CHRONIC OBSTRUCTIVE PULMONARY DISEASE

Admissions to hospital with exacerbations of chronic obstructive pulmonary disease: effect of age related factors and service organisation

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Background: Exacerbations of chronic obstructive pulmonary disease (COPD) have a high rate of mortality which gets worse with advancing age. It is unknown whether this is due to age related deficiencies in process of care. A study was undertaken in patients with COPD exacerbations admitted to UK hospitals to assess whether there were age related differences in the process of care that might affect outcome, and whether different models of care affected process and outcome.
Methods: 247 hospital units audited activity and outcomes (inpatient death, death within 90 days, length of stay (LOS), readmission within 90 days) for 40 consecutive COPD exacerbation admissions in autumn 2003. Logistic regression methods were used to assess relationships between process and outcome at $p<0.001$.
Results: 7514 patients (36% aged $\geqslant$75 years) were included. Patients aged $\geqslant$75 years were less likely to have blood gases documented, to have FEV_1 recorded, or to be given systemic corticosteroids. Those admitted under care of the elderly (CoE) physicians were less likely to enter early discharge schemes or to receive non-invasive ventilation when acidotic. Overall inpatient and 90 day mortality was 7.4% and 15.3%, respectively. Inpatient and 90 day adjusted odds mortality rates for those aged $\geqslant$85 years (versus $\leqslant$65 years) were 3.25 and 2.54, respectively. Mortality was unaffected by admitting physician (CoE *v* general *v* respiratory). Age predicted LOS but not readmission. Age related deficiencies in process of care did not predict inpatient or 90 day mortality, readmission, or LOS.
Conclusions: Management of COPD exacerbations varies with age in UK hospitals. Inpatient and 90 day mortality is approximately three times higher in very elderly patients with a COPD exacerbation than in younger patients. Age related deficiencies in the process of care were not associated with mortality, but it is likely that they represent poorer quality of care and patient experience. Recommended standards of care should be applied equally to elderly patients with an exacerbation of COPD.

Chronic obstructive pulmonary disease (COPD) is a common condition with 900 000 diagnosed patients in England and Wales and nearly as many undiagnosed.[1 2] This equates to a prevalence of 11% in those aged over 45 years, with an even higher prevalence in those aged over 65 years.[3] Elderly people cite respiratory conditions as the third most common cause of chronic illness and disability—three times more common than neurological diseases including stroke.[4] It is likely that most of this burden results from COPD. There were 30 000 deaths from COPD in the UK in 1999, the mean age of death ranging from 74 years in severe disease to 77 years in mild disease.[1 5] Internationally, COPD is projected to be the fifth most common cause of combined mortality and disability by 2020.[6]

Mortality related to exacerbations of COPD is high, both during hospitalisation and for 3 months thereafter.[7] Advanced age is an adverse prognostic factor, with age above 80 giving a relative risk of death of 3.0 compared with age under 65.[7] It is, however, not known whether this is an inevitable consequence of age related functional decline, co-morbidity and disease severity, or whether it is in part the consequence of age related deficiencies in the organisation or processes of care or, indeed, whether such deficiencies exist.

Previous large scale audits of COPD admissions in the UK revealed large variability in both process of care and outcome not explained by case mix variability.[7–9] In 2003 the British Thoracic Society and Royal College of Physicians led the largest ever UK-wide audit of hospital care of patients admitted with COPD exacerbations providing new and extensive data. The current paper examines, from these data, differences in process and outcome of care of elderly patients compared with that of younger patients and, in particular, whether any age related differences in the process of care are related to outcome(s). Secondly, the paper explores the potential effect of different models of care (supervised by respiratory physician *v* general physician *v* geriatrician and, if the latter, admission to an age related *v* an integrated unit) on process and outcome.

METHODS

Study design

The methods have been described in detail elsewhere.[10] The project was run by the Clinical Effectiveness and Evaluation unit (CEEu) of the Royal College of Physicians and the British Thoracic Society. Of 193 eligible UK trusts, 187 registered and a total of 247 hospital units participated (96% of units eligible).

There were two audit proformas: (1) a survey of resources and organisation of care (completed between August and

Abbreviations: CoE, care of the elderly; COPD, chronic obstructive pulmonary disease; LOS, length of stay

October 2003); and (2) a record of clinical activity and outcomes for 40 consecutive cases per site identified prospectively from 1 September 2003 but audited from the notes retrospectively.

