Respiratory Medicine (2014) 108, 1771–1778

Available online at www.sciencedirect.com

ScienceDirect

journal homepage: www.elsevier.com/locate/rmed

# COPD care programme can reduce readmissions and in-patient bed days

**Fanny W.S. Ko, Jenny C.N. Ngai, Susanna S.S. Ng, Ka-pang Chan, Rita Cheung, Mei-yi Leung, Man-chi Pun, David S.C. Hui***

*Department of Medicine and Therapeutics, The Chinese University of Hong Kong, Hong Kong*

Received 25 July 2014; accepted 30 September 2014
Available online 18 October 2014

**KEYWORDS**
COPD programme;
Readmissions;
Exacerbations

**Summary**
*Background:* Chronic obstructive pulmonary disease (COPD) is a common disease worldwide with significant morbidity and mortality.
*Aim:* To investigate the effect of a comprehensive COPD management programme in decreasing COPD readmissions 1 year before and 1 year after the programme.
*Method:* 185 (166 males) patients admitted for acute exacerbation of COPD (AECOPD) were recruited between September 2010 and December 2012. COPD care team provided crisis support and maintenance therapy for the COPD patients for a total of 16 weeks. The protocol included COPD clinic run by respiratory physicians, COPD education and nurse clinics by respiratory nurses, out-patient pulmonary rehabilitation programme by physiotherapists, fast track doctor's clinic, telephone hotline for patients and nurse telephone calls to patients. Readmissions over a period of 1 year were assessed.
*Results:* The mean (SD) age of the subjects and $FEV_1$ % predicted normal were 76.9 ± 7.37 yrs and 44.4 ± 20.7% respectively. 40 (21.6%) patients required non-invasive positive pressure ventilation during the recruitment admission. Admissions for AECOPD decreased from 2.39 ± 2.05 one year before programme to 1.65 ± 2.1 one year after programme (mean difference 0.75 ± 2.11 episodes, $p < 0.001$). The length of hospital stay was reduced from 12.17 ± 9.14 days one year before programme to 9.09 ± 12.1 days one year after the programme (mean difference 3.09 ± 12.1 days, $p < 0.001$). The $FEV_1$ percentage predicted and quality of life measured by St George's Respiratory Questionnaire showed no significant improvement at 16 weeks after recruitment into the programme as compared to at 6 weeks.
*Conclusion:* COPD care programme is effective in decreasing readmissions and length of hospital day for COPD patients.


* Corresponding author. Department of Medicine and Therapeutics, The Chinese University of Hong Kong, Prince of Wales Hospital, 30-32 Ngan Shing Street, Shatin, New Territories, Hong Kong. Tel.: +852 2632 2785; fax: +852 2637 5396.
*E-mail address:* dschui@cuhk.edu.hk (D.S.C. Hui).

http://dx.doi.org/10.1016/j.rmed.2014.09.019
0954-6111/

## Introduction

COPD is a common disease worldwide [1,2] with significant morbidity and it incurs heavy utilization of healthcare resources. The prevalence of COPD varied from 11.4 to 26.1% in a multi-city population study with spirometry [1]. In 2005, COPD ranked second as a respiratory cause for hospitalization and inpatient bed days in Hong Kong. Among those >75 years of age, hospitalization rate for acute exacerbation of COPD (AECOPD) was as high as 2225/100,000 [3]. The prevalence of moderate COPD, using the spirometric reference of $FEV_1/FVC$ ratio of <70%, among 1008 elderly HK Chinese (age ≥60 years) in the community, were 19.6% and 11.9% in the male and female subjects respectively [4].

Efforts have been made to test various integrated programmes for the COPD patients in an attempt to improve their quality of life and reduce hospital readmissions in various countries. These interventions include disease specific self-management plans [5,6], implementation of the chronic care model [7], integrated model with multidisciplinary input [8] and home visits by respiratory health workers [9–11], with mixed success. A recent study even found that a comprehensive care management programme could not decrease COPD-related hospitalizations and the trial was terminated prematurely due to the unanticipated excess mortality in the active arm [12]. It is thus important to explore other COPD programme for its efficacy and safety.

The target group of this study consisted of severe COPD patients who required hospitalization for management of their exacerbation (about 1/5 of our subjects were using home oxygen therapy at baseline and 1/5 required non-invasive positive ventilation (NPPV) support during hospital admission). We aimed to assess if the comprehensive care programme would confer benefit to this group of "severe COPD patients" by decreasing their readmissions for AECOPD.

