CHRONIC OBSTRUCTIVE PULMONARY DISEASE

UK National COPD Audit 2003: impact of hospital resources and organisation of care on patient outcome following admission for acute COPD exacerbation

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Background: Acute chronic obstructive pulmonary disease (COPD) exacerbations use many hospital bed days and have a high rate of mortality. Previous audits have shown wide variability in the length of stay and mortality between units not explained by patient factors. This study aimed to explore associations between resources and organisation of care and patient outcomes.

Methods: 234 UK acute hospitals each prospectively identified 40 consecutive acute COPD admissions, documenting process of care and outcomes from a retrospective case note audit. Units also completed a resources and organisation of care proforma.

Results: Data for 7529 patients were received. Inpatient mortality was 7.4% and mortality at 90 days was 15.3%; the readmission rate was 31.4%. Mean length of stay for discharged patients was 8.7 days (median 6 days). Wide variation was observed in all outcomes between hospitals. Both inpatient mortality (odds ratio (OR) 0.67, CI 0.50 to 0.90) and 90 day mortality (OR 0.75, CI 0.60 to 0.94) were associated with a staff ratio of four or more respiratory consultants per 1000 hospital beds. The length of stay was reduced in units with more respiratory consultants, better organisation of care scores, an early discharge scheme, and local COPD management guidelines.

Conclusions: Units with more respiratory consultants and better quality organised care have lower mortality and reduced length of hospital stay. This may reflect unit resource richness. Dissemination of good organisational practice and recruitment of more respiratory specialists offers the potential for improved outcomes for hospitalised COPD patients.

Chronic obstructive pulmonary disease (COPD) is one of the most common causes of acute hospital admissions in the UK,[1] accounting for 10% of all medical admissions[2] and over 90 000 admissions to hospital every year.[3] The number of admissions has increased by 50% in the last decade[4] and now accounts for about 1 million bed days per annum. Hospital admissions carry a high mortality and patients may have extended lengths of stay.[5]

There is a wide variation in both length of stay (LOS) and mortality between hospitals.[5 6] Some of the variability can be explained by patient factors but much cannot. An earlier pilot study suggested that better resourced hospitals achieve better outcomes.[7] This study aimed to explore possible relationships between resources available for the care of COPD patients and organisation of care with the patient outcomes of death, LOS, and readmission.

METHODS

The study was run jointly by the Clinical Effectiveness and Evaluation unit (CEEu) of the Royal College of Physicians and by the British Thoracic Society (BTS). It was coordinated from the CEEu but employed local data collection using standardised methods. It had a multidisciplinary steering committee with representation from professional bodies and managerial organisations as well as policy makers. All units within the UK identified as admitting acute medical cases were invited by letter to participate in the study.

Data collection

Participating units were asked to complete a single resources and organisational questionnaire and individual clinical proformas for each of 40 consecutive acute COPD cases admitted from 1 September 2003 up to a closing date 6 weeks later. Both questionnaires were developed from those used successfully in previous studies[5–7] but with added input from participants. They are available in full on the RCP website (http://www.rcplondon.ac.uk/college/ceeu/ceeu_copd_home.htm).

All respiratory consultants in the UK registered with the BTS were asked for their views on the content of the audit tool, supplemented by a one day workshop of national experts.

The resource and organisational proforma collected data on the numbers and types of staff, the numbers of patients treated, and the way the admission and discharge process was organised. The patient proforma recorded clinical care and the outcome at 90 days for each patient. The case mix adjustment factors are shown in table 1 together with the completeness of data items and the way in which they were divided a priori for analysis. Both proformas were pilot tested in five trusts following which minor modifications were made to the audit tool. Each unit was enabled to enter data

Abbreviations: COPD, chronic obstructive pulmonary disease; FEV_1, forced expiratory volume in 1 second; LOS, length of stay

Table 1 Patient admission data (7529 patients from 234 units)

