Turk Thorac J 2017; 18: 119-24 DOI: 10.5152/TurkThoracJ.2017.17026

ORIGINAL ARTICLE

Characterization of Chronic Obstructive Pulmonary Disease Patients with a Long Length of Stay: A Retrospective Observational Cohort Study

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Cite this article as: Madani Y, Saigal A, Sunny J, et al. Characterization of Chronic Obstructive Pulmonary Disease patients with a long length of stay: a retrospective observational cohort study. Turk Thorac J 2017;18:119-24.

Abstract

OBJECTIVES: Chronic obstructive pulmonary disease (COPD) exacerbation is one of the most common reasons for hospital admission. Patients with COPD with a long length of stay (LoS) occupy a disproportionately high fraction of hospital bed-days. The objective of this study was to identify associations of long LoS in patients admitted with COPD exacerbation.

MATERIAL AND METHODS: From December 2012 until June 2013, 499 patients were admitted to Queens Hospital, Romford, UK, with COPD exacerbation. Mean LoS was 7 days, with a median of 5 days, and a 90th percentile of 14 days. In this retrospective observational cohort study, 64 patients with a short LoS were compared with 62 patients with a long LoS.

RESULTS: Relative to the short LoS, patients with long LoS had significantly lower arterial blood pH, higher arterial PaCO2 and HCO3, higher white cell count, higher globulin and more frequent chest X-ray changes, lower albumin levels, and lower Barthel and Braden scores. They were less likely to have seen the hospital COPD specialist nurse, more likely to require escalation of social care on discharge, and more likely to die during admission. Nearly 66% of the long LoS patients remained in hospital beyond the time of being medically fit for discharge. Commonly cited reasons for delayed discharge were the wait for therapy and social services assessments and the wait for commencement of community social care.

CONCLUSION: Meticulous targeting of features peculiar to long LoS patients has the potential to reduce future hospital bed-days for patients with COPD in our and other hospitals.

KEYWORDS: Chronic obstructive pulmonary diseases, length of stay

Received: *25.03.2017* ***Accepted:*** *20.06.2017*

INTRODUCTION

Chronic obstructive pulmonary disease (COPD) is a common chronic disease in the UK with a likely prevalence of 3 million people or 4% of the population [1]. Episodic exacerbations are usual and often require hospital admission. COPD exacerbation is the second most common reason for emergency admission to hospital behind circulatory disease and is associated with considerable risks of re-admission, death, and expense. Each COPD hospital admission is estimated to cost NHS commissioners £1960 [2].

Estimates of typical length of stay (LoS) vary in the published literature. A British Thoracic Society study found a mean value of 7.1 days, whereas in Norway, it was 8.9 days, and a study in Blackpool reported 9.8 days [3-5]. Importantly, there is significant variation across England and Wales between many aspects of service provision and clinical outcomes for patients with respiratory disease. The NHS Atlas of Variation in Healthcare 2010 highlighted a four-fold variation in hospital bed-days occupied by COPD patients [6]. In London, there is a variation in LoS between hospitals by nearly 5 days [7]. Those patients with long LoS also occupy disproportionately more bed-days, and 50% of bed-days have been shown to be occupied by the minority of patients who stay at least 11 days [8]. Previously described associations of long LoS in COPD include poor organization of care, lack of early discharge schemes, advancing age, poor performance status, extensive co-morbidity (in particular, heart failure), being female, being admitted at the weekend, low albumin, hyperglycemia, infection, hypoxia, hypercapnia, and being managed by a general medical rather than by a respiratory team [4-5,9-11].

As well as being an important national issue, COPD is also very much a local one. Queens Hospital, Romford, is a busy Acute District General Hospital, which together with its smaller sister hospital King George's serves a large population of

This study was presented at the European Respiratory Society International Congress, 8 September 2014, Munich, Germany.
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around 700,000 people. High levels of socioeconomic deprivation are common: The majority of COPD patients admitted to Queens Hospital, during the period of data collection for the Royal College of Physicians COPD national audit in 2014, belonged to the lowest two quintiles of national deprivation [12]. COPD prevalence in Barking & Dagenham and in Havering, the two main boroughs whose patients are served by Queens Hospital, is among the highest of any in Greater London and is increasing [13]. The COPD emergency admission rate for Havering is the same as that of London overall, but for Barking & Dagenham is more than 1.8 times that of England overall [14]. In addition, the standardized mortality ratio for COPD for Barking & Dagenham is close to twice the London rate [14].

