

Mortality and readmissions in patients with acute exacerbation of chronic obstructive pulmonary disease treated at a specialised pulmonary ward and general wards

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ABSTRACT

INTRODUCTION: Acute exacerbation of chronic obstructive pulmonary disease (AECOPD) is the most common cause of admission to medical wards. In Denmark, patients are often referred to general medical wards, e.g. departments of internal medicine (IM), and only a minority are admitted to highly specialised units such as departments of pulmonary diseases (DPD).

MATERIAL AND METHODS: This retrospective study investigated the risk of readmission 12 months after primary admission in 136 patients admitted to either IM or DPD due to AECOPD. Furthermore, mortality 18 months after primary admission was investigated. A subanalysis was made for patients receiving non-invasive ventilation and for patients with telehealthcare. Data were obtained from patients' case records.

RESULTS: There was no difference in readmission in patients' primary admission at DPD versus IM. The median number of readmissions for patients participating in telehealthcare was four compared with two in patients who did not ($p = 0.026$). In-hospital mortality during primary admission was significantly higher at DPD than at IM (relative risk (RR) = 3.54; $p = 0.047$). Telehealthcare participation was associated with a trend towards a lower mortality. Mortality was significantly higher in patients receiving non-invasive ventilation than in patients at DPD who did not receive non-invasive ventilation at their primary admission (RR = 5.02; $p = 0.011$).

CONCLUSION: There was no difference in the risk of readmission in patients admitted to DPD and IM, respectively. Patients assigned to telehealthcare did not have a higher readmission rate, but those who were readmitted were readmitted more times ($p = 0.026$).

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TRIAL REGISTRATION: This trial was registered with the Danish Data Protection Agency (J. no. 2008-58-0028).

Chronic obstructive pulmonary disease (COPD) is defined as irreversibly impaired lung function, judged by spirometric measurement of the forced expiratory volume in the first second (FEV1) and airflow obstruction

defined as FEV1/forced ventilator capacity (FVC) below 0.7 [1]. Many COPD patients experience acute exacerbations of COPD (AECOPD) [1], which accelerate progression of the disease [2] which is the most common cause of admission to medical wards in Denmark as well as worldwide [3, 4]. In Denmark, patients are often referred to general medical wards, departments of internal medicine, and only the minority are admitted to highly specialised units, e.g. departments of pulmonary diseases. In a Danish study, 46% were readmitted one or several times within the first year after discharge [4]. Numerous factors have been shown to predispose patients to further hospital admissions; previous hospital admission for AECOPD, hypercapnia, low FEV1, preadmissional long-term oxygen therapy and need for non-invasive ventilation, amongst others [2, 4-7].

Patients presently admitted to hospital who do not need non-invasive ventilation may be managed equally well with telehealthcare [3, 8]. Telehealthcare has been shown to reduce patient contact with the emergency department and readmissions without changing mortality rates [4, 8].

The mortality is high in COPD patients and is associated with co-morbidity [3], the frequency of admission for AECOPD [2] and the degree of respiratory acidosis at admission [3].

The aim of this study was to investigate whether the primary site of admission for AECOPD, either a department of pulmonary diseases or a department of internal medicine (i.e. departments of nephrology, endocrinology, infectious diseases, haematology, gastroenterology, medical emergency and general internal medicine, the Medical Centre, Aalborg University Hospital), has any influence on readmission rates within 12 months and mortality within 18 months, and to elucidate the number of readmissions and mortality in patients treated for AECOPD with non-invasive ventilation. Finally, we evaluated the effect of telehealthcare on the number of readmissions and mortality within a year.

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MATERIAL AND METHODS

Study design and setting

In this retrospective study, we studied a patient cohort admitted to the Medical Centre of Aalborg University Hospital, Denmark, due to AECOPD in a three month period from 1 January 2011 to 31 March 2011. Patients were either admitted to Department of Pulmonary Diseases or one of six departments of internal medicine (i.e. Department of Nephrology, Endocrinology, Infectious Diseases, Haematology, Gastroenterology, Medical Emergency and General Internal Medicine, the Medical Centre, Aalborg University Hospital.) Patients were identified by International Classification of Diseases 10 codes J44.0, 1 and 9 in the hospital register. Through patients' case files, the number of readmissions was registered during 2011. Patient survival was registered until 18 months after their primary admission. The arterial punctures referred to below are punctures from the time of the primary admission. Departments at the Medical Centre were sub-specialised, and they all received patients with general internal medicine problems. Only non-invasively ventilated patients were automatically admitted to the Department of Pulmonary Diseases. As a consequence of this, non-invasively ventilated patients were only compared with other patients at the Department of Pulmonary Diseases.