Statistical analysis

The outcomes analysed were inpatient death, death within 90 days of admission and, for discharged patients, readmission within 90 days of admission and length of stay (LOS) beyond 7 and 14 days. Logistic regression methods (SPSS Version 11; SPSS UK Inc, Woking, Surrey, UK) were used to obtain sets of independent patient case mix predictors at $p<0.001$. The main predictors were those found in earlier COPD exacerbation audits.[7 9] Random effects logistic regression methods involving Stata 8 statistical software (Stata Corp, College Station, TX, USA) were used to assess associations of age, admitting physician, and admissions policy with patient outcome and to obtain odds ratios after adjusting for hospital clustering and relevant case mix. Patient data were categorised mainly on clinical criteria used in previous audits, with missing data forming one of the categories.[7 9] Only patient factors known at or close to admission were considered in case mix adjustment. The random effects method was unsuitable for the analysis of process of care measures because of computational problems with parameter convergence (probably caused by the much higher level of site clustering than seen for the outcome measures). Standard logistic regression methods adapted to account for clustering were used instead.

UK age-sex mortality rates for the last quarter of 2003 were used to compute the number of deaths expected in the cohort within a 90 day outcome period.[11] The ratio of observed to expected mortality and the absolute excess over expected mortality was computed for different groups of patients.

RESULTS

Patient and organisational data were available for 234 units. A few patients (5%) were entered more than once into the audit (multiple admissions), but only their first episode was analysed. Data are expressed in percentage and absolute terms and, where data were missing, the denominator is adjusted accordingly. There were 7529 patients, but 15 were excluded as neither age nor sex was recorded. The mean (SD) age was 71 (10) years, with 24% aged under 65 years, 40% aged 65–74 years, 29% aged 75–84 years, and 7% aged ⩾85 years.

Demographic features

Patients aged over 85 years were more likely to live alone (53% *v* 30%), require statutory social care at home (at least twice weekly) (27% *v* 10%), or to live in sheltered or institutional accommodation (28% *v* 7%) than patients aged under 60 with intermediate values for age cohorts between. Similarly, the oldest group were more likely to be of performance status 4 or 5 (38% *v* 15%) and to have two or more co-morbid conditions (24% *v* 12%) than the youngest group. Full details of the demographic characteristics of the patients are given in table S1 available online at the *Thorax* website http://www.thoraxjnl.com/supplemental.

Admitting physician

Patients were admitted under respiratory (2216, 31%), general (3711, 52%) or care of the elderly (CoE) physicians

Table 1 Clinicodemographic characteristics of patients by admitting physician

	Respiratory (n = 2216) [median age 70]		General (n = 3711) [median age 71]		CoE (n = 1186) [median age 76]	
	%	n	%	n	%	n
Age (years)						
<65	29	637	25	32	12	136
65–74	39	866	38	1424	21	251
75–84	28	627	30	1119	50	590
85+	4	86	6	236	18	209
Male	51	1140	53	1961	52	622
Living alone	37	777/2108	38	1320/3478	45	508/1121
Living in own home without social care	72	1320/1831	70	2156/3067	62	612/991
Living in own home with social care	16	297/1831	17	507/3067	22	216/991
Other (sheltered 50%; institutional 36%)	12	214/1831	13	404/3067	16	163/991
Performance status						
Normal activity/strenuous activity limited	30	603/1991	32	1059/3271	26	269/1044
Limited activity but self care	46	916/1991	46	1509/3271	48	496/1044
Limited self-care/bed or chair bound	24	472/1991	21	703/3271	27	279/1044
Documented co-morbidity						
Heart disease	35	771	38	1391	44	517
Stroke	5	105	6	218	8	90
Other chest problems	12	260	10	385	9	112
Diabetes	10	212	10	378	10	113
Locomotor problems	11	238	12	438	16	193
Visual impairment	2	49	3	105	4	52
None of the above	45	996	44	1624	36	427
One of the above	40	885	33	1411	42	494
Two or more of the above	15	335	18	676	22	265
Current smoker	42	903/2128	43	1508/3542	35	387/1119
Ex-smoker	55	1160/2128	54	1901/3542	61	679/1119
Lifelong non-smoker	3	65/2128	4	133/3542	5	53/1119
40+ pack years of smoking (ex/current)	61	602/995	60	967/1610	59	265/449
Previous COPD admission or early discharge scheme	69	1458/2128	65	2264/3489	62	697/1117

CoE, care of elderly physician.
χ^2 test with age group: all $p<0.001$ except for sex ($p=0.58$), stroke ($p=0.003$), other chest problems ($p=0.09$), diabetes ($p=0.67$), visual impairment ($p=0.001$), pack years ($p=0.88$), and previous COPD admission ($p=0.001$).

