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**Changes in critical care admissions and outcomes in individuals with bronchiectasis in the UK from  
2009 to 2013**

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## **Abstract**

**Background:** There are limited data on admission trends and outcomes of individuals with bronchiectasis admitted to intensive care (ICU). Using national critical care data, we analysed admissions to ICU and estimated outcomes in terms of mortality in individuals with bronchiectasis and chronic obstructive pulmonary disease (COPD) admitted to ICU.

**Methods:** Using data from the Intensive Care National Audit and Research Centre, admissions from bronchiectasis and COPD from 1/1/2009 to 31/12/2013 were extracted. Crude admission rates for bronchiectasis and COPD were calculated and Poisson regression was used to estimate unadjusted annual admission rate ratios. We investigated changes to length of stay on ICU, ICU mortality and in hospital mortality during the study period. We also analysed mortality rates in people with bronchiectasis and COPD aged 70 or above.

**Results:** We found an annual increase of 8% (95% Confidence Interval [CI] 2 to 15%) in the number of ICU admissions from bronchiectasis, whilst the yearly increase in ICU admissions from COPD was 1% (95% CI: 0.3% to 2%). ICU and in-hospital mortality in individuals with bronchiectasis remained high throughout the study, especially in people aged 70 years or above, whilst in people with COPD both ICU and in-hospital mortality decreased.

**Conclusion:** Admission to ICU in people with bronchiectasis are uncommon, but are increasing in frequency over time, and carries a substantial mortality rate. This needs to be considered allocating health care resources and planning respiratory services.

(236 words)

## **Introduction**

Bronchiectasis is a chronic lung disease characterised by repeated episodes of infection and chronic inflammation.(1) Recent studies suggest that incidence(2), hospital admissions(3) and mortality(4) from bronchiectasis in the UK are increasing, but there are no data on admission rates to intensive care (ICU). There are also limited data on outcomes of individuals with bronchiectasis admitted to ICU in terms of survival. These data are important to help health care planning and form guidance for thresholds for admission to critical care.

The aim of our study was to investigate trends in bronchiectasis admissions to ICU in the UK and estimate outcomes in patients with bronchiectasis admitted to ICU. To benchmark these data we also investigated these outcomes in patients with Chronic Obstructive Pulmonary Disease (COPD), a common chronic respiratory disease in the UK. In addition, we estimated financial impact of bronchiectasis admissions to ICU on secondary care services.

## **Methods**

### *Data source*

We used data from the Intensive Care National Audit and Research Centre (ICNARC), an electronic database of patient outcomes from adult general critical care units across England, Wales and Northern Ireland.(5) 99% of adult critical care units contribute data to ICNARC, which includes information from 1.5 million individuals. Data from ICU admissions from adults over the age of 18 with bronchiectasis and COPD from 1<sup>st</sup> January 2009 to 31<sup>st</sup> December 2013 were extracted.

### *Definition of outcomes*

Our definition of bronchiectasis admissions to ICU included patients whose main reason for admission to ICU was exacerbation of bronchiectasis and excluded individuals with cystic fibrosis. COPD admissions were defined as admissions whose main reason for admission was either COPD with acute

lower respiratory infection; or COPD with acute exacerbation, cause unspecified. Patients who had COPD-bronchiectasis overlap(6) were excluded from these analyses (n=36). The ICNARC Coding Method is a hierarchical method specifically designed for coding reasons for admission to critical care. Primary reason for admission is mandated; however, secondary reason for admission is optional, unless the patient was admitted following surgery. There are currently no national criteria for admission to critical care for either bronchiectasis or COPD, and admissions are based on clinical discretion.

ICU mortality was defined as the status at discharge from the ICU, whilst in-hospital mortality was defined as the status on discharge from hospital. We also extracted demographic information, intubation rates, length of stay on ICU (duration from date of admission to date of discharge from ICU or date of death), total hospital length of stay (date of admission to date of discharge from hospital or date of death), as well as mean Acute Physiology and Chronic Health Evaluation II (APACHE II) scores.