## Methods

We assessed the readmissions and length of hospital stay for AECOPD for our patients 1 year before and 1 year after the programme. The quality of life, lung function and exercise capacities of the patient were also assessed at 6 weeks and 16 weeks post discharge from the hospital. This was basically an audit of our service programme by comparing changes involving the subjects before and after the programme and there was thus no control group. There is no need for ethical committee approval for clinical audit in our institution. All patients who joined our programme had given verbal consent for their clinical data to be used for auditing purposes. The programme commenced in September 2010 and we included the subjects who had first

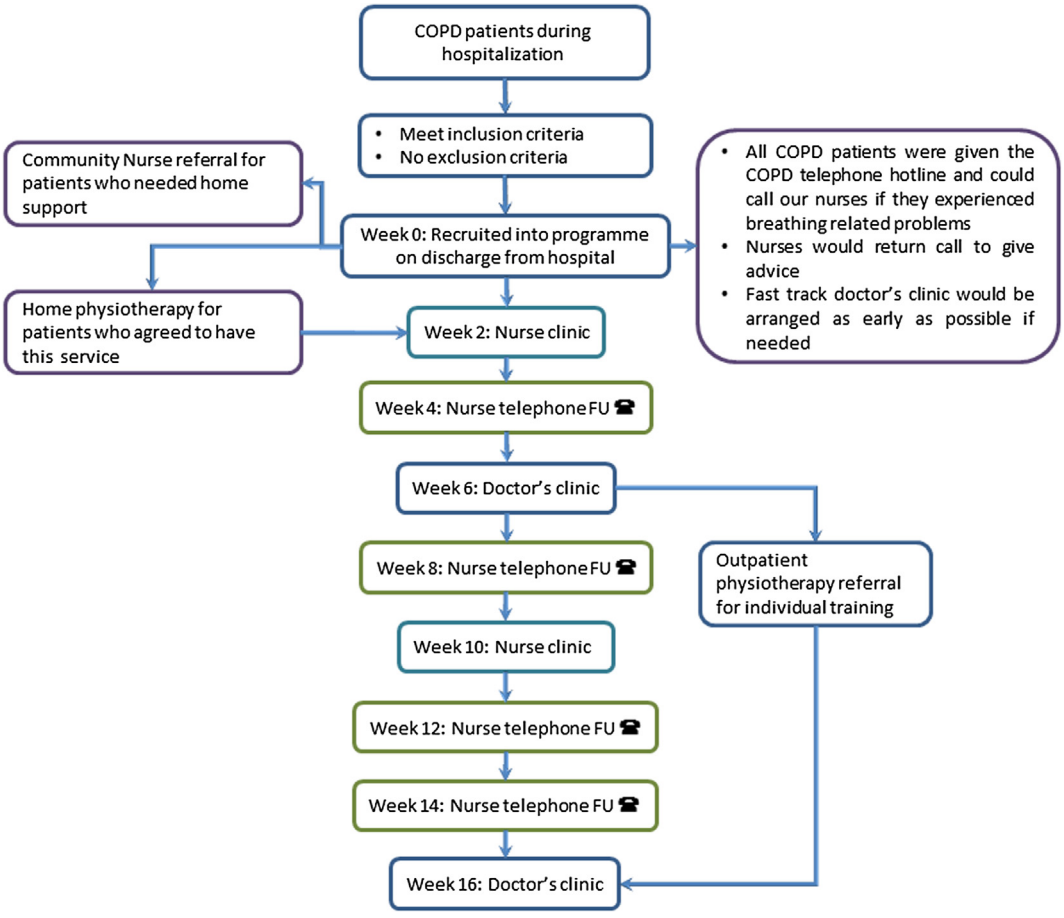


**Figure 1** Workflow of the COPD care programme.

joined the programme from September 2010 to December 2012 in this audit.

Patients who were hospitalized for AECOPD at the Prince of Wales Hospital, a tertiary teaching hospital affiliated with the Chinese University of Hong Kong with 1500 beds, were recruited into this programme. AECOPD was defined as a patient with background COPD who presented with at least two of the following major symptoms (increased dyspnoea, increased sputum purulence, increased sputum volume) or one major and one minor symptom (nasal discharge/congestion, wheeze, sore throat, cough) for at least two consecutive days. Exclusion criteria included patients who have terminal malignancy or serious major organ disease (e.g. severe renal failure not offering renal replacement therapy, severe liver disease and intractable heart failure) with limited expected survival.

Our programme consisted of input from a COPD care team, including respiratory physicians, respiratory nurses, physiotherapists and community nurses (CS), who provided crisis support and maintenance therapy for up to 16 weeks for the COPD patients. Due to the limited resources, we only enrolled up to 2 patients per day on weekdays. Patients were identified by the respiratory nurse in the medical wards and invited to join our programme. The nurse would explain the nature of the programme and obtain permission for using his/her data to assess the effectiveness of the programme. The protocol included designated COPD clinic run by respiratory physicians, COPD education and nurse clinics managed by respiratory nurses, out-patient pulmonary rehabilitation programme by physiotherapists, fast track doctor's clinic, telephone hotline (patient could talk to respiratory nurse directly during office hours. After office hours, calls were recorded and returned as soon as possible in the next working day) and other post-discharge support (CS visits and out-patient physiotherapist training) (Fig. 1).