Patients included in the study

A total of 234 admissions were identified. Among these,

98 admissions were excluded; 60 due to double registration, 37 cases as the COPD diagnosis could not be verified and one patient did not have AECOPD as primary disease. Consequently, 136 were included in the study population. For 119 persons, spirometry was available, and COPD was diagnosed according to the GOLD 2010 criteria [9]. In 31 patients there was no spirometry, mainly because the patients could not cooperate, were in poor general condition or were dead before investigation could be performed. Based on an assessment of arterial punctures, medication and prior medical history, 17 were assessed to suffer from COPD and were included. Data were obtained from the patients' case records and from the Telehealthcare Registry kept at the Department of Pulmonary Diseases. Excluded from all non-invasive ventilation calculations were those who could not cooperate or were unable to tolerate non-invasive ventilation at their primary admission (n = 3) and needed it.

Statistics

To analyse the demographics, Microsoft Excel 2003 and MYSTAT (Systat Software, Inc. Chicago, USA) were used. Results are reported as medians and quartiles and the Wilcoxon signed-rank test and relative risk (RR) were used to analyse the non-variable parameters. GraphPad Prism (GraphPad software, Inc. La Jolla, USA) was used for the survival curve and the GraphPad quick calculator for p-values. A p-value of less than 0.05 was regarded as being statistically significant.

TABLE 1

Baseline characteristics of the study population: the total study population admitted to either the Department of Pulmonary Diseases or a department of internal medicine. Subgroup analysis of patients receiving home telehealthcare and patients treated with non-invasive ventilation at the Department of Pulmonary Diseases.

	Parent department (N = 136)		Telehealthcare (N = 136)		NIV treated at the DPD (N = 63)	
	DPD	IM	yes	no	yes	no
Participants, n	66	70	30	106	20	43
Men, n (%)	27 (41)	37 (53)	10 (33)	54 (51)	9 (45)	18 (42)
Age, yrs, median (quartiles)	69 (62-75)*	73 (65-79)*	69 (65-74)	72 (63-78)	70 (64-75)	68 (61-76)
PaCO ₂ , kPa, median (quartiles) ^a	6.8 (5.5-8.2)*	5.9 (5.1-6.7)*	6.5 (5.4-7.9)	5.9 (5.2-7.4)	9.2 (7.6-11.7)*	5.8 (5.0- 6.9)*
pH, median (quartiles)	7.38 (7.30-7.43)	7.40 (7.37-7.45)	7.40 (7.37-7.43)	7.40 (7.34-7.44)	7.25 (7.18-7.34)*	7.42 (7.38-7.45)*
FEV1%, median (quartiles)	29 (22-43)*	38 (28-53)*	27 (17-40)	37 (27-48)	27 (18-43)	30 (25-43)
FEV1/FVC, median (quartiles)	0.41 (0.36-0.52)	0.43 (0.36-0.53)	0.39 (0.31-0.42)*	0.45 (0.38-0.54)*	0.41 (0.35-0.47)	0.42 (0.38-0.53)
LTOT-receivers, n (%)	20 (30)	17 (24)	16 (53)	21 (20)	7 (35)	13 (30)
LTOT, l, median (quartiles)	2 (1-2.5)	1.5 (1.5-2)	2 (1.5-2)	1.5 (1-2)	2 (2-2.5)	1.5 (1-2)
Current smokers, n (%)	27 (41)	30.0 (43)	9 (30)	48 (45)	9 (45)	16 (37)
Ex-smokers, n (%)	38 (58)	40 (57)	21 (70)	57 (54)	10 (50)	27 (63)
Pack years, median (quartiles)	40 (24-50)	40 (20-51)	40 (25-54)	40 (20-50)	37.5 (28-50)	40 (20-50)

DPD = Department of Pulmonary Diseases; FEV1% = forced expiratory volume in the first second in % of predicted value;

FVC = forced ventilator capacity; IM = departments of internal medicine; LTOT = long-term oxygen therapy; NIV = non-invasive ventilation.

*) p < 0.05

a) Initial A puncture.

Trial registration

The study was reported to the Danish Data Protection Agency and presented to the local ethical committee of the North Denmark Region which found no need for ethical approval. Data were registered and kept according to the legislation of the Danish Data Protection Agency.

Trial registration: This trial was registered with the Danish Data Protection Agency (Case no. 2008-58-0028).