MATERIAL AND METHODS

The aims of this study were to characterize patients who had a prolonged LoS and to identify any associations which might be potentially targetable to reduce LoS in subsequent episodes of COPD inpatient care. Full requisite approval was granted by the trust Clinical Governance department as an audit-related project prior to it being undertaken. The study was conducted according to the Helsinki Declaration.

Patients who had a hospital admission at Queens Hospital with COPD as the primary admitting diagnosis between December 1, 2012, and May 31, 2013, were identified from our Trust Information Services monthly COPD report. This captures hospital admissions with International Statistical Classification of Disease- (ICD-10) codes J43.9, J44.0, J44.1, J44.8, J44.9, or J47X. The mean LoS for the 499 patients admitted during this period was 6.96 days with a median of 5 days and a 90th percentile of 14 days. Two cohorts of patients were derived corresponding to "short" LoS and "long" LoS. The short LoS group was derived by identifying consecutive cases with a LoS close to median of 5 days (range between 4 and 7 days). The long LoS group was derived by identifying consecutive cases with a LoS equal to or above the 90th percentile of 14 days. Where a patient had been admitted more than once during the study period, only their first admission was included. The intention was to compare two groups of around 70 patients each, although case notes or other pivotal data were missing for a small number of patients in each group. The final dataset comprised 64 short LoS patients and 62 long LoS patients.

For each patient, data were collected pertaining to patient demographics, co-morbidities, pre-existing community support and social care, initial laboratory tests, admission arterial blood gas, last recorded FEV_1, admission chest radiograph, input from hospital respiratory specialists, nutrition, measure of performance in activities of daily living (Barthel scale), pressure score risk (Braden scale), and requirement for escalation of social care or placement on discharge. Data sources comprised patient case notes; pathology, radiology, and cardiac investigation systems; and records from the hospital COPD nursing and social services teams. Data was statistically analyzed by a statistician, Paul Bassett, from Statsconsultancy Ltd., Amersham, Buckinghamshire, United Kingdom, using Stata version 12.1 software (StataCorp LLC, Texas, USA). The distribution of continuous variables was inspected using histograms. Continuous variables that were found to be normally distributed were compared between groups using the unpaired t-test. The Mann-Whitney test was used for those continuous variables that were not found to be normally distributed. The chi-squared test was used to compare categorical variables between the two groups. The significance of the group comparisons was determined by the size of the p-values resulting from all analysis methods. A p-value of less than 0.05 was regarded as representing evidence of a statistically significant difference.

Table 1. Patient demographics, prevailing disease severity, and pre-admission levels of social care

Variable	Short LoS (n=64)	Long LoS (n=62)	p
Age (years)	76 (10.7)	77.6 (11.4)	0.44
Male gender	32 (51%)	24 (39%)	0.17
Last recorded FEV1 (liters)	1.15 (0.44)	0.98 (0.71)	0.34
Atrial fibrillation	17 (27%)	18 (29%)	0.80
Oxygen at home	18 (29%)	23 (37%)	0.31
Diuretics used pre/during admission	29 (46%)	28 (45%)	0.92
Nebulizers at home	22 (35%)	30 (48%)	0.13
Carers at home	18 (29%)	26 (42%)	0.12
Lives in care home	5 (8%)	6 (10%)	0.76
Heart failure	21 (46%)	28 (61%)	0.14
Previous admissions	1 [0, 4]	1.5 [1, 3]	0.55
Known to respiratory consultant	26 (41%)	22 (35%)	0.51

LoS: length of stay; FEV1: forced expiratory volume in 1 second

Figures reported for continuous variables are the mean (standard deviation) for normally distributed variables; and median [interquartile range] for non-normally distributed variables. For categorical variables the number of patients and (percentage) are reported.

For a subset (around 50%) of the patients in the long LoS group, the comparison of the date the patient was deemed medically fit for discharge in the hospital case notes with actual date of hospital discharge was examined to determine whether delay in the hospital discharge process contributed to the prolonged hospital stay.

RESULTS

Age and sex distribution did not differ between the two groups as shown in Table 1. Atrial fibrillation, diuretic usage, and heart failure were common in both groups with no difference in prevalence. In this study, heart failure was defined as either a listed diagnosis of heart failure in the case notes or echocardiographic evidence of left-sided heart dysfunction. There was also no difference in the incidence of right heart dysfunction on echocardiogram between the groups (data not shown). Mean FEV_1 (last value in case notes) was low and close to 1 liter in both groups. Use of home nebulizers and home oxygen was common in both groups. No significant differences were observed for either FEV_1, use of nebu-

