characteristics of Patients

Variable	Group A (a) (n=424)	Group B (b) (n=287)	Group C (c) (n=179)	Group D (d) (n=191)	P value	Post Hoc Tests*
Age, y	70.25±9.69	71.20±10.10	69.72±9.31	71.29±10.33	0.198	
Male, n (%)	357 (84.2)	244 (85.0)	154 (86.0)	168 (88.0)	0.663	
BMI, kg/m^2-mean±SD	24.32±3.90	23.97±4.33	24.65±4.19	23.72±4.54	0.015	(a) vs (d); (b) vs (c); (c) vs (d)
Family history of COPD, n (%)	37 (8.7)	18 (6.3)	33 (18.4)	22 (11.5)	<0.001	(a) vs (c); (b) vs (c); (b) vs (d)
Smoking status						
History of smoking	329 (77.6)	227(79.1)	148 (82.7)	160 (83.8)	0.244	
Quit smoking	220 (51.9)	131 (45.6)	100 (55.9)	105 (55.0)	0.123	
Underlying disease						
Hypertension, n (%)	177 (41.4)	105 (36.6)	85 (47.5)	82 (42.9)	0.129	
Cardiovascular disease, n (%)	136 (32.1)	71 (24.7)	61 (34.1)	69 (36.1)	0.035	(a) vs (b); (b) vs (c); (b) vs (d)
Diabetes mellitus, n (%)	64 (15.1)	48 (16.7)	34 (19.0)	49 (25.7)	0.015	(a) vs (d); (b) vs (d)
Chronic liver disease, n (%)	36 (8.5)	14 (4.9)	16 (8.9)	8 (4.2)	0.076	
Asthma, n (%)	26 (6.1)	23 (8.0)	11 (6.1)	14 (7.3)	0.762	
History of tuberculosis, n (%)	34 (8.0)	19 (6.6)	17 (9.5)	12 (6.3)	0.595	
Occupational lung disease, n (%)	3 (0.7)	3 (0.7)	1 (0.6)	0 (0)	0.573	
Thoracic surgery, n (%)	11 (2.6)	4 (1.4)	4 (2.2)	6 (3.1)	0.613	
Baseline lung function						
Pre-BD-FEV$_1$ (L)	1.58±0.56	1.42±0.55	1.36±0.57	1.18±0.48	<0.001	(a) vs (b); (a) vs (c); (a) vs (d) (b) vs (d); (c) vs (d)
Pre-BD-FEV$_1$ (%)	67.05±19.62	61.80±22.40	57.54±18.85	51.95±20.14	<0.001	(a) vs (b); (a) vs (c); (a) vs (d) (b) vs (c); (b) vs (d); (c) vs (d)
Pre-BD-FEV$_1$/FVC (%)	56.18±10.49	53.91±11.60	52.19±11.08	49.33±11.78	<0.001	(a) vs (b); (a) vs (c); (a) vs (d) (b) vs (c); (b) vs (d); (c) vs (d)
Post-BD-FEV$_1$ (L)	1.67±0.56	1.51±0.55	1.45±0.52	1.27±0.51	<0.001	(a) vs (b); (a) vs (c); (a) vs (d) (b) vs (d); (c) vs (d)
Post-BD-FEV$_1$ (%)	70.87±19.5	65.93±22.62	62.17±19.41	56.01±21.13	<0.001	(a) vs (b); (a) vs (c); (a) vs (d) (b) vs (d); (c) vs (d)

Post-BD-FEV_1/FVC (%)	56.94±10.64	54.56±12.10	53.44±11.29	49.92±12.79	<0.001	(a) vs (b); (a) vs (c); (a) vs (d) (b) vs (d); (c) vs (d)
CAT score	5.48±2.41	12.52±4.46	5.41±2.24	14.62±5.78	<0.001	(a) vs (b); (a) vs (d); (b) vs (c) (b) vs (d); (c) vs (d)
mMRC score	0.78±0.43	1.77±0.79	0.83±0.40	2.33±0.75	<0.001	(a) vs (b); (a) vs (d); (b) vs (c) (b) vs (d); (c) vs (d)
Episode of COPD exacerbation in prior year	0.16±0.37	0.29±0.54	2.88±1.86	3.88±4.90	<0.001	(a) vs (b); (a) vs (c); (a) vs (d) (b) vs (c); (b) vs (d)