RESULTS

Table 1 shows the baseline characteristics, gender, age, PaCO₂ (kPa), pH, FEV1 as percentage of the predicted value (FEV1%), FEV1/FVC, long-term oxygen therapy, smoking status and pack years for patients at primary admission.

Patients at the Department of Pulmonary Diseases were significantly younger than patients admitted to departments of internal medicine ($p = 0.001$), had higher PaCO₂ accumulation at admission and had a lower FEV1% than patients at departments of internal medicine. There were no differences in FEV1/FVC, current smoking status, number of pack years and percentage of patients with long-term oxygen therapy when comparing patients admitted to the Department of Pulmonary Diseases with patients admitted to departments of internal medicine. More patients at the Department of Pulmonary Diseases ($n = 20$) than at the departments of internal medicine ($n = 10$) were included in the telehealthcare project. Patients participating in the telehealthcare project were more obstructive and had more days at hospital than non-participating patients did. There was a trend for patients participating towards being females and previous smokers. There was no difference in FEV1% between participating and non-participating patients.



A patient, suffering from exacerbation of chronic obstructive pulmonary disease, is receiving non-invasive ventilation at the Department of Pulmonary Diseases.

Looking at patients admitted to the Department of Pulmonary Diseases, there was no significant difference in the demographic characteristics between patients receiving non-invasive ventilation and those who did not, although those who received non-invasive ventilation had a significantly lower pH and PaCO₂, which were also the indication for non-invasive ventilation treatment according to national guidelines [1]. Non-invasively ventilated patients had more days at hospital. Long-term oxygen therapy did not increase the risk for non-invasive ventilation treatment needs.

Table 2 shows the readmission risk, main cause of readmission and days at hospital.

There was no difference in readmission in patients primarily admitted at the Department of Pulmonary Diseases versus at the departments of internal medicine. In 53% of the admitted patients, the main cause for readmission was AECOPD; other reasons were heart disease, abdominal diseases, dehydration cancer and infections, among others. There was a trend towards that patients admitted to the Department of Pulmonary Diseases had more days at hospital than patients ad-



TABLE 2

	Parent department (N = 123 ^a)			Telehealthcare (N = 123 ^a)			NIV treated at the DPD ^a (N = 53 ^a)		
	DPD	IM	RR ratio	yes	no	RR ratio	yes	no	RR ratio
Participants, n ^a	56	67	–	29	94	–	13	40	–
Were readmitted in 2011, n (%)	32 (57)	40 (60)	0.96	17 (59)	55 (59)	1.00	7 (54)	24 (60)	0.90
Readmissions in 2011, n, median (quartiles)	2 (1-4)	2 (1-3)	–	4 (2-8)*	2 (1-3)*	–	2 (1-3)	2 (2-5)	–
Readmitted due to AECOPD, n (%)	17 (53)	21 (53)	1.01	16 (94)	22 (40)	2.35*	4 (57)	14 (58)	0.98
Days at hospital at PA ^a , median (quartiles)	9 (6-17)	7 (4-11)	–	8 (5-11)	8 (4-15)	–	15 (8-24)	8 (5-14)	–
Days at hospital in 2011, median (quartiles)	15 (7-29)	11 (6-23)	–	15 (10-24)*	11 (5-27)*	–	22 (12-30)*	11 (6-25)*	–

AECOPD = acute exacerbation of chronic obstructive pulmonary disease; DPD = Department of Pulmonary Diseases;

IM = departments of internal medicine; NIV = non-invasive ventilation; PA = primary admission; RR = relative risk.

*) $p < 0.05$.

a) Patients who survived primary admission.

Readmission risks for the total study population admitted to either the Department of Pulmonary Diseases or a department of internal medicine. Subgroup analysis of readmission risk in patients receiving telehealthcare and patients treated with non-invasive ventilation at the Department of Pulmonary Diseases.

mitted to the departments of internal medicine at their primary admission and during 2011.

When comparing patients with and without telehealthcare, patients with telehealthcare were readmitted a median of four times during follow-up compared with two times for patients who did not have telehealthcare ($p = 0.026$) and admissions were more often due to AECOPD (RR = 2.35; $p < 0.0001$).

Table 3 illustrates the mortality during primary admission and the total mortality during the 18-month follow-up.