The COPD education sessions were conducted in the nurse clinics on a one to one basis (total 2 sessions, first session lasted for 45 min to 1 h and second session lasted for 30—45 min). The patients were provided with general knowledge of COPD (the causes, simple pathology, symptoms and treatment) and their inhaler techniques were checked and errors corrected. In addition, the respiratory nurses made telephone calls to patients at week 4, 8, 12 and 14 following hospital discharge to discuss with the patients over their COPD management and offer advice or fast tract clinics (doctor/nurse clinic) as appropriate. In addition, patients were offered out-patient physiotherapy training sessions (up to 3 times a week for 3 months, each session 1 h). If patients were reluctant to return for these sessions, training on home exercise would be provided.

Patients also attended the doctor's clinic on week 6 and week 16 post discharge, where the medical therapy of their COPD was optimized according to guidelines [13] and co-morbid illnesses managed by the respiratory physician. At the doctor's visit, the height and weight of the subjects were measured. In addition, spirometry pre and post-bronchodilator and 6 min walk test [14] were performed. Subjects also completed the St George's Respiratory Questionnaire (SGRQ) [15] for assessment of quality of life and the modified Medical Research Council (mMRC) questionnaire [16] for assessment of subjective feeling of dyspnoea. Data of the hospital admissions (including the number of admissions and length of stay) before recruitment into the programme were charted by both reviewing the record and cross-checking with the patient during the first visit to the doctor's clinic. Their subsequent hospital admissions and mortality after the index admission were recorded up to a period of 12 months. The information was collected at the doctor's clinic at 16 weeks and patients were also contacted by phone and also their hospital records were checked at 12 months.

We have estimated the sample size needed to decrease 0.5 episode of readmission after the programme. Based on previous study [17] on integrated care on prevention of readmissions (with 0.9 $\pm$ 1.3 vs 1.3 $\pm$ 1.7 readmissions in the following year in the intervention versus the usual care group), a sample size of 122 was needed for a statistically significant effect of 0.5 episode reduction in readmissions over a year period by accepting an alpha risk of 0.05 and a beta risk of 0.15 in a two-sided test.

Analysis was conducted using Statistical Package for the Social Sciences Version 21.0 (IBM Corporation, NewYork, USA). Demographic data were presented as the number (%)

**Table 1** Demographic data of the subjects ($n$ = 185).

| | | |
|---|---|---|
| Male/female | | 166 male/ 19female |
| Age (years) | | 76.9 $\pm$ 7.37 |
| Smoking history | | |
| Current smoker | | 34 (18.3) |
| Ex-smoker | | 144 (77.8) |
| Non-smoker | | 7 (3.8) |
| Post-bronchodilator | $FEV_1$ (L) | 0.86 $\pm$ 0.39 |
| | FVC (L) | 1.73 $\pm$ 0.63 |
| | $FEV_1$ % predicted normal | 44.4 $\pm$ 20.7 |
| | FVC % predicted normal | 63.6 $\pm$ 21.5 |
| | $FEV_1$/FVC ratio (%) | 49.6 $\pm$ 13.4 |
| $FEV_1$% predicted normal | $\geq$80% | 11 (5.9) |
| | $\geq$50—79% | 55 (29.7) |
| | $\geq$30—49% | 68 (36.8) |
| | <30% | 51 (27.6) |
| 6 min walk test (meters) | | 194 $\pm$ 131 |
| BMI ($kg/m^2$) | | 21.02 $\pm$ 4.15 |
| MMRC | | 2.5 $\pm$ 1.01 |
| Baseline medications | Inhaled SABA | 166 (89.7%) |
| | Inhaled LAMA | 18 (9.7%) |
| | Inhaled LABA | 94 (50.8%) |
| | ICS | 159 (85.9%) |
| | Theophylline | 44 (23.8%) |
| Number of COPD exacerbations in the previous 12 months | | 2.39 $\pm$ 2.05 |
| On home oxygen therapy | | 38 (20.5%) |
| Need for NIV in the recruitment admission | | 40 (21.6%) |

Data are presented as mean $\pm$ SD or $n$ (%).
SABA = short acting beta agonist, LAMA = long acting muscarinic agent, LABA = long acting beta agonist, ICS = inhaled steroid.