Item	Metric	% Patient data completeness
Age	Years	99.9
Age group	<55, 55–9, 60–4, 65–9, 70–4, 75–9, 80–4, 85+	99.9
Sex	Male, female	99.9
Admitting physician	Respiratory, care of the elderly (CoE), general, other	98
Previous COPD admission	Yes, no	94
Living alone	Alone, with others	94
Social circumstances	Own home without social care, own home with social care, warden controlled, residential, other	82
Performance status	Normal, strenuous, limited activity, limited self care, bed/chair bound	88
Co-morbidity	Yes, no to presence in notes of heart disease, stroke, other chest problems, diabetes, locomotor problems, visual impairment	100
Smoking status	Current, ex (stopped >3 months ago), lifelong non-smoker	95
Pack years of smoking	<20, 20–39, 40–59, 60+	46 current/ex
Chest radiography	Yes, no to suspected/definite cancer, changes consistent with COPD, pneumonia, other abnormalities	82
Signs/symptoms	Increasing level of breathlessness	97
	Increasing volume of sputum	81
	Changes in colour of sputum	78
	Colour of sputum	80
Weight (kg)	<57.1, 57.1–73.0, >73.0	40
FEV_1 tertiles (most recent in last 5 years)	M <0.77, F <0.60; M 0.77–1.15, F 0.60–0.90; M >1.15, F >0.90	55
% predicted FEV_1 tertiles	<31%, 31–51%, >51%	43
Serum albumin (g/l)	<34, 34+	67
Blood urea (μmol/l)	⩽7.1, >7.1	92
Blood creatinine tertiles (mmol/l)	<78, 78–99, 100+	92
pH	<7.26, 7.26–7.34, 7.35+	82
Bicarbonate	<23, 23–30, >30	73
PCO_2 (kPa)	⩽6.0, >6.0	81
PO_2 (kPa)	<7.3, 7.3–8.0, >8.0	81
Respiratory rate	<20, 20–9, 30+	81
Saturated oxygen on inspired fraction	<86%, 86–92%, >92%	90 inspired fractions

FEV_1, forced expiratory volume in 1 second; PCO_2, PO_2, carbon dioxide and oxygen tensions.

directly to a self contained Microsoft Access database that included automated consistency checks. *Binley's Directorate of NHS Management* was also used to validate data.[8]

Gaps and inconsistencies within the resource and organisational forms were queried with units. Reliability of the clinical data was tested by asking each unit to use a second person to independently collect data on their first five audit patients. 190 units submitted 910 cases for analysis. Reliability levels were good with a median kappa value across data items of 0.80 (IQR 0.69–0.89).

Organisational score

An ''organisational score'' was produced for each unit by adding one point for the presence of each of 14 factors thought to represent good clinical practice and that might reasonably be expected to have a positive effect on patient outcome. These were: a ward based system of medical care, a specialist respiratory ward, two daily consultant post-take rounds, speciality triage, integrated admissions policy, admissions ward, early discharge scheme, high dependency unit (HDU), >median intensive care unit (ICU) beds per 1000 total beds, early warning detection/ICU outreach, invasive ventilation, non-invasive ventilation, formal pulmonary rehabilitation programme, all patient access to a respiratory nurse.

Outcome analysis

The outcomes analysed were inpatient death, death within 90 days of admission, and (for discharged patients) the LOS and readmission within 90 days of admission. To assess the association of resource and organisation factors with outcome, a two stage procedure was adopted: (1) logistic regression methods (SPSS Version 11; SPSS UK Inc, Woking, Surrey, UK) were used to obtain a parsimonious set of patient case mix predictors; and (2) random effects logistic regression methods using Stata 8 statistical software (Stata Corp, College Station, TX, USA) were used to assess the correlation of unit resources and organisation with outcome after adjusting for relevant case mix and for any clustering effects of patients within units. Only patient factors known at or close to admission were considered as case mix predictors. We were mindful not to adjust for the confounding effect of factors during the process of care as they might lie on the causal pathway between the resource and organisational factors and outcome. In the final modelling the not known categories were included. Clustering was significant ($p<0.001$) for all outcomes, the intra-class correlation coefficient values being 0.043 (death <90 days), 0.059 (inpatient death), 0.084 (readmission), 0.050 (LOS >7 days) and 0.063 (LOS >14 days).

Numerical resources data were categorised automatically by SPSS statistical software Version 11 into tertiles.

RESULTS

Patient and organisational audit data were available on 7986 episodes of care for 7529 patients from 234 units. Only the first episode on each patient is included in this paper.