Table 2 Aspects of process of care for patients by age group

	Age <65 (n = 1798) [median age 59]		Age 65–74 (n = 2683) [median age 70]			Age 75–84 (n = 2472) [median age 79]			Age 85+ (n = 561) [median age 87]		
	%	n	%	n	OR* (95% CI)	%	n	OR* (95% CI)	%	n	OR* (95% CI)
Accepted by an early discharge scheme	14	243/1716	15	399/2576	1.16 (1.00 to 1.34)	16	368/2352	1.26 (1.04 to 1.52)	10	53/532	0.83 (0.59 to 1.18)
Admitted under a respiratory physician	36	637/1762	33	866/2623	0.87 (0.75 to 1.00)	26	627/2420	0.63 (0.53 to 0.75)	16	86/550	0.34 (0.25 to 0.47)
NOT seen by respiratory nurse or physician at all	22	379/1748	24	633/2616	1.15 (0.98 to 1.35)	33	795/2381	1.72 (1.45 to 2.08)	42	223/530	2.33 (1.75 to 3.03)
NO gases on admission	13	228/1753	14	354/2601	1.02 (0.85 to 1.23)	16	383/2399	1.15 (0.94 to 1.39)	22	120/536	1.56 (1.19 to 2.04)
NO FEV_1 within last 5 years documented	39	698	41	1099	1.14 (1.00 to 1.31)	50	1241	1.61 (1.37 to 1.89)	65	367	2.86 (2.22 to 3.57)
NO respiratory rate documented	18	323	19	519	1.06 (0.90 to 1.26)	20	497	1.06 (0.88 to 1.28)	22	125	1.11 (0.85 to 1.45)
NO systemic corticosteroids for >24 hours as inpatient	14	241/1745	15	402/2605	1.13 (0.94 to 1.36)	18	423/2388	1.28 (1.06 to 1.54)	24	126/534	1.69 (1.28 to 2.22)
Receiving ventilatory support if pH <7.35	41	178/438	40	254/634	1.05 (0.82 to 1.34)	33	163/497	0.77 (0.57 to 1.02)	28	28/100	0.66 (0.39 to 1.11)

*Odds relative to <65 year age group. Odds ratios (OR) were adjusted for the case mix variables in Table 1 using standard logistic regression methods adapted to adjust for hospital clustering. p values were computed using the χ^2 values from the regression models with and without age groups.

(1186, 17%). Patients admitted under CoE physicians were older and more likely to have cardiac and locomotor problems (table 1).

Unit admissions policy

Fifty five units operated an age related admissions policy (that is, elderly patients, regardless of diagnosis, are directed to a CoE unit) and 121 had an integrated policy. Admissions policy was unrecorded for 58. Mean (SD) ages for patients in these groups were similar: age related: 72 (10) years; integrated: 71 (10) years; unknown: 71 (10) years. For older patients (⩾75 years), units with age related policies admitted fewer patients under a respiratory physician than units with integrated policies (16%, 117/729 *v* 26%, 412/1599).

Process of care

Older patients (aged ⩾75 years) were less likely to be admitted under a respiratory physician or to be seen by a respiratory nurse or physician during admission (table 2). They were less likely to have arterial blood gases documented or for forced expiratory volume in 1 second (FEV_1) to have been recorded within the previous 5 years or in the 90 days after admission. It was less likely that they would be given systemic corticosteroids for >24 hours during hospitalisation.

Patients admitted under CoE physicians were less likely than patients admitted under respiratory physicians to be accepted for early discharge schemes, to be seen by a respiratory nurse or physician, to have FEV_1 documented, and to have received ventilatory support when pH levels were below 7.35 (table 3).

For patients aged >75 years, those in units with an age related admissions policy were more likely not to be seen by a respiratory physician or nurse (49% *v* 31%) and were less likely to have their FEV_1 recorded (62% *v* 50%) than patients in units with integrated policies, but otherwise there were no significant differences in the process of care recorded (see table S2 available online at the *Thorax* website http://www.thoraxjnl.com/supplemental).