Table 2. Inpatient investigations

Variable	Short LoS (n=64)	Long LoS (n=62)	p
pH	7.43 [7.39, 7.34]	7.38 [7.34, 7.44]	0.02
pCO_2 (kPa)	5.4 [4.6, 6.6]	6.4 [5.3, 8.1]	0.001
HCO3- (mmol/L)	26.6 (5.1)	28.9 (6.8)	0.004
CO (%)	0.60 [0.30, 1.25]	0.55 [0.30, 0.90]	0.57
WCC ($x10^9$/L)	10.7 [8.9, 13.6]	12.5 [9.9, 16.1]	0.04
Urea (mmol/L)	7.1 [5.4, 9.9]	7.8 [5.6, 9.4]	0.49
Hb (g/L)	13.5 (2.8)	13.3 (1.9)	0.75
CRP (mg/L)	28 [9, 63]	36 [15, 118]	0.13
Globulin (g/L)	32.0 (4.1)	34.4 (5.6)	0.008
Albumin (g/L)	38.0 (5.2)	36.3 (4.5)	0.04
Creatinine (umol/L)	92 [74, 107]	93 [72, 108]	0.67
CXR changes	15 (24%)	30 (48%)	0.004
Braden score	21 [19, 22]	18 [16, 20]	<0.001
Barthel score	17 [15, 19]	16 [14, 18]	0.04
MUST score	0 [0, 0]	0 [0, 0]	0.25
Weight (kg)	63.4 [50.5, 77.6]	63.3 [52.8, 80.1]	0.43
Known to hospital COPD nurse	33 (52%)	19 (31%)	0.01
Discharged/ managed by Respiratory Team	26 (41%)	28 (45%)	0.66

LoS: length of stay; pCO_2: partial pressure of carbon dioxide: HCO_3: bicarbonate; CO: carbon monoxide; WCC: white cell count; Hb: hameoglobin; CRP: C-reactive protein; CXR: chest x-ray; MUST: malnutrition universal screening tool; COPD: chronic obstructive pulmonary disease

Figures reported for continuous variables are the mean (standard deviation) for normally distributed variables; and median [inter-quartile range] for non-normally distributed variables. For categorical variables the number of patients and (percentage) are reported.

Table 3. Discharge outcomes: Social care provision and in-hospital mortality

Variable	Short LoS (n=64)	Long LoS (n=62)	p
Extension of POC: No	52 (84%)	52 (87%)	0.008
Restart	10 (16%)	3 (5%)	
Yes	0 (0%)	5 (8%)	
New POC	3 (5%)	8 (13%)	0.10
Placement at discharge: No	57 (92%)	43 (73%)	0.02
Yes	3 (5%)	8 (14%)	
Died	2 (3%)	8 (14%)	
Death as Inpatient	2 (3%)	11 (18%)	0.009
New POC and/or Placement at discharge in patients surviving to discharge	6/60 (10%)	15/51 (29%)	0.009

LoS: length of stay; POC: package of care

Figures reported for continuous variables are the mean (standard deviation) for normally distributed variables; and median [inter-quartile range] for non-normally distributed variables. For categorical variables the number of patients and (percentage) are reported.

lizers, or use of oxygen at home. Similar numbers of patients in each group were known to a respiratory consultant within the trust. There was no significant difference in the number of previous hospital admissions. A substantial proportion of our patients in both groups had either carers at home or lived in a care home prior to admission, although the proportions did not differ significantly between groups.

In comparison to short LoS, long LoS was associated with significantly lower pH, higher pCO_2, and higher HCO_3 on admission arterial blood gas (Table 2). Long LoS was also associated with elevated admission white cell count (WCC), elevated serum globulin, and more frequent admission chest X-ray (CXR) changes. The proportion of patients with previous isolates of *Pseudomonas aeruginosa* or other specific pathogens did not differ between the two groups (data not shown). Long LoS was associated with lower serum albumin levels and lower Braden and Barthel scores. Being managed by a specialist respiratory team rather than a general medical team did not obviously influence LoS, as the proportion discharged by a specialist respiratory team did not significantly differ between the two groups. However, patients in the long LoS group were significantly less likely to have seen the hospital COPD specialist nurse.

Important discharge outcomes are described in Table 3. There was a significant association of in-hospital mortality with long LoS. Death was around six times more common in the long LoS group. Relative to the short LoS group, patients in the long LoS group who survived to hospital discharge were also almost three times more likely to require extension of a pre-existing package of care (POC) or require a new POC or community placement at discharge.

Thirty-two case notes of the 62 long LoS patients were evaluated for entries pertaining to the time of the patient being medically fit for discharge and for any documentation as to reasons for delayed hospital discharge beyond this point. In 21 of 32 (66%) cases, there was evidence of a delay beyond this time. Documentation about specific reasons for delay was, in some cases, limited, but where documented, chiefly related to the discharge process itself including waits for social services and multidisciplinary assessment, wait for provision of equipment or carers, wait for a care home bed, or family or patient wishes.