**Table 2** Number of admissions and length of hospital stay before and after the programme ($n = 185$).

| | 1 year before programme | 1 year after programme | Mean difference | *p*-value |
|---|---|---|---|---|
| Number of admissions | 2.39 ± 2.05 | 1.65 ± 2.1 | 0.75 ± 2.11 (↓ 31.2%) | <0.001 |
| Length of stay (days) | 12.17 ± 9.14 | 9.09 ± 12.1 | 3.09 ± 12.1 (↓ 25.4%) | <0.001 |
| | 6 months before programme | 6 months after programme | Mean difference | *p*-value |
| Number of admissions | 1.79 ± 1.23 | 0.96 ± 1.42 | 0.83 ± 1.35 (↓ 46.4%) | <0.001 |
| Length of stay (days) | 9.70 ± 6.96 | 5.26 ± 8.70 | 4.44 ± 8.95 (↓ 45.7%) | <0.001 |

or mean ± standard deviation(SD). Comparison of the pre- and post programme parameters including the length of hospital stay and number of admissions were analysed using the two-tailed Student's *t*-test, and for non-normally distributed data the non-parametric Wilcoxon signed rank test was used. *P* value of <0.05 was considered as statistically significant.

## Results

The demographic characteristics of our subjects are shown in Table 1. There were altogether 224 subjects who had joined our programme. Eight subjects passed away before the first doctor's follow up and 24 refused to return for follow up. The age and sex of those subjects who refused to return for follow up were similar to the subjects who returned for follow up. In the first doctor's follow up, 3 refused spirometry examination and 4 did not have obstructive pattern on spirometry. We had thus included the 185 subjects who attended the first doctor clinic follow up with spirometry confirmed COPD in this analysis. Our patients were mostly male with a mean $FEV_1$ of 43.2 ± 20.2% predicted normal. Forty (21.6%) of these patients required NPPV support in the recruitment admission.

All of the 185 subjects included in the analysis had agreed to have nurse follow up by phone calls and returned to nurse and doctor's clinics. 125 patients agreed to have assessment by physiotherapists and these subjects all had attended at least 1 session (2 h) of out-patient physiotherapy training and learned about home exercise. Only 32 subjects agreed for a prolonged course of out-patient exercise training whereas 20 subjects could complete 80% or more of the 3-month (3 times a week) exercise training programme. Only 3 patients agreed for home physiotherapist visits and 2 agreed for visits by community nurse. Ten and 31 patients died at 6 months and 12 months after recruitment into the programme, respectively. The number of subjects that had participated different components of the comprehensive programme is shown in Supplementary Table 1.

Table 2 shows the number of hospitalizations and length of hospital stay before and after 6 and 12 months of the programme. At both 6 months and 12 months after joining the programme, the number of hospitalizations and length of hospital remained lower than before joining the programme and the reduction had reached statistical significance (hospitalizations for AECOPD 6 month before and after the programme were 1.79 ± 1.23 vs 0.96 ± 1.42 times, $p \leq 0.001$; length of hospital stay for AECOPD 6 month before and after the programme were 9.70 ± 6.96 vs 5.26 ± 8.70days, $p \leq 0.001$; hospitalizations for AECOPD 12 months before and after the programme were 2.39 ± 0.05 vs 1.65 ± 2.1.times, $p \leq 0.001$; length of hospital stay for AECOPD 12 months before and after the programme were 12.17 ± 9.14 vs 9.09 ± 12.1 days, $p \leq 0.001$). We also performed analysis comparing if patients with different age groups, baseline lung function, MMRC score, 6 min walk test distance and SGRQ score would have any impact on their readmissions and length of hospital stay before and after the programme. We found that their outcomes were not affected by the above factors (Supplementary Table 2).

Even after excluding those cases that had deceased in the calculation of hospitalizations and length of stay for AECOPD, the reduction of the hospitalizations and length of hospital stay for AECOPD remained significant at 6 and 12 months (Table 3).

We also assessed the patients' $FEV_1$, 6 min walk test, MMRC score and SGRQ score at the doctor's clinic at 6 and 16 weeks post recruitment to the programme (Table 4). Comparing these parameters at week 16 vs week 6, patients had significant improvement in the post-bronchodilator FVC (1.77 ± 0.63 vs 1.83 ± 0.66, $p = 0.04$). The MMRC and SGRQ score remained unchanged during these time points.

**Table 3** Number of admissions and length of hospital stay before and after the programme, after excluding all subjects who died after recruitment into the programme ($n = 154$ in 1 year, $n = 175$ in 6 months).

| | 1 year before programme | 1 year after programme | Mean difference | *p*-value |
|---|---|---|---|---|
| Number of admissions | 2.15 ± 1.91 | 1.54 ± 2.11 | 0.61 ± 1.97 (↓ 28.4%) | <0.001 |
| Length of stay (days) | 10.8 ± 8.1 | 8.20 ± 11.94 | 2.60 ± 11.1 (↓ 24.1%) | <0.001 |
| | 6 months before programme | 6 months after programme | Mean difference | *p*-value |
| Number of admissions | 1.76 ± 1.21 | 0.89 ± 1.35 | 0.87 ± 1.35 (↓ 49.4%) | <0.001 |
| Length of stay (days) | 9.41 ± 6.49 | 4.72 ± 8.2 | 4.69 ± 8.82 (↓ 49.8%) | <0.001 |