There was wide inter-unit variation in both the resources available (table 2) and in outcomes. The number of respiratory consultants per 1000 beds varied from 0 to 27 (median 3.5). In-hospital mortality was 7.4% (542/7313) (IQR 3–11%) and mortality within 90 days was 15.3% (1112/7274) (IQR 9–21%). For discharged patients the readmission rate within 90 days was 31.4% (2069/6585) (IQR 22–40%). Median LOS for discharged patients was 6 days (IQR 5–7).

Table 2 Unit level resource and organisational data (234 units)

Item	Metric	% Unit data completeness
Bed numbers*	Tertiles: 128–464, 465–702, >702	100
Trust star rating (England only)*	0–1, 2, 3	100 England
Trust catchment population	Tertiles: 61–233k, 234–359k, >359k	100
Patients admitted to unit in 2002	Tertiles: 111–358, 364–638, >638	97
Organisational		
Access to early discharge scheme	Yes, no	100
Daily post-take ward rounds by consultant	1, 2, other	100
Physician of week scheme	Yes, no	100
Ward based system	Yes, no	99
Admission ward	Yes, no	100
Speciality triage	Yes, no	100
Specialist respiratory ward	Yes, no	100
Operational ICU beds per 1000 beds*	Tertiles: 0–8, 9–12, >12	99
Ventilatory support	Yes, no to each of: invasive, doxapram, non-invasive	100
Non-invasive ventilation	Yes, no to each of: on ICU, on HDU, on wards	100
Early warning detection or ICU outreach	Yes, no	99
Admissions policy	Age related, integrated	75
Patient access to respiratory nurse	Yes, no	100
Formal pulmonary rehabilitation programme	Yes, no	100
Written local guidelines	Yes, no to assessment, treatment and follow up of COPD	99
Resources (Whole time Equivalent):		
N respiratory consultants	Tertiles: 0–1.6, 1.7–2.0, >2.0	100
N respiratory consultants per 1000 beds	Tertiles: 0–2.7, 2.8–4.0, >4.0	100
N respiratory juniors†	Tertiles: 0–3.0, 3.5–5.0, >5.0	100
N respiratory juniors per 1000 beds	Tertiles: 0–5.2, 5.3–9.1, >9.1	100
N respiratory staff grades‡	Tertiles: 0–5.0, 5.2–7.8, >7.8	100
N respiratory staff grades per 1000 beds	Tertiles: 0–9, 10–13, >13	100
N all respiratory staff§	Tertiles: 0–9, 10–14, >14	100
N all respiratory staff per 1000 beds	Tertiles: 0–15, 16–24, >24	100
N general medicine consultants	Tertiles: 1–9, 10–13, >13	98
N general med consultants per 1000 beds	Tertiles: 0.8–17, 18–24, >24	98
N general medicine juniors†	Tertiles: 0–21, 22–31, >31	98
N general med juniors per 1000 beds	Tertiles: 0–42, 43–55, >55	98
N general medicine staff grades‡	Tertiles: 3–34, 35–47, >47	98
N general med staff grades per 1000 beds	Tertiles: 1–63, 64–83, >83	98
N general medicine SpR at 03.00 hours	0, 1–6	99
N general medicine SHO at 03.00 hours	1, 2–9	96
N general medicine PRHO at 03.00 hours	0, 1–7	99
N general medicine juniors† at 03.00 hours	1–2, 3, >3	96

Binley's Directory of NHS Management, Spring 2004 edition, published January 2004.[8]
†Specialist Registrar (SpR), Senior House Officer (SHO), Pre-registration House Officer (PRHO).
‡Consultants, associate specialists, staff grades, juniors includes lung function technicians, COPD nurses, other specialist nurses and physiotherapists.
§Star ratings for NHS trusts (see www.ratings2003.healthcarecommision.org.uk/ratings).

Mean LOS was 8.3 days with 40% (2611/6544) staying more than 7 days and 15% (969/6544) more than 14 days.

The most important patient level prognostic factors of those recorded were performance status, blood urea, serum albumin, arterial pH, arterial oxygen saturation and age (see table S1 available on *Thorax* website at http://www.thoraxjnl.com/supplemental). For LOS, performance status, serum albumin, age, arterial oxygen saturation, and respiratory rate were the main predictors. Performance status and previous admission were the two main factors associated with readmission. To incorporate both patient and unit level factors in the analysis, random effects logistic regression modelling was used. For each outcome we investigated the correlation of unit organisation and resource factors after adjusting for the relevant set of patient case mix factors. Mortality rates (both inpatient and 90 day) were lower in units with more respiratory staff per 1000 beds (table 3). There were no other apparent associations with death among the other resource or organisational factors.