### *Statistical Analysis*

Only summary data grouped by calendar year were available for these analyses. We calculated crude admission rates for bronchiectasis and COPD for each year by dividing the number of admissions from bronchiectasis or COPD by the total number of admissions to ICU. Poisson regression modelling(7) was used to estimate crude annual admission rate ratios. We calculated the cost of critical admissions from bronchiectasis for each year by multiplying the cost of a critical care bed day in the NHS with single organ support for the 2012-2013 financial year ([www.dh.gov.uk](http://www.dh.gov.uk)) by the median length of stay on ICU and number of admissions for each calendar year. We developed an unadjusted Poisson regression model to predict future critical care admissions from bronchiectasis for the year 2020 and estimated cost of critical care admissions for that year without adjusting for inflation costs or changes to market forces. We investigated changes in mean age at admission, mean APACHE II scores, rates of intubation, ICU and in-hospital mortality over the study period in people with bronchiectasis and COPD. As increasing age is strongly associated with poor survival in bronchiectasis,(8) and COPD(9) we assessed

these outcomes in older individuals with COPD and bronchiectasis. We pragmatically chose individuals aged 70 years or above in these separate analyses. Two-sided likelihood ratio, unpaired t tests, Chi squared and Wilcoxon rank sum tests were used for hypothesis testing. Stata v12 (College Station, Texas) was used for all statistical analyses.

## Results

There were 614,352 admissions to ICU across 219 critical care units between 2009 and 2013, of which 536 (0.1%) were due to bronchiectasis and 19,754 (3.2%) due to COPD. Admissions from bronchiectasis increased from 74 in 2009 to 121 in 2013, equating to a crude annual increase of 8% (Rate Ratio [RR] 1.08; 95% Confidence Interval [CI]: 1.02 to 1.15;  $p=0.01$ ). Individuals with bronchiectasis were more frequently female (57.5%) and the mean age at admission increased from 56.6 (standard deviation [SD] 18) to 65.8 years (SD 15.2) during the study period (linear regression  $p=0.042$ ). However, rates of intubation (47.9% vs 44.6%;  $p=0.65$ ) and mean APACHE II acute physiology scores remained similar (12.7 vs. 13.5;  $p=0.17$ ) during this time. ICU mortality did not change (27.0% vs. 28.9%;  $p=0.83$ ), neither did in hospital mortality (35.7% vs. 33.9%;  $p=0.86$ ) (see Table 1). There was also no change in median length of stay in ICU ( $p=0.21$ ) or median length of stay in hospital ( $p=0.36$ ) (see Table 2). During the five year study period, the estimated financial burden on the National Health Service (NHS) in terms of critical care bed days from bronchiectasis increased marginally from £189,144 to £298,967 per year (see Table 2). Using an unadjusted Poisson regression model, we estimate that by 2020, there will be close to 220 critical care admissions per year from bronchiectasis, which will cost the health service almost £500,000 annually in critical care bed day costs.

In contrast, there were 3126 admissions due to COPD in 2009, which rose to 4652 in 2013. The unadjusted year on year increase in COPD admissions was 1% (RR 1.010, 95% CI: 1.003-1.023;  $p=0.012$ ). The mean age at admission remained static (67.5 years [SD 10.6] in 2009 vs. 67.9 years [SD

10.6] in 2013;  $p=0.16$ ), but ICU mortality decreased during the study period (20.5% vs. 18.0%;  $p=0.02$ ), as did in-hospital mortality (30.7% vs. 26.7%;  $p=0.005$ ) (see Table 1). The proportion of individuals with COPD who were intubated also decreased during this time (53.7% vs. 44.2%;  $p<0.001$ ).

