

## **Brief Communication**

### **Title**

COPD discharge bundle and pulmonary rehabilitation referral and uptake following hospitalisation for acute exacerbation of COPD

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**Word count:** 1163

**Key words:** Pulmonary rehabilitation, respiratory infection, COPD exacerbations

## **ABSTRACT (100/100 words)**

Pulmonary rehabilitation (PR) following hospitalisations for acute exacerbation of COPD (AECOPD) is associated with improved exercise capacity and quality of life, and reduced readmissions. However, referral for, and uptake of, post-hospitalisation PR are low. In this prospective cohort study of 291 consecutive hospitalisations for AECOPD, COPD discharge bundles delivered by PR practitioners compared to non-PR practitioners were associated with increased PR referral (60% vs 12%,  $p < 0.001$ ; adjusted OR: 14.46, CI: 5.28 to 39.57) and uptake (40% vs 32%,  $p = 0.001$ ; adjusted OR: 8.60, CI: 2.51 to 29.50). Closer integration between hospital and PR services may increase post-hospitalisation PR referral and uptake.

## **MAIN TEXT (1163/1000 words)**

### **Introduction**

There is an established evidence base supporting the benefits of pulmonary rehabilitation (PR) following hospitalisation for acute exacerbations of COPD (AECOPD), including improved exercise capacity and health-related quality of life, and reduced readmissions and mortality.(1, 2) However, PR referral and uptake rates are low. Previous data have shown that only 30% of eligible patients are referred for post-hospitalisation PR, with less than 10% completing a programme.(3) Barriers to referral and uptake are complex and multi-factorial.(4)

The COPD discharge bundle (a structured package of evidence-based measures which should be delivered to all individuals) was introduced to facilitate implementation of evidence-based care following hospitalisation for an AECOPD and includes offering referral to PR.(5) However, bundles can be challenging to implement and their impact unclear.(6, 7)

The aim of this study was to determine predictors of referral for and uptake of post-hospitalisation PR. We hypothesized that delivery of a COPD discharge bundle by a PR practitioner would be associated with increased PR referral and uptake.

### **Methods**

This prospective cohort study included consecutive hospital episodes for an AECOPD at Hillingdon Hospital, London, UK from 1st April 2018 to 31st March 2019 and was considered

service evaluation by the Health Research Authority. Patients admitted previously during the study period (and therefore already included in the data collection) were excluded.

Patients were classified according to three exposures (no COPD discharge bundle received; COPD discharge bundle received from a current PR practitioner; COPD discharge bundle received from a practitioner with no involvement in PR) and followed-up for four weeks after hospital discharge. All COPD discharge bundles (Figure E1 Online Supplement) were delivered by a hospital-based multidisciplinary respiratory team with responsibility for early supported discharge, admission avoidance and community respiratory clinics. Two out of six team members were current PR practitioners, defined as someone also employed to deliver PR (assessments and/or supervision of classes) for a minimum 20% of their job plan. The research team played no involvement in exposure allocation (no randomisation, no influence on care team assignment). The clinical team delivering the bundle were blinded to the study objectives.

The outcomes were referral for PR (defined as a referral received by PR service) and uptake of PR (defined as the proportion of those referred attending a PR assessment) within four weeks of hospital discharge.

Covariates were selected *a priori* as patient or hospital admission variables which have been shown to be predictors of non-referral and non-uptake of post-hospitalisation PR, including age, length of hospital stay and index of multiple deprivation (IMD) (<http://imd-by-postcode.opendatacommunities.org/>) (8, 9).

The sample size calculations are available in the online data supplement. Outcomes were compared between the two COPD discharge bundle exposure groups using independent T-

Test (or Mann-Whitney for non-normally distributed data) or Chi-Squared tests. Associations were investigated using logistic regression. Adjusted odds ratios (OR) with 95% confidence intervals were estimated with p-values <0.05 considered significant, with all clinically relevant covariates inputted into the model using the enter method.

## Results

Of 411 hospital episodes screened, 120 were excluded (24 were due to the patient being ineligible for PR and 96 as it was a readmission of a patient already included) (Figure E2 Online data supplement). Baseline demographics of the 291 episodes included in the study were: 145 women, 146 men; 33% current smokers; age 72 (SD: 9) years, FEV<sub>1</sub> 38 (IQR: 26, 52) percent predicted; length of stay 3 (IQR: 2, 7) days. Baseline demographics according to COPD discharge bundle exposure are shown in Table 1.