There were no resource or organisational factors associated with readmission rates. The percentage of patients staying beyond 7 days decreased with a greater number of respiratory consultants, the availability of an early discharge scheme, and the presence of local guidelines about follow up of patients after discharge (table 4). Trends regarding the benefits of a formal pulmonary rehabilitation programme on LOS were more tenuous (>7 days OR 0.90 (95% CI 0.76 to 1.05); >14 days OR 0.83 (95% CI 0.68 to 1.02).

Units with the worst organisational scores had proportionately more patients staying longer in hospital (table 5). There were no obvious associations of organisational score with mortality or with readmission. There were no apparent associations between size of hospital (as reflected by catchment population, bed numbers, or annual number of patients admitted) and mortality or readmission, but there was evidence (table 5) that patients stayed longer in the hospitals with fewest beds. At the unit level there was a weak correlation between the proportion of discharged patients staying more than 14 days in hospital and death within 90 days (Spearman 0.19, $p = 0.003$). The correlation of LOS with the readmission rate of discharged patients was weaker still (Spearman 0.06, $p = 0.36$).

DISCUSSION

This study of hospital inpatient COPD care included all four countries of the UK. Considerable effort was put into achieving a high participation rate and a high standard of data quality.

Table 3 Unit respiratory staffing and patient mortality

	No of patients	% (n) dead	OR (95% CI) adjusting for relevant case mix and for unit clustering
Death <90 days of admission			
Respiratory consultants per 1000 beds			
0–2.7	2336	17.0 (396)	1.00
2.8–4.0	2585	15.5 (400)	0.93 (0.75 to 1.15)
>4.0	2353	13.4 (316)	0.75 (0.60 to 0.94)
No of respiratory juniors per 1000 beds			
0–5.2	2393	16.5 (396)	1.00
5.3–9.1	2411	15.6 (376)	0.99 (0.79 to 1.23)
>9.1	2470	13.8 (340)	0.84 (0.67 to 1.04)
No of respiratory staff grades per 1000 beds			
0–9	2303	16.4 (377)	1.00
10–13	2544	16.1 (410)	1.00 (0.81 to 1.25)
>13	2427	13.4 (325)	0.81 (0.64 to 1.01)
No of all respiratory staff per 1000 beds			
0–15	2263	16.3 (368)	1.00
16–24	2539	16.1 (409)	0.99 (0.79 to 1.23)
>24	2472	13.6 (335)	0.84 (0.67 to 1.05)
Inpatient death			
Respiratory consultants per 1000 beds			
0–2.7	2360	8.3 (196)	1.00
2.8–4.0	2593	7.9 (205)	1.00 (0.76 to 1.32)
>4.0	2360	6.0 (141)	0.67 (0.50 to 0.90)
No of respiratory juniors per 1000 beds			
0–5.2	2415	8.3 (200)	1.00
5.3–9.1	2415	8.0 (193)	1.03 (0.78 to 1.37)
>9.1	2483	6.0 (149)	0.69 (0.51 to 0.92)
No of respiratory staff grades per 1000 beds			
0–9	2327	7.9 (184)	1.00
10–13	2547	8.8 (224)	1.20 (0.92 to 1.58)
>13	2439	5.5 (134)	0.66 (0.49 to 0.89)
No of all respiratory staff per 1000 beds			
0–15	2289	7.9 (181)	1.00
16–24	2540	8.8 (223)	1.16 (0.88 to 1.53)
>24	2484	5.6 (138)	0.70 (0.52 to 0.95)

There are limitations within the methodology of retrospective case note audit and there is limited power (related to only 40 case sample size per site) to determine what factors affect performance at the individual trust level.[5] Not all items of data collection were complete and, given the many variables and analyses, some associations could have arisen by chance. However, the measures of the quality of data collected compare well with the best audit data,[9] and the very high participation rate (94%) permits some generalisation of the results with implications not just for the UK health economy but also for other healthcare systems providing COPD services.