Outcome

Inpatient mortality was 7.4% (542/7300) overall and 10.8% (318/2951) for those aged >75 years. Death within 90 days of admission was 15.3% (1112/7261) overall and 21.4% (629/2934) for those aged >75 years. For 6758 discharged patients, the readmission rate within 90 days of admission was 31.4% (2067/6574). Mean (median) LOS for discharged patients was 8.7 (6) days with 40% (2607/6534) staying over 7 days and 15% (967/6534) staying over 14 days.

Mortality (external adjustment)

We have used age-sex all cause UK mortality rates for the last quarter of 2003 to compute expected mortality for the patient cohort. The ratio of actual to expected deaths was much greater in younger patients. The standardised mortality ratio (SMR) was 46 (137 actual/3.0 expected) for patients <65 years, 23 (346/14.9) if 65–74 years, 12 (478/39.8) if 75–84 years, and 6 (151/25.7) if >85 years. However, in terms of sheer numbers of lives lost beyond those expected, the greater losses were of elderly patients. Absolute excess of actual to expected deaths was 7.7% for patients <65 years, 12.8% if 65–74 years, 18.3% if 75–84 years, and 23.3% if >85 years. These comparisons were unaffected by admitting physician or by admissions policy.

Mortality (internal adjustment)

Logistic regression analyses gave the same six major independent predictors for inpatient death and for death within 90 days: performance status, blood urea, serum

Table 3 Aspects of process of care for patients by admitting physician

	Respiratory physician (n = 2216) [median age 70]		General physician (n = 3711) [median age 71]			CoE physician (n = 1186) [median age 76]		
	%	n	%	n	OR* (95% CI)	%	n	OR* (95% CI)
Accepted by an early discharge scheme	17	368/2116	15	523/3587	0.84 (0.64 to 1.10)	11	125/1130	0.63 (0.45 to 0.88)
NOT seen by respiratory nurse or physician at all	3	75/2159	36	1290/3623	15.1 (10.9 to 20.9)	48	547/1131	23.0 (15.7 to 33.6)
NO gases on admission	11	250/2167	17	598/3605	1.43 (1.18 to 1.69)	16	190/1150	1.23 (0.94 to 1.59)
NO FEV_1 within last 5 years documented	37	815	46	1705	1.37 (1.15 to 1.64)	55	657	1.69 (1.35 to 2.13)
NO respiratory rate documented	19	431	19	691	0.91 (0.76 to 1.09)	20	232	0.94 (0.73 to 1.21)
NO systemic corticosteroids for >24 hours as inpatient	13	287/2144	17	617/3605	1.27 (1.05 to 1.54)	19	217/1153	1.25 (0.95 to 1.61)
Receiving ventilatory support if pH <7.35	44	251/569	36	279/781	0.71 (0.56 to 0.90)	26	61/235	0.48 (0.33 to 0.70)

*Odds relative to respiratory physician group. Odds ratios (OR) were adjusted for the case mix variables in table 2 including age group using standard logistic regression methods adapted for hospital clustering.

albumin, arterial pH, age, and arterial oxygen saturation. Both these sets included patient age, whether actual age or age group was considered. Mortality odds ratios for age group were adjusted in random effects logistic regression for the case mix predictors relevant to each outcome (table 4). The adjusted odds of a patient aged >85 years (compared with a patient aged <65 years) dying in hospital or within 90 days were 3.25 for dying in hospital and 2.54 for dying within 90 days. These odds were virtually unchanged (3.15 and 2.55) when the process variables of table 2 were adjusted for in addition to adjustment for case mix.

The crude mortality experience of patients by admitting physician and by admissions policy is shown in table 5. In random effects logistic regression, the adjusted (including age) odds of dying in hospital under a CoE physician relative to a respiratory physician were 1.06 (95% CI 0.78 to 1.44) and of dying within 90 days were 0.85 (95% CI 0.68 to 1.07). The adjusted odds of dying in hospital for patients in units with integrated admissions policies relative to units with age related policies were 1.19 (95% CI 0.88 to 1.61) and of dying within 90 days were 0.96 (95% CI 0.76 to 1.20).

Readmission

Having had a previous admission and poor performance status were the major predictors of readmission. After relevant case mix adjustment, age did not predict readmission ($\chi^2 = 0.83$, $p = 0.84$). Crude readmission rates by admitting physician and by admissions policy ranged from 25% to 34% between hospitals and, after case mix adjustment, there was no evidence of an association with type of admitting physician ($\chi^2 = 2.09$, $p = 0.56$) or admissions policy ($\chi^2 = 0.55$, $p = 0.76$).