**Table 1. Baseline characteristics of cohort according to COPD discharge bundle exposure status**

Variable	No bundle received (n=63)	Bundle received from a hospital practitioner involved in PR delivery (n=25)	Bundle received from a hospital practitioner with no involvement in PR (n=203)	Between group comparison for those who received bundles (p value)
Age (years)	72 (9)	72 (11)	72 (9)	0.975
Male (n (%))	29 (46)	12 (48)	105 (52)	0.725
FEV <sub>1</sub> % predicted	42 (26, 62)	41 (30, 63)	37 (26, 48)	0.131
Smoking status: Never / former / current (n (%))	2 (3) / 42 (67) / 18 (29)	1 (4) / 17 (68) / 7 (28)	1 (1) / 132 (65) / 70 (34)	0.180
Median (interquartile range) duration of inpatient stay (days)	4 (2, 9)	3 (2, 8)	3 (1, 6)	0.438

<b>Review of respiratory specialist within 24 hours (n(%))</b>	44 (70)	24 (96)	203 (100)	0.116
<b>Non-invasive or invasive ventilation required during admission (n (%))</b>	4 (6)	5 (20)	23 (11)	0.213

*Data expressed as mean (SD) or median (Interquartile range) unless otherwise stated; Independent T-Test (or Mann-Whitney for non-normally distributed data) or Chi-Squared test was used to compare groups according to involvement in PR delivery of the hospital practitioner delivering the bundle for those who receive bundles.*

*Abbreviations: PR = Pulmonary rehabilitation; FEV<sub>1</sub> = Forced Expiratory Volume in one second; DECAF = Dyspnoea Eosinopenia Consolidation Acidaemia atrial Fibrillation.*

Of the 63 episodes where the COPD discharge bundle was not used, none were referred for PR. Significantly higher referral and uptakes rates were observed for those who received a COPD discharge bundle from a current PR practitioner (referral: 60% versus 12%,  $p < 0.001$ ; uptake: 40% versus 32%,  $p < 0.001$ ).

In adjusted multivariate logistic regression, COPD discharge bundle delivered by a current PR practitioner was a predictor of increased PR referral and uptake (Table 2), with length of inpatient stay also an independent predictor for PR referral (Table 2).

**Table 2. Multivariate logistic regression for predictors of PR referral and uptake within 28 days of hospital discharge for those with completed bundles**

Variable	PR referral within 28 day of hospital discharge			PR uptake within 28 days of hospital discharge		
	Adjusted multivariate			Adjusted multivariate		
	OR	95% CI	p value	OR	95% CI	p value
Practitioner delivering bundle involved in PR delivery (ref: not involved in PR delivery)	14.46	5.28 to 39.57	<b>&lt;0.001</b>	8.60	2.51 to 29.50	<b>0.001</b>
Age (years)	0.98	0.94 to 1.02	0.277	0.99	0.99 to 1.05	0.717
Gender (ref: male)	0.56	0.25 to 1.24	0.152	1.83	0.54 to 6.19	0.325
Smoking status (ref: current)	0.87	0.37 to 2.06	0.748	0.93	0.24 to 3.65	0.917
Index of multiple deprivation	1.00	1.00 to 1.00	0.481	1.00	1.00 to 1.00	0.227
Non-invasive or invasive ventilation required (ref: no)	1.31	0.36 to 4.72	0.680	1.53	0.23 to 3.64	0.917
Duration of inpatient stay (days)	0.89	0.80 to 0.99	<b>0.037</b>	0.88	0.72 to 1.03	0.178

*p* value significance =  $\leq 0.05$  (in bold); all variables were entered in the model using the enter method.

Abbreviations: PR = Pulmonary rehabilitation.

## Discussion

In this prospective cohort study, provision of a COPD discharge bundle was an important factor in determining referral and uptake rates for post-hospitalisation PR. No resulting PR referrals or uptake occurred when a COPD discharge bundle was not delivered to the patient. Our data supports earlier observations that the introduction of COPD discharge bundles can generate increased referrals for post-hospitalisation PR.(10)



A novel aspect of our study examined whether the role of the practitioner delivering the bundle is influential. Intriguingly, we demonstrated that referral rates were significantly increased when the practitioner delivering the bundle also had responsibilities for delivering PR. Although this could simply represent referrer bias, we were reassured to also observe a higher PR uptake rate in those patients referred by current PR practitioners. After multivariate analysis, taking into account potential confounders such as patient demographics and hospital admission factors, the practitioner's current involvement in delivering PR remained an independent predictor for both increased PR referral and uptake (Table 2). We did not collect data on patient face-to-face exposure time with healthcare professionals but there was no difference between the COPD bundle groups in the proportion receiving specialist respiratory review within 24 hours of admission (Table 1). Furthermore, respiratory outpatient review took place at six weeks post-discharge, and therefore did not influence the primary outcomes (uptake and referral within 28 days of discharge).