In-hospital mortality during primary admission was significantly higher at the Department of Pulmonary Diseases (15.2%) than at the departments of internal medicine (4.3%) (RR = 3.54; $p = 0.047$) (**Figure 1**). The mortality risk during primary admission was lower at the departments of internal medicine (4.3%) comparing with patients at the Department of Pulmonary diseases who did not receive non-invasive ventilation (7.0%).

There was a trend towards a lower mortality during primary admission among participants in the telehealthcare project (3.3%) compared with non-participating patients (11.3%), and telehealthcare-participants tended to have a lower total mortality (30.0%) than patients who did not participate (40.6%).

Mortality was significantly higher in patients receiving non-invasive ventilation (35%) than among patients at the Department of Pulmonary Diseases who did not receive non-invasive ventilation (7%) at their primary admission (RR = 5.02; $p = 0.011$). During follow-up, patients who were treated with non-invasive ventilation did not have a higher mortality risk, but the total mortality risk was significantly higher than patients who did not receive non-invasive ventilation at the Department of Pulmonary Diseases (RR = 2.01; $p = 0.006$).

DISCUSSION

This study shows that patients with primary admission at the Department of Pulmonary Diseases were significantly younger, had a higher PaCO₂ accumulation and a

lower FEV1% than those admitted to the departments of internal medicine. Furthermore, mortality during the primary admission was higher for those admitted to the Department of Pulmonary Diseases than for those admitted to the departments of internal medicine. Patients who participated in telehealthcare had a significantly increased risk of readmission and more often due to AECOPD. Patients treated with non-invasive ventilation at their primary admission had an increased mortality risk during their primary admission and follow-up.

Patients at the Department of Pulmonary Diseases were younger, had lower FEV1% and higher PaCO₂ than those admitted to the departments of internal medicine. Both a low FEV1 and altered blood gasses are known predictors for risk of hospitalisation [10]. Despite these signs of more advanced COPD, patients at the Department of Pulmonary Diseases did not have a higher risk for readmission than those primarily admitted to the departments of internal medicine, even if the FEV1 % was significantly lower than predicted ($p = 0.005$). This is surprising as both FEV1 and a higher PaCO₂ have previously been associated with a higher risk of readmission [5, 11]. However, a recent study by Wang et al also shows that readmission rates are equal whether the primary admission was to a pulmonary department or not [12]. Moreover, in a study by Kadri et al it was shown that the level of care at the primary admission does not influence readmission rates [13].

The mortality risk during primary admission was significantly higher at the Department of Pulmonary Diseases (15.2%) than at the departments of internal medicine (4.3%) ($p = 0.047$). For patients primarily admitted to the Department of Pulmonary Diseases and who did not receive non-invasive ventilation, the mortality risk was 7%. PaCO₂, which was significantly higher in patients admitted to the Department of Pulmonary Diseases than to the departments of internal medicine ($p = 0.026$), is a well known predictor of mortality [14]; and more severe COPD in terms of a lower FEV1 has also been shown to be a risk factor for in-hospital mortality



TABLE 3

Mortality risks for the total study population admitted to the Department of Pulmonary Diseases or a department of internal medicine and subgroup analysis in patients receiving telehealthcare and patients treated with non-invasive ventilation at the Department of Pulmonary Diseases.

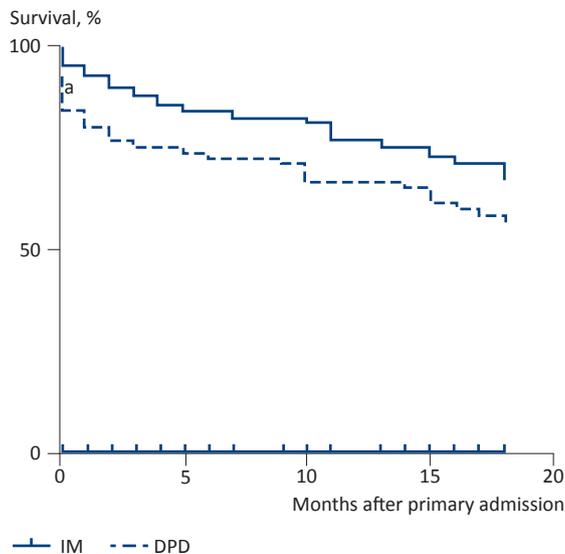
	Parent department (N = 136)			Telehealthcare (N = 136)			NIV-treated at the DPD (N = 63)		
	DPD	IM	RR ratio	yes	no	RR ratio	yes	no	RR ratio
Participants, n	66	70	–	30	106	–	20	43	–
Mortality, n (%)									
During PA	10 (15)	3 (4)	3.54*	1 (3)	12 (11)	0.29	7 (35)	3 (7)	5.02*
After PA	19	20	1.14	8	31	0.84	7	12	1.79
Total	29 (44)	23 (33)	1.34	9 (30)	43 (41)	0.74	14 (70)	15 (35)	2.01*

DPD = Department of Pulmonary Diseases; IM = department of internal medicine; NIV = non-invasive ventilation; PA = primary admission; RR = relative risk.