Length of stay

Regression analyses gave the same four major independent predictors for LOS beyond 1 and 2 weeks: poor performance status, low serum albumin, increased age, and reduced arterial oxygen saturation. After relevant case mix adjustment, the odds (relative to patients under 65) of staying more than 7 days in hospital were 1.19 (95% CI 1.03 to 1.37) for patients aged 65–74+ years, 1.51 (95% CI 1.29 to 1.75) for patients aged 75–84 years, and 2.15 (95% CI 1.69 to 2.73) for those aged >85 years. These odds ratios remained raised (1.29, 1.75, 2.51) when, in addition, the process variables of table 2 were also adjusted for. Case mix adjusted odds ratios for hospitalisation exceeding 14 days were similar (1.17, 1.64 and 2.06), and were 1.22, 1.78 and 2.19 after further adjustment for the process variables in table 2.

For a stay of more than 7 days, adjusted (including age) odds for patients under a CoE physician relative to patients under a respiratory physician were 1.17 (95% CI 0.98 to 1.40), and under integrated relative to age related policies the adjusted odds were 1.06 (95% CI 0.88 to 1.29). For more than 14 days the adjusted odds under a CoE physician were 1.09 (95% CI 0.87 to 1.37) and for integrated policies 1.10 (95% CI 0.86 to 1.42).

DISCUSSION

The fact that severe COPD (and its burden on secondary care) is a disease of the elderly is reinforced by the current data: three quarters of admissions were over the age of 65 and more than one third were over 75 years.

The management of COPD patients does vary with age. The NICE guidelines on management should apply regardless of age, but the present data show quite clearly that fewer old

Table 4 Patient mortality by age group

		Died in hospital (during index audit episode)			Died within 90 days of admission		
Patient age	N	%	n/N	OR* (95% CI)	%	n/N	OR† (95% CI)
<65	1798	3.4	59/1749	1.00	7.9	137/1738	1.00
65–74	2683	6.3	165/2600	1.45 (1.04 to 2.02)	13.4	346/2589	1.38 (1.10 to 1.74)
75–84	2472	9.7	233/2412	1.97 (1.42 to 2.73)	19.9	478/2396	1.86 (1.49 to 2.34)
85+	561	15.8	85/539	3.25 (2.18 to 4.85)	28.1	151/538	2.54 (1.89 to 3.42)

Random effects logistic regression:
*In hospital: odds ratio adjusted for performance status, arterial saturation, blood urea, pH, serum albumin, FEV_1, *x* ray cancer, and *x* ray pneumonia.
†90 day: odds ratio adjusted for performance status, blood urea, serum albumin, pH, arterial saturation, *x* ray cancer, weight, and smoking status.

Table 5 Patient mortality by admitting physician and by unit admission policy

	N	Died in hospital (during index audit episode) %	Died in hospital (during index audit episode) n/N	Died within 90 days of admission %	Died within 90 days of admission n/N
Admitting physician					
Respiratory	2216	6.8	145/2137	15.7	335/2129
General	3711	7.1	257/3627	14.2	510/3602
CoE	1186	9.3	107/1151	17.7	203/1146
Other/unknown	401	8.6	33/385	16.7	64/384
Type of unit admissions policy					
Patients aged <75					
Age related	1049	4.7	47/1007	12.1	121/1003
Integrated	2332	5.3	120/2260	11.1	248/2242
Unknown	1100	5.3	57/1082	10.5	114/1082
Patients aged 75+					
Age related	729	9.8	69/704	20.3	142/701
Integrated	1599	11.2	175/1557	21.7	335/1546
Unknown	705	10.7	74/690	22.1	152/687

CoE, care of elderly physician clustering.

people receive the full package of investigations or management recommended.[2] The reasons for this are unclear as there are overlapping organisational features that could contribute.

Some hospitals organise acute admissions primarily by age and it is not surprising that, if older people are selectively admitted under CoE physicians, fewer will be seen by respiratory physicians or respiratory nurses. However, even in hospitals with integrated admission policies there are disturbing age related deficiencies in other aspects of the process of care.

Despite clear evidence of the benefit of systemic corticosteroid therapy in this situation (improved lung function and gas exchange, reduction in hospital stay[12–17]), elderly patients were less likely to receive systemic corticosteroids. They were less likely to have blood gases checked on admission and, when gases were done and demonstrated acidosis, the elderly were less likely to be offered ventilatory support even though non-invasive ventilation (without intubation) has few contraindications.[18] A quarter of those over 85 years of age neither had gases checked nor received oral steroids. These process deficiencies occurred largely irrespective of the specialty to which elderly patients were admitted. If these basic and important markers of care are not being performed for older people, it raises questions about the more detailed aspects of their care not measured in this study.