The findings detailed here are consistent with previous audits of COPD from the UK and with other sources in the

Table 4 Unit resource and organisation and length of stay of discharged patients

	No of patients	% (n)	OR (95% CI) adjusting for relevant case mix and for unit clustering
LOS >7 days			
No of respiratory consultants			
⩽1.6	1996	41.2 (822)	1.00
1.7–2.0	2399	40.9 (982)	0.95 (0.79 to 1.14)
>2.0	2149	37.6 (807)	0.81 (0.67 to 0.98)
Patient access to early discharge scheme			
No	3491	43.3 (1513)	1.00
Yes	3053	36.0 (1098)	0.69 (0.60 to 0.81)
Local written guideline for follow up of COPD			
No	4199	41.3 (1735)	1.00
Yes	2318	37.1 (2318)	0.84 (0.72 to 0.98)
LOS >14 days			
No of respiratory consultants			
⩽1.6	1996	16.2 (323)	1.00
1.7–2.0	2399	15.0 (359)	0.86 (0.68 to 1.09)
>2.0	2149	13.4 (287)	0.75 (0.59 to 0.97)
Patient access to early discharge scheme			
No	3491	15.8 (553)	1.00
Yes	3053	13.6 (416)	0.78 (0.64 to 0.95)

Table 5 Other unit features and outcome: odds ratio (95% CI) adjusted for relevant case mix and clustering effect

	No of patients	All patients		Discharged patients		
		Death <90 days of admission	Inpatient death	Readmission <90 days of admission	Length of stay >7 days	Length of stay >14 days
Organisational score						
1–7	2409	1.00	1.00	1.00	1.00	1.00
8–9	2522	1.02 (0.82 to 1.28)	1.20 (0.90 to 1.62)	1.04 (0.83 to 1.29)	0.88 (0.73 to 1.06)	1.00 (0.78 to 1.27)
10–14	2598	0.95 (0.76 to 1.19)	1.16 (0.86 to 1.56)	1.08 (0.87 to 1.35)	0.80 (0.66 to 0.96)	0.83 (0.66 to 1.06)
Catchment population ($\times 10^3$)						
61–233	2534	1.00	1.00	1.00	1.00	1.00
234–359	2646	1.05 (0.84 to 1.31)	1.15 (0.86 to 1.53)	0.93 (0.75 to 1.16)	1.01 (0.84 to 1.21)	0.99 (0.78 to 1.26)
>360	2344	1.12 (0.90 to 1.41)	1.18 (0.88 to 1.59)	1.01 (0.81 to 1.25)	0.97 (0.80 to 1.18)	0.96 (0.75 to 1.23)
Patients admitted 2002						
111–358	2092	1.00	1.00	1.00	1.00	1.00
364–638	2512	0.99 (0.78 to 1.24)	0.97 (0.72 to 1.30)	0.99 (0.79 to 1.23)	0.87 (0.73 to 1.06)	0.73 (0.57 to 0.93)
>638	2683	1.08 (0.86 to 1.36)	1.14 (0.84 to 1.53)	0.98 (0.78 to 1.22)	1.00 (0.82 to 1.21)	0.95 (0.75 to 1.22)
Bed numbers*						
128–464	2215	1.00	1.00	1.00	1.00	1.00
465–702	2603	0.92 (0.74 to 1.16)	0.98 (0.73 to 1.32)	0.97 (0.78 to 1.21)	0.94 (0.78 to 1.13)	0.81 (0.64 to 1.04)
>702	2711	1.04 (0.83 to 1.30)	1.00 (0.75 to 1.35)	1.00 (0.80 to 1.24)	0.84 (0.70 to 1.02)	0.76 (0.60 to 0.97)
Star ratings (England)*						
0–1	1750	1.00	1.00	1.00	1.00	1.00
2	2051	0.87 (0.68 to 1.12)	0.69 (0.51 to 0.94)	0.94 (0.75 to 1.19)	1.09 (0.88 to 1.34)	1.03 (0.78 to 1.36)
3	2041	0.97 (0.75 to 1.24)	0.83 (0.61 to 1.12)	1.18 (0.93 to 1.49)	0.91 (0.74 to 1.13)	0.89 (0.67 to 1.19)

Binley's Directory of NHS Management Spring 2004 Edition, published January 2004.[8]

United States that have examined hospital outcomes and related these to resource issues.[10–12] Mortality rates for exacerbations of COPD (both in hospital and in the period immediately after) are high, with 15.3% of patients dying within 90 days of admission. The wide variation between hospital units, unexplained by the clinical case mix of admitted patients, is probably unacceptable. We have also confirmed a high variability between different units for many other aspects of both organisation of care and the processes of care.