**Table 4** Comparison of the lung function, quality of life, exercise capacity, dyspnoea score of patients at 6 weeks and 16 weeks after joining the programme.

| | | *N* | 6-week | 16-week | *p*-value |
|---|---|---|---|---|---|
| Pre-bronchodilator | $FEV_1$ (L) | 167 | 0.86 ± 0.37 | 0.88 ± 0.37 | 0.11 |
| | FVC (L) | | 1.71 ± 0.62 | 1.77 ± 0.64 | 0.04 |
| | $FEV_1$ % predicted normal | | 44.6 ± 20.0 | 45.4 ± 18.8 | 0.21 |
| | FVC % predicted normal | | 62.6 ± 21.1 | 64.5 ± 20.2 | 0.10 |
| | $FEV_1$/FVC ratio (%) | | 50.9 ± 13.2 | 50.5 ± 13.6 | 0.61 |
| Post-bronchodilator | $FEV_1$ (L) | 167 | 0.89 ± 0.38 | 0.9 ± 0.38 | 0.31 |
| | FVC (L) | | 1.77 ± 0.63 | 1.83 ± 0.66 | 0.04 |
| | $FEV_1$ % predicted normal | | 46.0 ± 20.4 | 46.4 ± 19.3 | 0.49 |
| | FVC % predicted normal | | 64.8 ± 21.4 | 66.5 ± 20.8 | 0.11 |
| | $FEV_1$/FVC ratio (%) | | 50.5 ± 12.6 | 49.9 ± 13.3 | 0.49 |
| 6 min walk test (m) | | 172 | 205 ± 128 | 208 ± 127 | 0.29 |
| mMRC | | 168 | 2.43 ± 1.01 | 2.38 ± 1.00 | 0.42 |
| SGRQ | Symptoms | 164 | 54.6 ± 18.4 | 58.0 ± 17.3 | 0.05 |
| | Activities | | 56.8 ± 30.3 | 55.1 ± 31.1 | 0.60 |
| | Impacts | | 34.9 ± 28.6 | 35.1 ± 26.7 | 0.85 |
| | Total score | | 44.8 ± 25.3 | 45.0 ± 24.3 | 0.90 |

Data are presented as mean ± SD.
mMRC = modified Medical Research Council questionnaire; SGRQ= St George's Respiratory Questionnaire.

## Discussions

This study has shown that a comprehensive COPD programme consisting of input from respiratory physicians, nurses and physiotherapists that involved optimization of COPD drug treatment, management of comorbidities (data not shown), patient education, telephone call by nurses, telephone hotline for advice, and physiotherapy training, was effective in decreasing hospital readmissions and length of hospital stay among the enrolled subjects with COPD in comparisons to 1 year before joining the programme.

Since this was a multi-disciplinary programme, we could not differentiate which component had made the programme a success. A previous meta-analysis found that implementation of the chronic care model for COPD had no effect on symptoms, quality of life, lung function, and functional status, but could decrease emergency/unscheduled visits and hospitalizations for the group that received at least 2 chronic care model components [7]. Our results concur with the finding in this meta-analysis. The interventions in this meta-analysis were categorized into several components: self-management, delivery system design, decision support and clinical information system [7]. Our programme had provided all of these components, including education (part of self-management as defined in the meta-analysis), "advanced access" to medical care through our telephone hotline and fast tract clinics (delivery system design), guideline based pharmacotherapy for treatment of COPD (decision support) and nurse call for providing support (clinical information system). A recent meta-analysis on integrated programme that included interventions consisting of multidisciplinary team (two or more health care providers) and multi-treatment (two or more components) with a duration of at least three months found that this type of programme not only improved disease-specific quality of life and exercise capacity, but also reduced hospital admissions and hospital days per person [8].

Previous studies on self-management showed conflicting results in decreasing AECOPD and hospitalizations [18,19]. A programme that involved patient education, stock of steroid and antibiotic with action plan, together with case manager follow up and patient's phone call to case managers as needed was able to decrease hospitalizations [18]. Another programme by Monninkhof et al. consisting of patient education, stock of steroid and antibiotic with action plan, and exercise programme but no case manager follow up/phone calls [19] found that the intervention group reported more exacerbations than the control group. However, this study did not assess readmissions for AECOPD and could not demonstrate benefits in quality of life and symptoms. Another study by Rice et al. involving patients receiving a single 1- to 1.5-h education session, an action plan for self-treatment of exacerbations, and monthly follow-up calls from a case manager for 1 year was able to reduce hospitalizations and emergency department visits for COPD [20]. In our study, we did not include a written action plan or prescription of any stock of antibiotic and prednisolone to patients for self-administration when the patient experienced increasing symptoms or exacerbation. Instead we offered education, a telephone hotline and access to fast track clinic. Education for self-management of exacerbations included use of bronchodilator, relaxed breathing, reduced physical exertion and calling our nurses for opinions. The diversity of components in different programmes makes direct comparisons difficult. It appears that contact with nurses/case managers plays an important role in decreasing recurrent COPD admissions. A previous study of patients discharged from hospital with AECOPD with an intermediate care package incorporating pulmonary rehabilitation, self-management education and the receipt of a written COPD action plan, together with regular nurse contact, demonstrated a reduced need for