Notes: *The post hoc tests were used to show the specific difference between groups as the p-value of overall had statistical significance. a: Group A, b: Group B, c: Group C, d: Group D.

https://doi.org/10.2147/COPD.S349468

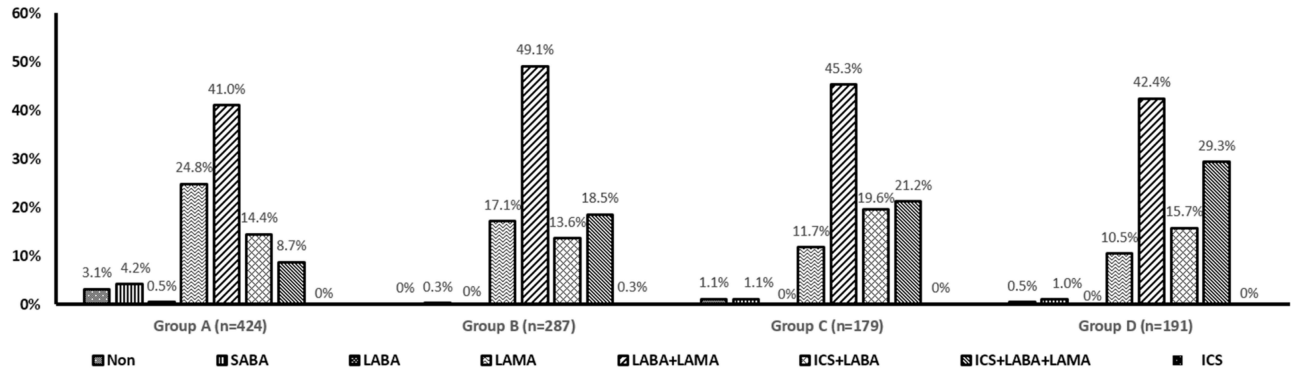

Figure 2 Inhaled bronchodilator uses according to COPD group.

ICS/LABA combination (n = 165, 15.3%). In addition, 16 (1.5%) patients did not use inhaled bronchodilator and 23 (2.1%) patients used short-acting beta agonist (SABA). Dual therapy was the most commonly used inhaled bronchodilator in more than 40% of the patients in each COPD group.

Clinical Outcomes After One-Year Intervention

Table 2 shows the change in pulmonary function, symptomatic scores, and episode of exacerbation between the baseline and after one year. After a year of intervention, 374 (34.6%) and 323 (29.9%) patients had their pre- and post-BD-FEV_1 increase of more than 100 mL. Both the CAT and mMRC scores had a mean change of −2.2 ± 5.5 and −0.3 ± 0.9, respectively. The improvements in pulmonary function and symptom score were observed across four groups. Group C had the most significant improvement in pulmonary function (38.5%), while Groups B and D had more improvement in symptom scores than Groups A and C. The decrease in the risk of exacerbation was only observed in Groups C and D, and not in Groups A and B.

Discussion

This real-world study investigated the impact of a multidisciplinary intervention for patients of COPD in Taiwan and found several significant findings. Overall, the P4P program was found to help improve pulmonary function and reduce

Table 2 The Change of Pulmonary Function, Symptom Score and Number of Exacerbations Between Baseline and One-Year Follow-Up