In separate analyses of 219 people with bronchiectasis aged 70 or above, we found that ICU mortality was higher compared to that amongst those aged under 70 (31.1% vs. 18.3%;  $p<0.001$ ) despite having similar mean APACHE II acute physiology scores. Furthermore, in hospital mortality in individuals with bronchiectasis aged 70 or above was almost double compared to individuals with bronchiectasis under 70 (47.4% vs. 24.6%;  $p<0.001$ ). During the study period, patients with bronchiectasis aged 70 or above had substantially higher rates of death whilst on ICU (23.1% vs. 31.1%;  $p=0.03$ ) and during hospital admission (36.4% vs. 46.6%;  $p=0.04$ ) than individuals with COPD of the same age group (see Table 3). Individuals with bronchiectasis over the age of 70 were also less likely to be intubated compared to those less than 70 years. However, the proportions of individuals over the age of 70 with bronchiectasis and COPD who were intubated were similar (41.6% vs. 42.2%;  $p=0.90$ ) (see Table 3).

Table 1: Crude admission rates, Poisson regression modeling of admissions, mortality and median ICU length of stay in people with Bronchiectasis and Chronic Obstructive Pulmonary Disease (COPD)

	Number of admissions	Person years	Crude admission rate per 100,000 person years (95% CI)	Crude admissions rate ratio (95% CI)	Number of ICU deaths (%)	Number of hospital deaths (%)
<b>Bronchiectasis</b>						
<b>Year</b>						
<b>2009</b>	74	97,457	75.9 (60.5-95.4)	1.00	20 (27.0)	25 (35.7)
<b>2010</b>	78	114,207	68.3 (54.7-85.3)	0.90 (0.65-1.24)	18 (23.1)	31 (41.3)
<b>2011</b>	108	128,659	83.9 (69.5-101.4)	1.11 (0.82-1.49)	22 (20.4)	32 (31.4)
<b>2012</b>	155	137,062	113.1 (96.6-132.7)	1.49 (1.13-1.96)	31 (20.00)	48 (31.8)
<b>2013</b>	121	136,877	88.4 (74.0-105.6)	1.16 (0.87-1.55)	35 (28.9)	40 (33.9)
				*p for trend=0.022		
<b>COPD</b>						
<b>Year</b>						
<b>2009</b>	3126	97,457	3204.6 (3094.2-3318.9)	1.00	642 (20.5)	941 (30.7)
<b>2010</b>	3675	114,207	3217.8 (3115.5-3223.6)	1.01 (0.96-1.05)	717 (19.5)	1096 (30.4)
<b>2011</b>	3924	128,659	3049.9 (2956.0-3146.9)	0.95 (0.91-1.00)	718 (18.3)	1109 (28.8)
<b>2012</b>	4377	137,062	3193.4 (3100.2-3289.5)	0.99 (0.95-1.04)	818 (18.7)	1184 (27.4)
<b>2013</b>	4652	136,877	3398.7 (3302.4-3497.8)	1.06 (1.01-1.11)	837 (18.0)	1220 (26.7)
				*p for trend=0.0003		

\*p value for likelihood ratio test

Table 2: Median length of stay on intensive care, median length of stay in hospital and associated costs for individuals with bronchiectasis



Bronchiectasis	Median length of stay on ICU (IQR) <sup>#</sup>	Median length of stay in hospital (IQR) <sup>#</sup>	Cost on NHS in terms of critical care admission (£)
<b>Year</b>			
2009	3.0 (1.0-5.0)	14 (7-24)	189,144
2010	3.5 (1.4-6.4)	14 (7-29)	232,596
2011	2.1 (1.0-5.1)	17 (7-33)	193,233
2012	3.8 (1.1-7.3)	16 (8-30)	501,828
2013	2.9 (1.4-7.3)	12 (6-25)	298,967

<sup>#</sup>length of stay in days

Table 3: Characteristics of individuals with bronchiectasis and COPD aged 70 or above admitted to intensive care

	Individuals with bronchiectasis aged ≥70 years (n=219)	Individuals with COPD aged ≥70 years (n=8,844)
Mean age at admission (SD)	76.6 (5.0)	76.9 (5.1)
Male (%)	98 (44.7)	4567 (51.6)
Mean APACHE II acute physiology score (SD)	13.3 (5.9)	12.5 (5.6)
Number of people intubated (%)	91 (41.6)	3727 (42.2)
Number of ICU deaths (%)	68 (31.1)	2042 (23.1)
Number of hospital deaths (%)	102 (46.6)	3215 (36.4)
Median length of stay on ICU (IQR)	2.9 (1.1-6.4)	2.8 (1.2-5.9)