DISCUSSION

There was no age difference between the groups in this study, although the average age overall is slightly higher than that reported for our trust in the COPD national audit of secondary care [12]. An explanation for this could be that COPD patients identified retrospectively from hospital coding data (as in this study) include a number of elderly patients where COPD is one of several co-morbidities which precipitate hospital admission. They may therefore represent a subtly distinct population than those COPD patients presenting to the acute medical take and identified prospectively by specialist COPD nurses (as for the COPD national audit of secondary care). In reality, both methods are likely to be imperfect.

The significantly lower Barthel score in our long LoS group is consistent with these patients having poorer performance in activities of daily living. Indeed, lower physical activity is a predictor of prolonged stay in another study [15]. The lower Barthel score in our patients might also indicate greater frailty; and increased frailty is known to promote prolonged hospital stay [16]. In addition, there was a trend for home carers to be required more frequently in our long LoS group, although this trend failed to reach statistical significance (p=0.12).

The majority of patients in both groups probably had severe COPD, as evidenced by low FEV_1, and high prevalence of the use of home oxygen and nebulizers. Co-morbidities were common in both groups, particularly heart failure, but also ischemic heart disease and other vascular disease (data not shown). Heart failure has been shown to be a strong independent predictor for a long LoS after a COPD exacerbation [4], and a high degree of co-morbidity, as shown by the Charlson Index, correlates with LoS [5,17] in other studies. There was a trend for heart failure being slightly more prevalent in the long LoS group in this study, although this did not reach statistical significance (p=0.14). Nonetheless, it is possible that a real association does exist, but that this was not able to be appreciated because of our small sample sizes.

Admission arterial blood gas pH was lower, and pCO_2 and HCO_3 were significantly higher in the long LoS group. Our data are consistent with another report in the literature showing that pCO_2 independently predicts prolonged hospital stay [4]. This suggests that respiratory failure is more common in the long LoS group. This could be explained by more advanced respiratory disease, greater frailty, or reduced physiological reserve in these patients.

The demonstration of elevation of WCC and globulin and more frequent CXR changes in our long LoS group suggests that respiratory infection may promote prolonged hospital stay. Indeed COPD patients with infection as identified by coding data, by those needing antibiotics, or by those having pneumonic CXR changes, have all previously been shown to stay longer in hospital in other studies [5,15,18]. While some patients with COPD exacerbation in the context of recent *Pseudomonas* isolation are treated as inpatients with prolonged intravenous antibiotics in our institution, we did not find any difference in the prevalence of previous *Pseudomonas* isolation between our two groups (data not shown). Consistent with this, no association of LoS was found with any particular sputum pathogen in a six-month study of 329 patients admitted with COPD exacerbation in Hong Kong [19].

A number of indices of poor nutritional status predict prolonged LoS in adult patients [20]. Patients with advanced COPD often have nutritional deficiency and low body mass index; and long LoS in these patients can be significantly reduced by oral nutrition supplementation [21]. In our LoS patients, we found reduced serum albumin and an increased pressure sore risk as shown by reduced Braden score. Albumin is an imperfect marker of nutrition that correlates with body cell mass but is also greatly affected by systemic disease [22]. Malnutrition is an important risk factor for the development of pressure sores; and the Braden score is significantly influenced by nutritional status. Our findings suggest that malnutrition may well be a feature in our long LoS group, although significant differences in the Malnutrition Universal Screening Tool (MUST) score were not seen.

In contrast to other authors who found that being managed by a respiratory physician was associated with a shorter hospital stay, the proportion of patients discharged by a respiratory physician did not differ significantly between the groups in the current study [5]. However, being reviewed by the hospital COPD respiratory nurse was significantly less common in the long LoS group. In our trust, the COPD nurses have an instrumental role involving liaison with community respiratory teams and facilitating early supported discharge and hospital at home schemes. These reduce LoS, re-admissions, and mortality for selected patients [23,24]. Failure to ensure review of some patients by the hospital COPD nurse may have limited opportunities for post-discharge integrated care with community COPD services. This could have contributed to delays and avoidable bed-days in those patients requiring complex discharge planning. Thus, it is plausible that the care and LoS of some of the patients in our long LoS group could be improved if we made greater efforts to involve our expert specialist COPD nurses in their care.