Early discharge schemes are well documented as being safe and liked by patients. The lower rate of acceptance of elderly patients (admitted under geriatricians) onto early discharge schemes, though probably contributing to the greater length of stay seen in the elderly, is arguably of less concern. The audit made no attempt to assess the appropriateness of referral or acceptance of individuals onto such schemes and did not collect data on cognitive impairment, a relative contraindication to inclusion. Nonetheless, the non-significant trend to lower use of such schemes in age related units, coupled with their lower use by geriatricians, suggests either impaired access to or impaired awareness of the presence or value of these evidence based services.[19–22] Hospital organisation and physician awareness rather than clinical need may therefore dictate availability to the patient.

Reassuringly, despite the fact that older patients admitted under both general physicians and geriatricians were less likely to receive ventilatory support if acidotic (table 3), there was no overall age related difference in provision of ventilatory support to acidotic patients (table 2) which suggests that acidotic elderly patients were more likely to be admitted under respiratory physicians initially.

Even after allowing for considerable age related differences in case mix between elderly and younger patients, advanced age was a major adverse prognostic factor for inpatient mortality and 3 month mortality. Indeed, in an almost identical replication of the results of the previous national audit,[7] patients aged over 85 years were three times more likely to die than those aged under 65 years. There were similar (again independent) age related differences in LOS, but no such differences in readmission rates.

Analysing predictors of outcomes of care in an observational study is difficult. Although consecutive cases were included from a large number of hospitals and the total number of cases is large, there are many potential confounding influences. One challenge is to find a reliable comparator. For the outcome of death we performed the logistic regressions using age of patients within the study and then separately using the age specific mortality for the UK population. The SMR due to COPD exacerbations compared with the national expected mortality is less marked in the very old, largely because they have an increased underlying mortality risk. However, absolute numbers of deaths in the very old are much greater and thus there is a greater opportunity to intervene and save lives, which makes the deficiencies in process of care more worrying.

Readmission rates were not related to age but were related to whether or not the patient had been admitted previously. This might suggest that non-disease related (and unmeasured) factors (patient/carer expectations, social support) are more important. Alternatively (and arguably more likely), previous admission may simply be a marker of severity.

We were not able to show whether an age related admissions policy is better or worse than an integrated system. Indeed, none of the measured factors (access to respiratory specialist care during admission, type of admission policy, type of admitting physician) had any independent bearing on mortality rate, LOS, or readmission of elderly patients. Similarly, we did not find any statistical link between process of care and outcome despite some potentially important differences in process of care between those admitted under geriatricians and respiratory physicians. The age related process deficiencies that *did* exist did not appear to contribute to the excess mortality in the elderly. The reasons for this are unclear. It may be that the age related process differences were relatively small in terms of the relative proportions of patients in each age group suffering a disadvantage. While this is superficially reassuring (especially given the large proportion of elderly patients), what this study cannot tell us is whether the outcome of individual patients was affected by poor process of care. Nor can it differentiate those patients who would have died because of disease severity regardless of treatment from those who could have benefited from treatments not given. Furthermore, there must remain concern that the quality of care (and the patient experience) was not the same across the age range.

This lack of association may have other explanations and could imply that some interventions such as corticosteroids are less helpful in the elderly. Randomised controlled trials of COPD exacerbations have (with few exceptions) included relatively young patients, unrepresentative of the age spectrum seen in clinical practice as reflected in the present audit.[10 12–18] Further studies examining interventions in older patients are necessary if this concern is to be resolved.

Finally, the lack of association may indicate a limitation within the data collected as this audit was not and could not be comprehensive. Some features of patient care can only be studied in a randomised controlled trial. This study could not, for example, examine the *appropriateness* of interventions and, even though this is the largest UK study of acute COPD hospital care ever undertaken, the power to differentiate different organisational and process aspects of care in an observational study is limited.

In conclusion, this audit shows that there are more deaths among the oldest cohort of patients and there is more that can be done to ensure a ''NICE guidelines standard of care'' for the oldest patients. This particularly applies to non-respiratory specialists, but even the specialists are far from perfect. Many of the recommendations in the guidelines derive from strong evidence which suggests that better care should be delivered with the potential for the lives of more older people to be saved.

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Further details are given in tables S1 and S2 available online at the *Thorax* website at http://www.thoraxjnl.com/supplemental.

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