unscheduled primary care consultations and a reduction in deaths due to COPD but did not affect the hospital readmission rate [21]. Another study on a nurse-led 24-h hotline for patients found that this strategy could reduce hospital presentations with AECOPD [22].

Optimization of drug treatment might have played an important role in our programme. Many of our patients were not receiving long-acting anti-cholinergics at their baseline visits and we optimized their therapy by adding tiotropium. A previous study has shown that tiotropium, in comparisons to placebo, could provide benefit over sustained improvement in lung function, reductions in exacerbations and risk of exacerbation-related hospitalizations, and improvement in health status [23]. About 50% of our patients were not taking long-acting beta agonist (LABA) in the baseline visit and as these patients just had an episode of AECOPD. LABA and inhaled steroid (ICS) combination added in a large scale study has shown that combination LABA and ICS can decrease COPD exacerbations, but not mortality [24].

In our study, only a minority agreed for a formal out-patient exercise programme whereas most had agreed to return for assessment and be instructed to perform unsupervised exercise at home. Previous studies have shown that the acceptability of pulmonary rehabilitation was a major concern whereas feasibility of attending was an issue for some [25,26]. Our programme offered home physiotherapy and home visits by physiotherapists, but many declined due to the cost concerned. Out-patient programme involving multiple sessions was not well accepted by the majority of our patients. Most patients refused home visits by community nurses in our programme due to both the cost and doubt over its effectiveness. A previous study in Hong Kong found that intensive community nurse-led discharge programme could not prevent hospital readmissions in older patients with chronic lung disease [27].

A multicenter randomized control trial (RCT) of comprehensive care management program aiming at reducing the risk for COPD hospitalization was terminated because of excess mortality in the intervention group [12]. In addition, this programme involving patients with severe COPD had not decreased COPD-related hospitalizations [12]. The mortality rate was 13.3% in the intervention group versus 4.6% in the control group with a mean follow up of 250 days. Our mortality rate was high at 8.8% at 6 months and 21.1% at 12 months. Our study probably involved older and sicker patients than the study by Fan et al. In addition, our mean number of admissions in the 12 months prior to the recruitment was 2.5, with 21.6% requiring NPPV support during the recruitment admission. Previous studies on patients with COPD revealed high mortality among those with recurrent admissions and in particular admissions with respiratory failure requiring NPPV support [28] After excluding those subjects who had died in the follow up period, the patients who were alive at 12 months still had less hospital admissions/length of hospital stay than 1 year before the programme, suggesting the COPD programme was effective in decreasing recurrent admissions for AECOPD.

COPD management programme applied in different settings and patient groups may also have different results. A Canadian self-management programme "Living well with COPD." involving education, exercise programme and managed by respiratory specialist appears to reduce hospital utilization in a group of Canadian COPD patients [5]. However, a similar programme with less intensive education and no exercise training managed by primary care physicians in a group of Dutch patients was unable to show long term benefits in terms of quality of life or self-efficacy [29]. An intensive education component with exercise training component may be important to achieve improvement in clinical outcomes. However, a recent RCT found that adding an educational component to a pulmonary rehabilitation exercise programme could not improve the exercise capacity, quality of life and health care usage [30]. We suggest every programme must be audited for their efficacy.

There are several limitations in this study. This was not a RCT and there were no controls for comparisons. In addition, we did not compare the baseline characteristics of the subjects for those subjects who joined and those who did not join the programme. Change in meterological factors, influenza seasions, occupancy level of wards might also affect hospitalization rate and length of stay. However, the promising result of this programme reflected a "real-life field setting", with a 28.4% decrease in the number of readmissions and 24.1% reduction in length of hospital stay 1 year after the programme. This study not only contributed by filling in some gap in the knowledge about a comprehensive programme in a real life setting, but also provided more information on the effect of a comprehensive programme on a group of relatively more severe COPD patients. As this was a multi-disciplinary service programme, we were unable to identify which components had contributed more to the reduction in readmissions for AECOPD. The optimization of medications (change of medication in 66.5% of our patients in the first doctor's visit), education by our nurses (received by all our subjects), optimization of management of comorbidities at the doctor's clinic probably all played significant roles in decreasing readmissions for AECOPD in our group of patients.