## Discussion

To our knowledge, this is the first study to use national data to determine trends in ICU admissions amongst individuals with bronchiectasis. We found that the number of patients with bronchiectasis admitted to ICU is increasing. The mean age at admission increased during our study period but there was no change to length of stay on ICU. Throughout the five year study period, ICU and in-hospital mortality in people with bronchiectasis remained substantially high, whilst both decreased in people with COPD. We also found that both ICU and in-hospital mortality was highest in individuals with bronchiectasis aged 70 and above.

On the basis of our findings, we estimate the annual financial burden from bronchiectasis critical care admissions alone in the UK will be almost £500,000 by 2020, although this likely to be an

underestimation, as it assumes only single organ support and does not take into account inflation costs and changes to market forces.

We used a large, comprehensive dataset that includes admissions across almost all adult critical care centres in England, Wales and Northern Ireland, including specialist tertiary centres and district general hospitals. The ICNARC dataset has been shown to be broadly representative of the UK population of patients admitted to ICU.<sup>(10)</sup> This has enabled us to estimate a realistic disease burden in terms of critical care admissions without sampling bias. The long study period has also enabled us to examine changes to age at admission, rates of intubation, ICU mortality, in-hospital mortality and length of stay.

One of the limitations of our study is that only summary data were available, hence we were unable to standardise our admission rates to account for the increase in the number of critical care units contributing to ICNARC. Hence, it is possible that the increase in admissions seen in our study is due, at least in part, to increased diagnosis of cases of bronchiectasis in the UK. Another potential limitation relates to the validity of and accuracy of diagnostic coding of ICU admission data. We have not validated diagnoses of bronchiectasis or COPD within this dataset, but a previous study has shown that validity of admission coding within ICNARC is high.<sup>(11)</sup> Furthermore, the demographic features of individuals with bronchiectasis in these data are consistent with the UK population of patients with bronchiectasis.<sup>(12, 13)</sup> However, given that the diagnosis of COPD is co-existent in 36% of individuals with bronchiectasis,<sup>(14)</sup> there is likely to be some diagnostic imprecision within our dataset, including undiagnosed Bronchiectasis-COPD overlap syndrome (BCOS)<sup>(6)</sup> that may be included in the COPD population. Nevertheless, our study demonstrates a high ICU and in-hospital mortality rate in people with identified bronchiectasis, especially in those aged 70 years or above. Although this may be partly explained by other factors that influence mortality, this does not detract from our finding that survival in these individuals is poor. We were unable to identify patients who have had more than one admission to critical care. However, we believe that repeated admissions to critical care would not be

the main reason for the rising trends seen, given the substantially high mortality rate throughout the study.

There are sparse data on ICU admission rates in people with bronchiectasis, as well as outcomes with regards to mortality. A French study of 48 patients with bronchiectasis admitted to an intensive care unit over a 10 year period suggested that age over 65 years and long term oxygen therapy use were risk factors for increased mortality on ICU.(15) A single centre study from 1996 to 2004 by Alzeer et al. reported that the mean age of patients with bronchiectasis admitted to ICU was 63.5 years.(16) This study also found that older patients with bronchiectasis admitted to ICU had a worse outcome in terms of survival.(16) Both studies report variable ICU mortality rates, ranging from 19 to 34%,(15, 16) and long term oxygen therapy was also associated with increased mortality.(16)

In summary, this is the first ever national study of ICU outcomes in patients with bronchiectasis. These data derived from the UK have identified the increasing demand on critical care services and the financial impact of this on secondary care services. We have also highlighted the poor prognosis of individuals with bronchiectasis admitted to ICU, especially in the older population of 70 years or older. These data will aid updates in UK national bronchiectasis guidelines (17) and may help guide clinicians in the thresholds for admission to critical care.

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