In our study, there was a significantly increased rate of death by six-fold in those patients with a long LoS. This effect was also seen in a large cross-sectional U.S. study where the LoS was nearly twice as long in those patients who died, and LoS itself was an independent predictor of in-hospital mortality [25]. Requirement for social services assessment has previously been shown to independently predict prolonged length of stay in patients admitted with COPD exacerbation in a Canadian study [26]. Escalation of social care provision was also significantly more common in the long LoS group in the current study. Furthermore, many of our COPD long LoS group would be expected to require complex discharge planning based on their age, advanced disease, multiple co-morbidities, limited functional status, and pre-existing social care needs. Complex discharge involving multiple stakeholders has the potential to be delayed by a number of process problems. A London teaching hospital reported that discharge process delays accounted for 21% of medical inpatient bed-days, and in 77% of cases were due to assessment for, or provision of social care [27]. Our study highlights a similar problem in our institution since 66% of the long LoS patient group remained in hospital beyond the time that they were medically fit for discharge. Hospitals such as ours will undoubtedly face increasing challenges discharging many COPD patients in the future as the population ages, and the investment in social care provision is reduced year-on-year [28]. The best way for hospitals to mitigate against such discharge difficulties may be to ensure their workforce is intimately familiar with the local and national discharge process but also to strive for timely discharge-related decision making and ever more effective communication with community services, patients, and next-of-kin [29]. Current evidence is that being admitted over a weekend predicts prolonged hospital stay [4]. This is probably due to a number of factors including reduced weekend clinical decision making and reduced

assessments for and provision of social care. In an effort to achieve effective inpatient care and discharge-related decision making every day of the week, our hospital has recently commenced a 7-day consultant-led respiratory service. This practice is, in fact, a recommendation of the Royal College of Physicians national COPD audit report [12].

Our study has a number of limitations. LoS is a continuous variable that we have categorized into somewhat arbitrary short and long LoS groups. Given our limited dataset of small patient numbers, this was a pragmatic solution to highlight *potentially* real differences between patients with long LoS and a more usual LoS. In addition, many of the variables we studied, such as pH, HCO3, and CO2, would be expected to be related and not therefore independent. The best way to accurately identify independent predictors of long LoS would likely be by stepwise logistic regression analysis of a much larger sample of patients with all possible LoS, but unfortunately this was beyond the scope of our study. A number of the variables we have reported, for example, blood gas values may simply be a marker of severity of respiratory illness, and it is possible that it is disease severity which predominantly influences LoS. Unfortunately, data in the medical case notes were not sufficient for us to evaluate differences in a severity measure such as BODE (Body Mass Index, airflow Obstruction, Dyspnea, Exercise Capacity) index between the two groups. Similarly, incomplete information regarding co-morbidities in the medical case notes hindered our derivation and evaluation of differences in an established co-morbidity index such as the Charlson Co-morbidity index. Rather we focused on individual co-morbidities, in particular heart failure, for which we also had supportive echocardiographic data.

Despite the limitations of our study, it is likely to have value as a real-world observational study to highlight that features such as infection, respiratory failure, malnutrition, frailty, and requirements for social care are associations of prolonged LoS in COPD patients. It is tempting to speculate that, by meticulously targeting these features both during and after hospital stay, we might reduce future hospital bed-days for some of our COPD patients. Certainly, the existence of significant variability in LoS across hospitals in London supports the notion that LoS may be to some extent modifiable [7]. The key to reducing LoS may lie in adopting an integrated COPD service involving multiple specialties in primary and secondary care including physicians, respiratory nurses, therapists, social services, and community teams. Such a strategy in Salford which focused on smoking cessation, improving COPD early diagnosis and treatment, and improving access to pulmonary rehabilitation reduced their LoS from 8.3 to 7.7 days in a single year [30].

Ethics Committee Approval: Authors declared that the research was conducted according to the principles of the World Medical Association Declaration of Helsinki "Ethical Principles for Medical Research Involving Human Subjects", (amended in October 2013).

Informed Consent: N/A.

Peer-review: Externally peer-reviewed.

Author contributions: Concept - R.J., Y.M.; Design - R.J.; Supervision - R.J.; Data Collection and/or Processing - J.S., L.M., A.S., Y.M.; Analysis and/or Interpretation - R.J., Y.M., A.S., L.M., J.S.; Literature Search - R.J.; Writing - R.J., A.S., Y.M.; Critical Reviews - R.J., Y.M., A.S., L.M., J.S.

Acknowledgements: We are grateful to Denise Smith and Jane Elflain, COPD nurses, for expert advice and help with data collection; and to Paul Bassett for undertaking the statistical analysis for this study.

Conflict of Interest: No conflict of interest was declared by the authors.

Financial Disclosure: The authors declared that this study has received no financial support.

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