	Group A (a) (n=424)	Group B (b) (n=287)	Group C (c) (n=179)	Group D (d) (n=191)	P value	Post Hoc Tests*
ΔPre-BD-FEV1 >100 mL, n (%)	146 (34.4)	85 (29.6)	77 (43.0)	66 (34.6)	0.033	(a) vs (c); (b) vs (c)
ΔPost-BD-FEV1 >100 mL, n (%)	123 (29.0)	70 (24.4)	69 (38.5)	61 (31.9)	0.011	(a) vs (c); (b) vs (c)
ΔCAT score	−0.45±3.83	−4.34±6.10	−0.37±3.63	−4.81±6.63	<0.001	(a) vs (b); (a) vs (d); (b) vs (c); (c) vs (d)
ΔmMRC	−0.01±0.67	−0.69±1.06	0.06±0.71	−0.78±1.0	<0.001	(a) vs (b); (a) vs (d); (b) vs (c); (c) vs (d)
Δ Number of exacerbations/ patient/year	0.29±1.17	0.60±2.41	−0.91±2.71	−0.70±4.69	<0.001	(a) vs (c); (a) vs (d); (b) vs (c); (b) vs (d); (c) vs (d)

Notes:*The post hoc tests were used to show the specific difference between groups as the p-value of overall had statistical significance. a: Group A, b: Group B, c: Group C, d: Group D.

the symptom scores of COPD patients after one year. In addition, it was observed that it could reduce the risk of COPD exacerbation among Groups C and D patients. These findings were consistent with previous studies that assessed the impact of COPD care programs on the outcome of COPD patients.[6–9] In the US, the implementation of the Hospital Readmissions Reduction Program (HRRP) resulted in a reduction in the 30-day all-cause readmission rate during the implementation period compared with the preannouncement phase (18.74% vs 20.54%).[6] In Korea, the COPD Quality Assessment Program (CQAP) was launched in 2014 and, the risk of admission and all-cause mortality rate in the assessed subjects group were significantly reduced by 21.2% and 40.7%, respectively, compared to the not-assessed subjects group.[9] In Greece, they implemented an intervention that is comprised of 6 weeks of exercise and education sessions supervised by physiotherapists, nurses, and general practitioners. Clinically important improvements in all outcomes after intervention were documented such as mean differences (95% CIs) for COPD Questionnaire: −0.53 (−0.81, −0.24), CAT: −5.93 (−8.27, −3.60), St. George's Respiratory Questionnaire: −23.00 (−29.42, −16.58), Patient Health Questionnaire-9: −1.10 (−2.32, 0.12), Incremental Shuttle Walking Test: 87.39 (59.37, 115.40).[8] In summary, programs for COPD patients,[6–9] including the P4P program in Taiwan have been shown to help improve the clinical outcome of COPD patients.

In this study, dual therapy with LABA/LAMA was the most common type of long-acting bronchodilator, with over 40% of the patients in Groups A, B, C, and D were using it. This is different from the GOLD guideline,[10] in which dual therapy was recommended as one of the initial treatments for Group D patients. According to the clinical recommendations of the American Thoracic Society for the pharmacologic treatment of COPD patients,[11] dual therapy with LABA/LAMA can help decrease exacerbation and hospitalization, and improve dyspnea and quality of life better than monotherapy. Although this panel also noted that dual therapy is more expensive than long-acting bronchodilator monotherapy, and that this could pose health-equity challenges to patients of limited means who might be unable to obtain the drug because of cost or lack of availability, Taiwan has a totally different condition. Under the National Health Insurance in Taiwan, dual therapy was even cheaper than monotherapy and all patients could obtain medical treatment at a low cost. Therefore, this situation resulted in more COPD patients using dual therapy in Taiwan, as observed in the present study. In addition, non-adherence to the guideline is not uncommon in real-world studies.[12–16] In Belgium, a random survey of 386 general practitioners (GPs) and 86 pulmonologists reported that 49% of GPs and 25% of pulmonologists used ICS considerably more often than recommended by the guidelines; with some even prescribing them to all their COPD patients.[12] A similar situation of ICS overtreatment was observed in a Swiss teaching hospital.[13] Another survey of 364 subjects using the Geisinger Health System database disclosed that 39 of 68 patients who used dual therapy with LABA/LAMA were non-adherent to current GOLD guidelines.[14] In addition, non-adherence to the GOLD guideline was observed in 180 of 387 patients who were using LABA/ICS, and 25 of 57 patients who were using triple therapy.[14] Non-adherence to the guideline may be associated with a worse outcome than guideline adherence.[14,16–18] However, this kind of scenario might be different in the present study, in which low-cost dual therapy could be more effective than monotherapy for COPD patients with low disease activity. This kind of management was supposed to be associated with a better outcome of COPD patients; however, further study is needed to clarify this issue.