One explanation for our observation includes increased referrer knowledge about local referral pathways and processes. Referrer knowledge and attitudes may also influence the patient-referrer interaction, which in turn shape the patient's understanding and demystify their expectations of PR. Knowledge is frequently identified as a barrier/enabler for PR referral and participation.<sup>(11)</sup> We propose that further research is needed to test whether improving referrer knowledge and experience, perhaps through formal training or closer integration between hospital and PR practitioners, can increase referral and uptake for post-hospitalisation PR. This is particularly important given the paucity of effective interventions that address this area.<sup>(9)</sup>

A limitation was that this was a single-centre study with small number of practitioners involved, and therefore our results may not be generalisable. However, our results seem mechanistically plausible, and we are confident about the accuracy of the exposure data as the recruiting hospital was financially incentivised to keep rigorous audit records around bundle completion. Furthermore, as the recruiting hospital was served by a single PR service, collection of PR outcome data was simplified. Another limitation is that our study utilised routinely collected data as part of service evaluation and audit. It is possible that our findings could be explained by confounding factors not collected in our dataset, with differences in patient knowledge, beliefs and attitudes between the exposure groups potentially relevant.(11)

In summary, we have demonstrated that COPD discharge bundles are associated with increased referral and uptake rates for post-hospitalisation PR. In particular, COPD discharge bundle delivered by a practitioner delivering PR within their workplan is an independent predictor of PR referral and uptake. Closer integration between clinical services could increase post-hospitalisation PR referral and uptake.

## **Acknowledgements**

We would like to express our gratitude to the patients for participating in this study. We would also like to thank the staff of the Hillingdon Integrated Respiratory Service for their support with data collection.

## **Competing interests**

REB, SSCK, SFC, JW, CMN, SEJ, SP, JA Walsh, MM, MF and NSH have no competing interests to report. WD-CM reports personal fees from Jazz Pharmaceuticals, personal fees from Mundipharma, personal fees from Novartis, grants from Pfizer, non-financial support from GSK, grants from National Institute for Health Research, grants from British Lung Foundation, outside the submitted work.

## **Funding**

This paper presents independent research funded by the National Institute for Health Research (NIHR) under its Clinical Doctoral Fellowship Programme (Fellowship Reference Number ICA-CDRF-2017-03-018). The funder had no role in the collection, analysis and interpretation of the data; the funder had no role in the writing of and decision to publish this report. The views expressed are those of the author(s) and not necessarily those of the NIHR or the Department of Health and Social Care.

REB is funded an NIHR Clinical Doctoral Research Fellowship (ICA-CDRF-2017-03-018); CMN was funded by a NIHR Doctoral Research Fellowship (DRF-2014-07-089) and a NIHR Clinical

Trials Fellowship (CTF-2017-06-005); MM is funded by a NIHR Career Development Fellowship (CDF-2017-10-009) and NIHR Applied Research Collaboration South London; MF is currently part-funded by the NIHR Applied Research Collaboration East of England programme.

### **Author Contributions**

Concept and design of Study: REB, MM, MF, JAW, WD-CM; Acquisition of Data: REB, SSCK, SFC, WD-CM; Analysis of Data: REB and WD-CM; Interpretation of Data: All authors; Drafting and revisions of Manuscript: All authors; Final approval of manuscript: All authors; Guarantor: WD-CM.

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## ONLINE DATA SUPPLEMENT

### Title

COPD discharge bundle and pulmonary rehabilitation referral and uptake following hospitalisation for acute exacerbation of COPD

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## COPD discharge bundle

The COPD discharge bundle is a structured list of evidence-based practices delivered prior to hospital discharge following admission for an acute exacerbation of chronic obstructive pulmonary disease to attempt to standardise post-discharge care in the UK. The bundle delivered in this cohort study incorporates all five items recommended by the British Thoracic Society COPD Discharge Bundle (<https://www.brit-thoracic.org.uk/quality-improvement/clinical-resources/copd-spirometry/>), namely: 1) Review of medication and providing inhaler technique education; 2) Provision of a self-management plan; 3) Assess and offer referral for smoking cessation; 4) Arrangement of post-hospitalisation follow-up; and 5) Assess suitability and refer for pulmonary rehabilitation. Figure E1 below provides an example of the standardised paperwork which requires completion when delivering the COPD discharge bundle.