In conclusion, this study has shown that a multi-disciplinary COPD service programme could reduce hospital admissions and length of hospital stay. Further RCTs are needed to provide a more accurate assessment of the relative importance of the individual components of COPD programme packages and the effectiveness of the programme through objective measurements, including readmission rates, quality of life and exercise capacity.

## Conflict of interest

All authors have no conflict of interest to declare.

## Summary at a glance

Multi-disciplinary COPD service programme (including COPD clinic by respiratory physicians, COPD education and nurse clinics by respiratory nurses, out-patient pulmonary rehabilitation programme by physiotherapists, fast track doctor's clinic, telephone hotline for patients and nurse

telephone calls to patients) could lead to reduction in hospital admissions and length of hospital stay.

## Authors contribution

Fanny Ko and David Hui designed the programme and the audit. Fanny Ko, Jenny Ngai, Alvin Tung, Susanna Ng, Kapang Chan recruited the subjects and looked after the patients in the doctor's clinic. Rita Cheung managed the data and performed the statistical analysis. Mei-yi Leung and Man-chu Pun performed patient education, ran the nurse clinics and were responsible for the telephone calls. All authors contributed to the manuscript writing.

## Appendix A. Supplementary data

Supplementary data related to this article can be found at http://dx.doi.org/10.1016/j.rmed.2014.09.019.

## References


[1] Buist AS, McBurnie MA, Vollmer WM, Gillespie S, Burney P, Mannino DM, Menezes AM, Sullivan SD, Lee TA, Weiss KB, Jensen RL, Marks GB, Gulsvik A, Nizankowska-Mogilnicka E. International variation in the prevalence of COPD (the BOLD Study): a population-based prevalence study. Lancet 2007; 370:741—50.

[2] Ko FW, Hui DS, Lai CK. Worldwide burden of COPD in high- and low-income countries. Part III. Asia-Pacific studies. Int J Tuberc Lung Dis 2008;12:713—7.

[3] Chan-Yeung M, Lai CK, Chan KS, Cheung AH, Yao TJ, Ho AS, Ko FW, Yam LY, Wong PC, Tsang KW, Lam WK, Ho JC, Chu CM, Yu WC, Chan HS, Ip MS, Hui DS, Tam CY. The burden of lung disease in Hong Kong: a report from the Hong Kong Thoracic Society. Respirology 2008;13(Suppl. 4):S133—65.

[4] Ko FW, Woo J, Tam W, Lai CK, Ngai J, Kwok T, Hui DS. Prevalence and risk factors of airflow obstruction in an elderly Chinese population. Eur Respir J 2008;32:1472—8.

[5] Bourbeau J, Julien M, Maltais F, Rouleau M, Beaupre A, Begin R, Renzi P, Nault D, Borycki E, Schwartzman K, Singh R, Collet JP. Reduction of hospital utilization in patients with chronic obstructive pulmonary disease: a disease-specific self-management intervention. Arch Intern Med 2003;163:585—91.

[6] Martin IR, McNamara D, Sutherland FR, Tilyard MW, Taylor DR. Care plans for acutely deteriorating COPD: a randomized controlled trial. Chron Respir Dis 2004;1:191—5.

[7] Adams SG, Smith PK, Allan PF, Anzueto A, Pugh JA, Cornell JE. Systematic review of the chronic care model in chronic obstructive pulmonary disease prevention and management. Arch Intern Med 2007;167:551—61.

[8] Kruis AL, Smidt N, Assendelft WJ, Gussekloo J, Boland MR, Rutten-van Molken M, Chavannes NH. Integrated disease management interventions for patients with chronic obstructive pulmonary disease. Cochrane Database Syst Rev 2013;10: CD009437.

[9] Littlejohns P, Baveystock CM, Parnell H, Jones PW. Randomised controlled trial of the effectiveness of a respiratory health worker in reducing impairment, disability, and handicap due to chronic airflow limitation. Thorax 1991;46:559—64.

[10] Cockcroft A, Bagnall P, Heslop A, Andersson N, Heaton R, Batstone J, Allen J, Spencer P, Guz A. Controlled trial of respiratory health worker visiting patients with chronic respiratory disability. Br Med J Clin Res Ed 1987;294:225—8.

[11] Pushparajah S, McClellan R, Henry A, Kuitert LM. Use of a chronic disease management programme in COPD to reduce hospital admissions. Chron Respir Dis 2006;3:187—93.