We have confirmed (in larger numbers) the patient factors that are predictors of outcome. The influence of performance status on each of the outcomes is of particular interest. This clinical variable was developed for use in oncology trials where it is established as a powerful independent predictor of outcome. Oncologists record it routinely (using either the ECOG[13] or WHO[14] 5 point scales) and apply it in clinical practice. In contrast, few physicians ask about or record performance status specifically in the case records. It had a much more powerful effect on mortality (2% in the best category compared with 38% in the most severe) than the more respiratory specific factors, probably because it combines all the disabilities affecting an individual within a single scale. This study confirms its value as a case mix control factor that is perhaps worthy of application to other chronic medical conditions.

But this study goes further and shows that, even after control for the patient case mix, both resources and organisation of care may impact on mortality and on LOS. Hospitals cannot control for the severity of underlying illness in patients, but they can ensure that their services are effectively staffed and organised to manage those being admitted.

Previous studies have suggested that better staffing levels are associated with better mortality outcome in UK hospitals.[7 10] In our study the number of respiratory specialists per 1000 hospital beds correlated best with outcome and suggests that units with four or more respiratory specialists per 1000 hospital beds—as recommended by the Royal College of Physicians[15]—have lower mortality rates. A trend for improved mortality with increasing numbers was seen across all tertile groups (table 3). Similar trends were also seen for junior doctors and for all respiratory medical staff (table 3).

No such relationship was seen for general physicians either at senior or junior level. It may not necessarily be the individual care offered by a consultant that makes the difference, but something about the whole unit that is associated with a higher number of respiratory consultant staff. The data relating to LOS (table 4) may give some indication as to the nature of this effect. Here both the number of respiratory consultant staff and some organisational issues (such as the availability of local management guidelines and a composite organisational score derived from good medical practice) are outcome indicators for shorter LOS. There was also evidence that patients stayed longer in hospitals with fewer beds (table 5), something associated also with fewer respiratory doctors. In essence, this might reflect a whole systems organisation and resource richness that affects care rather than any individual component. Many scores exist that look at patient factors to predict survival, but few exist to look at factors within a health care unit with regard to predicting outcome. We note a previous organisational score used where the authors suggest it is a reliable way of comparing units/trusts.[16–18] Care is provided by teams of health professionals and future organisational scores need to reflect this. In stroke care the factors that describe a well organised stroke unit have been set out[19] and a similar exercise is needed for COPD care.

It was disappointing that none of the resource or organisational factors accounted for the variation in readmission rate. Readmission rates are seen to be a ''failure'' by the health service to address the multiple needs of COPD patients, and the very high readmission rate heightens the political profile. Readmission rates have formed part of the UK hospital star ratings. However, our inability to identify organisational predictors in a very large study shows how complex a challenge it is to manage chronic ill health. We speculate that the high readmission rate may reflect the severity of illness in such patients who may be regarded as pre-terminal. Alternatively, there may simply be a lack of alternative coping strategies for acutely breathless patients to adopt other than admission to hospital. Empowering the ''expert patient'' to self-manage their exacerbation using rescue packs supplemented by loan of support equipment and access to healthcare staff at home offer alternative strategies as yet to be evaluated on a wide scale.

Balancing the provision of social or home care support with that of admission for further investigation and possible risks of hospital acquired infection is unclear. Further work into the value of case management and other innovations practised by many US healthcare providers[20] and now piloted in the UK[21] is required to evaluate a fresh approach to this cycle of recurrent admission.

Our conclusion that resources and organisation of care influence patient outcomes is important because health service providers can influence organisational structures. But managers and commissioners of care can only commission structures that are described for them, together with the evidence that new structures are better for patients. The creation of specialised stroke units has been possible because the features have been defined and shown to be valuable—and recent data suggest that outcomes are improving. We have shown that organisation (numbers of specialist staff) is relevant to patient outcome in COPD. Further studies are now needed to determine what it is that these specialists are adding to the care package.

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Further details are given in table S1 available on the *Thorax* website at http://www.thoraxjnl.com/supplemental.

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