British Thoracic Society		BTS Chronic Obstructive Pulmonary Disease (COPD) Discharge Care Bundle		COPD D1		Trust logo	
<p>This care bundle describes 5 high impact actions to ensure the best clinical outcome for patients admitted with an acute exacerbation of COPD (AECOPD). The aim is to reduce the number of patients who are readmitted following discharge after an AECOPD and to ensure that all aspects of the patients COPD care is considered.</p>							
Patient sticker							
PRIOR TO DISCHARGE	<b>1. REVIEW PATIENT'S MEDICATIONS &amp; DEMONSTRATE USE OF INHALERS</b> <i>Assess during medication rounds. Observe the patient using their inhalers and refer to _____ if technique is inadequate. Ensure medications have been optimised by respiratory specialist team.</i> Inhaler technique checked: <input type="checkbox"/> Medications reviewed by respiratory team before discharge? <input type="checkbox"/>						
	<b>2. PROVIDE WRITTEN SELF MANAGEMENT PLAN &amp; EMERGENCY DRUG PACK</b> <i>Prescribe COPD emergency drug pack and provide to patient at discharge. Ensure patient has a completed self management plan describing how and when to use medications provided. Provide oxygen alert card if patient is at risk of CO2 retention (referral to a community team for drug pack and plan is acceptable)</i> Self management plan? Given ... <input type="checkbox"/> Already has ... <input type="checkbox"/> Not applicable ... <input type="checkbox"/> Emergency drug pack provided? Yes ... <input type="checkbox"/> No ... <input type="checkbox"/> Not applicable ... <input type="checkbox"/> Oxygen alert card? Yes ... <input type="checkbox"/> No ... <input type="checkbox"/> Not applicable <input type="checkbox"/> Referred to community team for pack or plan? Yes ... <input type="checkbox"/> No ... <input type="checkbox"/> Not applicable ... <input type="checkbox"/>						
	<b>3. ASSESS AND OFFER REFERRAL FOR SMOKING CESSATION</b> <i>Ask every patient whether they are a current smoker and offer referral to smoking cessation service</i> Patient is a current smoker: Yes <input type="checkbox"/> Ex-smoker <input type="checkbox"/> Never smoked <input type="checkbox"/> (To be classed as an ex-smoker, patients must have abstained for 3 months) Referral made: Yes <input type="checkbox"/> No <input type="checkbox"/> Declined <input type="checkbox"/> N/A <input type="checkbox"/> Has smoking cessation been recorded as discussed? Yes <input type="checkbox"/> No <input type="checkbox"/>						
	<b>4. ASSESS FOR SUITABILITY FOR PULMONARY REHABILITATION</b> <i>All patients who report walking slower than others on the level or who need to stop due to dyspnea after a mile or after less than 15 minutes walking should be assessed for and offered pulmonary rehabilitation</i> Already completed pulmonary rehabilitation? <input type="checkbox"/> Referral made? <input type="checkbox"/> Declined? <input type="checkbox"/> Not applicable: <input type="checkbox"/> Not Done: <input type="checkbox"/>						
	<b>5. ARRANGE FOLLOW UP CALL WITHIN 72 HOURS OF DISCHARGE</b> <i>Follow up all patients at home within 72 hours in person or by phone. A call for the patient can be booked by calling _____ and faxing completed discharge bundle to: _____</i> Patient has agreed to be contacted: <input type="checkbox"/> Patients phone number: _____ Date of call given to patient: _____						
<b>Instructions for use of bundle:</b>							<b>ENSURE ALL ELEMENTS OF COPD SAFE DISCHARGE CHECKLIST COMPLETED</b> Nurse checking completion of discharge checklist (initials): _____ Checklist completed: <input type="checkbox"/> Date of admission: _____ Date of discharge: _____
Data entry: <a href="https://audits.brit-thoracic.org.uk/">https://audits.brit-thoracic.org.uk/</a> Enquiries: <a href="mailto:carebundles@brit-thoracic.org.uk">carebundles@brit-thoracic.org.uk</a>							v9 October 2016

Figure E1. Example of standardised paperwork which requires completion for the COPD discharge bundle.



## **Sample Size Calculation**

The sample size calculation was based on previous observations that approximately 30% of those receiving a discharge bundle are referred for pulmonary rehabilitation.<sup>(1)</sup> To demonstrate an increase in referral rate to 60% in those who received a discharge bundle from a pulmonary rehabilitation practitioner, with 80% power at the 5% significance level and assuming an exposure ratio of 1:9 (i.e. 10% of discharges would receive a bundle from a pulmonary rehabilitation practitioner) would require a minimum of 220 patients (MedCalc Software, Ostend, Belgium).