*) $p < 0.05$.

FIGURE 1

The cumulative survival for patients admitted to the Department of Pulmonary Diseases (DPD) and the departments of internal medicine (IM).



a) During primary admission, the mortality was significantly higher in patients in the DPD than in patients in the IM (relative risk (RR) = 3.54; $p < 0.047$). During follow-up, patients had the same mortality risk at both departments (RR = 1.14; $p < 0.484$).

in COPD [15]. In previous studies, age has been shown to be associated with a higher risk of mortality due to exacerbation of COPD [16]. In this study, the patients at the Department of Pulmonary Diseases with a high in-hospital mortality were younger than those at the departments of internal medicine. An explanation for this may be that patients admitted to this specific Department of Pulmonary Diseases are more severely ill than those admitted to the Departments of internal medicine in this hospital setting. Mortality among patients receiving non-invasive ventilation was considerable; in fact, patients had a five times increased mortality risk during their primary admission. The median pH at inclusion of the patients who received non-invasive ventilation was 7.25. At this value, the risk of treatment failure has previously been shown to increase [17]. A large number of those treated with non-invasive ventilation at the Department of Pulmonary Diseases had this treatment modality as the ceiling of treatment, which indicates a more complex and severe overall morbidity. Patients treated with non-invasive ventilation also had an increased risk of death compared with those who were not treated with non-invasive ventilation during follow-up. This is not surprising as patients with an increased PaCO₂ have previously been shown to have an increased risk of death after hospital admission for AECOPD [14], and patients treated with non-invasive ventilation have also

previously been shown to have a high mortality rate [18]. Furthermore, chronically ill patients sometimes de-select resuscitation and intensive care; instead of respiratory therapy, they are offered non-invasive ventilation in case of respiratory insufficiency even with pH under 7.25.

Patients who survived primary admission at the Department of Pulmonary Diseases or the departments of internal medicine had equal risk for readmission, despite increased PaCO₂ in patients admitted at the Department of Pulmonary Diseases. Increased PaCO₂ has been shown to be a risk factor for early readmission in a study by Lin et al [11] and low FEV₁, which has also been shown to increase the risk of readmission [5].

The median number of readmittances for patients assigned to telehealthcare was twice as high as that of patients who did not participate in the telehealthcare project, and readmittances were more often due to AECOPD. This is in contrast to the findings reported in a recent Cochrane study that showed a reduced risk for readmission in six out of ten studies [8]. It is also in contrast to a recent study by Pinnock et al who found that telehealthcare had no effect on readmission risk and did not improve quality of life [19]. Only a small number of patients included in this study participated in telehealthcare (30), all with very severe disease (median FEV₁ of 26.5%); and of those a small number of patients were readmitted a considerable number of times, which has great impact on the results. These results should therefore be interpreted with care.

This study has several limitations. Readmission to wards outside of the North Denmark Region could not be registered. Such readmission may therefore be underestimated in this study.

AECOPD in the year prior to inclusion could not be assessed. Previous AECOPD is a well known predictor of AECOPD [2, 6]. Data on the degree of dyspnoea could not be assessed systematically in this retrospective study, nor could data on patients' quality of life; both factors are well known predictors of risk of readmission [6]. Co-morbidity was not evaluated in the study population; co-morbidity is a well known risk factor for both mortality and readmission [2]. A Body mass index, air-flow Obstruction, Dyspnea and Exercise capacity (BODE) index on the patients would therefore have been desirable. As data were collected retrospectively, this could not be done. Finally, the size of the study population made some subgroups rather small, which always calls for a more cautious interpretation of results.

CONCLUSION

Despite significant differences in FEV₁, PaCO₂ and in-hospital mortality at primary admission among patients admitted to the Department of Pulmonary Diseases and

departments of internal medicine, respectively, there was no difference in risk of readmission between the two departments. Patients assigned to telehealthcare did not have a higher readmission rate, but those who were readmitted were readmitted more times. However, due to the number of patients included in this study, this number should be interpreted with caution. Larger studies are needed to elucidate this field in greater detail.

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