COPD patients in group D, characterized with high number of moderate or severe exacerbations and symptoms, the initial therapy can combine LABA/LAMA bronchodilation therapy. In case of further exacerbations or increased symptoms, they considered to prescript for triple therapy (LABA/LAMA/ICS) according to treatment guidelines. A similar result was also found in previous study. A study aimed to assess the adherence to a COPD treatment guideline among patients in Hong Kong[19] based on Global Initiative for Chronic Obstructive Lung Disease (GOLD) guideline published in 2011 and they showed 65.7% of groups D patients received LABA/LAMA/ICS and 20.8% of groups D patients received LABA/ICS. ICS are usually prescribed in patients with COPD who experience frequent exacerbations. However, we know that patients with COPD and eosinophilic inflammation tend to respond to ICS and not all patients with COPD have a beneficial to ICS treatment. LABA/LAMA bronchodilation can reduce COPD exacerbations, add-on ICS therapy to treat COPD should be restricted to patients who are more likely to benefit.[20]

There were several limitations in this study. First, the number of patients was limited and the analyses were based on the data collected in four hospitals in Taiwan. Thus, our findings might not be generalized to other countries or

populations. Second, we only included patients with regular follow-up for one year, which made it difficult to assess the impact of the P4P program on mortality. Third, most of the patients in this retrospective study did not have some of the data needed for further analysis, so we could not assess the confounding effect of biomarkers, especially eosinophil counts. Fourth, the confounding effect of smoking did not evaluate in this study.

Conclusion

According to the Official American Thoracic Society Clinical Practice Guideline, dual therapy was strongly recommended for in patients with COPD and dyspnea or exercise intolerance,[11] particularly in Taiwan, where dual therapy is cheaper than mono-therapy. This real-world study demonstrated that the intervention of the P4P program can help improve the clinical outcome of COPD patients. It also provided a different view regarding the use of dual therapy, which is considerably cheaper in Taiwan than in other countries making it readily available for mass usage.

Disclosure

The authors report no conflicts of interest in this work.