For the overall population at hospital discharge, we estimated the proportion taking up pulmonary rehabilitation to be 20%.<sup>(1)</sup> To demonstrate an increase in the proportion of those at hospital discharge taking up pulmonary rehabilitation to 50%, with 80% power at the 5% significance level and assuming an exposure ratio of 1:9 (i.e. 10% of discharges would receive a bundle from a pulmonary rehabilitation practitioner), would require a minimum of 190 patients (MedCalc Software, Ostend, Belgium).

We planned to collect data for a minimum of one year to take into account seasonal variations, and continue to collect if the planned sample size had not been recruited within one year.

## Diagram for study flow

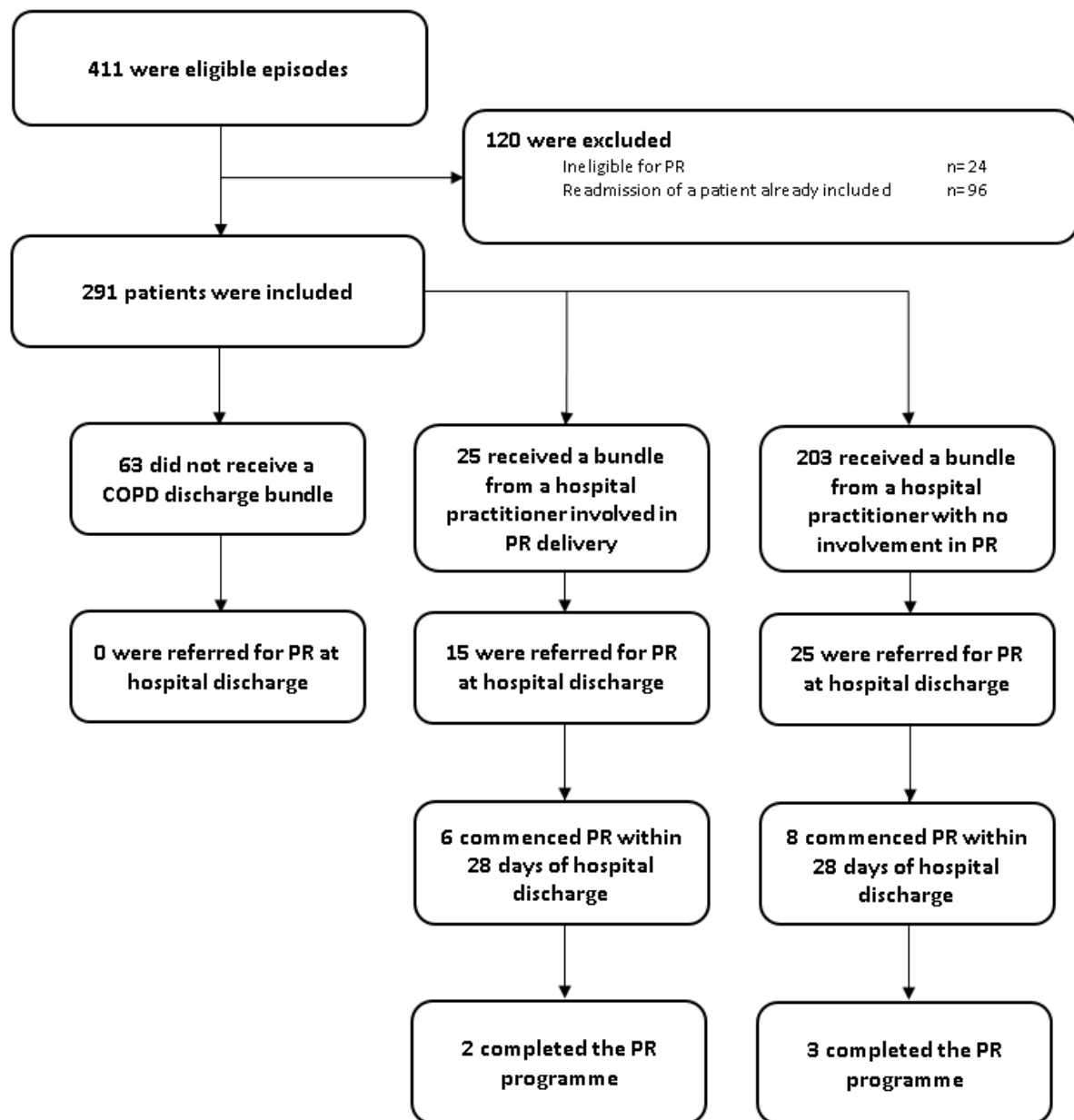


Figure E2. Diagram of study flow

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