[12] Fan VS, Gaziano JM, Lew R, Bourbeau J, Adams SG, Leatherman S, Thwin SS, Huang GD, Robbins R, Sriram PS, Sharafkhaneh A, Mador MJ, Sarosi G, Panos RJ, Rastogi P, Wagner TH, Mazzuca SA, Shannon C, Colling C, Liang MH, Stoller JK, Fiore L, Niewoehner DE. A comprehensive care management program to prevent chronic obstructive pulmonary disease hospitalizations: a randomized, controlled trial. Ann Intern Med 2012;156:673—83.

[13] Global initiative for chronic obstructive lung disease. Global strategy for the diagnosis, management and prevention of chronic obstructive pulmonary disease. 2013 [access date 26.01.14], http://www.goldcopd.org/uploads/users/files/GOLD_Report_2013_Feb20.pdf.

[14] American Thoracic Society. ATS statement: guidelines for the six-minute walk test. Am J Respir Crit Care Med 2002;166: 111—7.

[15] Jones PW, Quirk FH, Baveystock CM, Littlejohns P. A self-complete measure of health status for chronic airflow limitation. The St. George's Respiratory Questionnaire. Am Rev Respir Dis 1992;145:1321—7.

[16] Mahler DA, Wells CK. Evaluation of clinical methods for rating dyspnea. Chest 1988;93:580—6.

[17] Casas A, Troosters T, Garcia-Aymerich J, Roca J, Hernandez C, Alonso A, del Pozo F, de Toledo P, Anto JM, Rodriguez-Roisin R, Decramer M. Integrated care prevents hospitalisations for exacerbations in COPD patients. Eur Respir J 2006;28:123—30.

[18] Gadoury MA, Schwartzman K, Rouleau M, Maltais F, Julien M, Beaupre A, Renzi P, Begin R, Nault D, Bourbeau J. Self-management reduces both short- and long-term hospitalisation in COPD. Eur Respir J 2005;26:853—7.

[19] Monninkhof E, van der Valk P, van der Palen J, van Herwaarden C, Zielhuis G. Effects of a comprehensive self-management programme in patients with chronic obstructive pulmonary disease. Eur Respir J 2003;22:815—20.

[20] Rice KL, Dewan N, Bloomfield HE, Grill J, Schult TM, Nelson DB, Kumari S, Thomas M, Geist LJ, Beaner C, Caldwell M, Niewoehner DE. Disease management program for chronic obstructive pulmonary disease: a randomized controlled trial. Am J Respir Crit Care Med 2010;182:890—6.

[21] Sridhar M, Taylor R, Dawson S, Roberts NJ, Partridge MR. A nurse led intermediate care package in patients who have been hospitalised with an acute exacerbation of chronic obstructive pulmonary disease. Thorax 2008;63:194—200.

[22] Roberts MM, Leeder SR, Robinson TD. Nurse-led 24-h hotline for patients with chronic obstructive pulmonary disease reduces hospital use and is safe. Intern Med J 2008;38:334—40.

[23] Tashkin DP. Long-acting anticholinergic use in chronic obstructive pulmonary disease: efficacy and safety. Curr Opin Pulm Med 2010;16:97—105.

[24] Calverley PM, Anderson JA, Celli B, Ferguson GT, Jenkins C, Jones PW, Yates JC, Vestbo J. Salmeterol and fluticasone propionate and survival in chronic obstructive pulmonary disease. N Engl J Med 2007;356:775—89.

[25] Moore L, Hogg L, White P. Acceptability and feasibility of pulmonary rehabilitation for COPD: a community qualitative study. Prim Care Respir J — J General Pract Airw Group 2012; 21:419—24.

[26] Ko FW, Dai DL, Ngai J, Tung A, Ng S, Lai K, Fong R, Lau H, Tam W, Hui DS. Effect of early pulmonary rehabilitation on health care utilization and health status in patients hospitalized with acute exacerbations of COPD. Respirology 2011;16: 617—24.

[27] Kwok T, Lum CM, Chan HS, Ma HM, Lee D, Woo J. A randomized, controlled trial of an intensive community nurse-supported discharge program in preventing hospital

readmissions of older patients with chronic lung disease. J Am Geriatr Soc 2004;52:1240—6.
[28] Chu CM, Chan VL, Lin AW, Wong IW, Leung WS, Lai CK. Readmission rates and life threatening events in COPD survivors treated with non-invasive ventilation for acute hypercapnic respiratory failure. Thorax 2004;59:1020—5.
[29] Bischoff EW, Akkermans R, Bourbeau J, van Weel C, Vercoulen JH, Schermer TR. Comprehensive self management and routine monitoring in chronic obstructive pulmonary disease patients in general practice: randomised controlled trial. BMJ 2012;345:e7642.
[30] Blackstock FC, Webster KE, McDonald CF, Hill CJ. Comparable improvements achieved in chronic obstructive pulmonary disease through pulmonary rehabilitation with and without a structured educational intervention: a randomized controlled trial. Respirology 2014;19:193—202.