References

1. Li X, Cao X, Guo M, Xie M, Liu X. Trends and risk factors of mortality and disability adjusted life years for chronic respiratory diseases from 1990 to 2017: systematic analysis for the Global Burden of Disease Study 2017. *BMJ*. 2020;368:m234. doi:10.1136/bmj.m234
2. GBD 2015 Chronic Respiratory Disease Collaborators.. Global, regional, and national deaths, prevalence, disability-adjusted life years, and years lived with disability for chronic obstructive pulmonary disease and asthma, 1990–2015: a systematic analysis for the Global Burden of Disease Study 2015. *Lancet Respir Med*. 2017;5(9):691–706. doi:10.1016/S2213-2600(17)30293-X
3. Wang YC, Lin JM, Li CY, Lee LT, Guo YL, Sung FC. Prevalence and risks of chronic airway obstruction: a population cohort study in Taiwan. *Chest*. 2007;131(3):705–710. doi:10.1378/chest.06-1829
4. Lim S, Lam DC, Muttalif AR, et al. Impact of chronic obstructive pulmonary disease (COPD) in the Asia-Pacific region: the EPIC Asia population-based survey. *Asia Pac Fam Med*. 2015;14(1):4.
5. Lin CH, Yu CJ, Wang HC, Lin MC, Cheng SL. The beneficial effect of COPD pay-for-performance program in Taiwan. In: International perspectives on pulmonary and critical care medicine. *American Thoracic Society*; 2020:A6566.
6. Puebla Neira DA, Hsu ES, Kuo YF, Ottenbacher KJ, Sharma G. Readmissions reduction program: mortality and readmissions for chronic obstructive pulmonary disease. *Am J Respir Crit Care Med*. 2021;203(4):437–446. doi:10.1164/rccm.202002-0310OC
7. Myers LC, Faridi MK, Hasegawa K, Hanania NA, Camargo CA Jr. The hospital readmissions reduction program and readmissions for chronic obstructive pulmonary disease, 2006–2015. *Ann Am Thorac Soc*. 2020;17(4):450–456. doi:10.1513/AnnalsATS.201909-672OC
8. Anastasaki M, Trigoni M, Pantouvaki A, et al. Establishing a pulmonary rehabilitation programme in primary care in Greece: a FRESH AIR implementation study. *Chron Respir Dis*. 2019;16:1479973119882939. doi:10.1177/1479973119882939
9. Park HJ, Kim SR, Kim S, et al. Influence of government-driven quality assessment program on patients with chronic obstructive pulmonary disease. *Respir Res*. 2021;22(1):87. doi:10.1186/s12931-021-01684-1
10. Halpin DMG, Criner GJ, Papi A, et al. Global Initiative for the Diagnosis, Management, and Prevention of Chronic Obstructive Lung Disease. The 2020 GOLD Science Committee Report on COVID-19 and Chronic Obstructive Pulmonary Disease. *Am J Respir Crit Care Med*. 2021;203(1):24-36.
11. Nici L, Mammen MJ, Charbek E, et al. Pharmacologic management of chronic obstructive pulmonary disease. An official American Thoracic Society Clinical Practice Guideline. *Am J Respir Crit Care Med*. 2020;201(9):e56–e69.
12. Decramer M, Bartsch P, Pauwels R, Yernault JC. Management of COPD according to guidelines. A national survey among Belgian physicians. *Monaldi Arch Chest Dis*. 2003;59(1):62–80.
13. Fritsch K, Jacot ML, Klarer A, et al. Adherence to the Swiss guidelines for management of COPD: experience of a Swiss teaching hospital. *Swiss Med Wkly*. 2005;135(7–8):116–121.
14. Asche CV, Leader S, Plauschinat C, et al. Adherence to current guidelines for chronic obstructive pulmonary disease (COPD) among patients treated with combination of long-acting bronchodilators or inhaled corticosteroids. *Int J Chron Obstruct Pulmon Dis*. 2012;7:201–209. doi:10.2147/COPD.S25805
15. 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. doi:10.1007/s11845-017-1651-7
16. Świątoniowska N, Chabowski M, Polański J, Mazur G, Jankowska-Polańska B. Adherence to therapy in chronic obstructive pulmonary disease: a systematic review. *Adv Exp Med Biol*. 2020;1271:37–47.
17. Cousins JL, Wood-Baker R, Wark PAB, et al. Management of acute COPD exacerbations in Australia: do we follow the guidelines? *ERJ Open Res*. 2020;6(2):00270–2019. doi:10.1183/23120541.00270-2019
18. Torres-Robles A, Benrimoj SI, Gastelurrutia MA, et al. Effectiveness of a medication adherence management intervention in a community pharmacy setting: a cluster randomised controlled trial. *BMJ Qual Saf*. 2022;31(2):105–115. doi:10.1136/bmjqs-2020-011671
19. Chan KP, Ko FW, Chan HS, et al. Adherence to a COPD treatment guideline among patients in Hong Kong. *Int J Chron Obstruct Pulmon Dis*. 2017;12:3371–3379. doi:10.2147/COPD.S147070
20. Papaioannou AI, Loukides S, Bakakos P, et al. Dual bronchodilator in the era of triple therapy. *Int J Chron Obstruct Pulmon Dis*. 2020;15:2695–2705. doi:10.2147/COPD.S273987