Trends in hospital admissions for pulmonary embolism in England: 1996/7 to 2005/6

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ABSTRACT – Pulmonary embolism (PE) can be difficult to diagnose and manage. This paper examines recent national trends in admission rates and mortality for PE to help inform clinical practice. Admissions to NHS hospitals in England between 1 April 1996 and 31 March 2006 were studied. Trends in admission rates, the proportion of all admissions with PE as primary or secondary diagnosis and hospital mortality following PE identified. There were 251,449 admissions with a diagnosis of pulmonary embolus in the study period. Non-elective admission rates rose from 28.0 per 100,000 in 1996/7 to 32.1 per 100,000 in 2005/6. There was a significant increase in secondary diagnosis rates and a clear seasonal pattern with excess admissions in winter. There was significant in-hospital mortality for both primary (13%) and secondary diagnosis (31%). Mortality decreased over time and was highest among the elderly. Pulmonary embolism is associated with a significant mortality although overall trends in mortality are improving in England. Age and co-morbidities must be considered when developing guidelines and individual treatment plans.

KEY WORDS: hospital mortality, pulmonary embolism, seasonal variation, trends

Introduction

Pulmonary embolism (PE) can be difficult to diagnose and manage.[1] Consequently, decision support algorithms, risk stratification scores and guidelines have been developed over the last 15 years.[2–6] These have incorporated the role of tests such as D-dimer, to help rule out thromboembolic disease in low-risk patients, and the increasing role of computed tomography pulmonary angiography as well as giving clear guidance about treatment and prophylaxis.[7] The National Institute for Health and Clinical Excellence (NICE) issued further clinical practice guidelines for the prevention of venous thromboembolism in April 2007.[8] Pulmonary embolism is also a condition which has attracted media attention with increasing public awareness and concerns, particularly in relation to air travel.[9] A previous study of thromboembolism, including deep vein thrombosis (DVT) and PE, found declining mortality rates, with the suggestion that between 1975 and 1998 the admission rates had initially fallen but were rising again in the early 1990s.[10] National trends in admission rates and outcomes for PE in England have not been described previously and it is timely to understand the current patterns of hospital admissions.

Methods

Trends in admission rates, the proportion of all admissions with PE as primary or secondary diagnosis and hospital mortality following PE using Hospital Episode Statistics for England were examined. All NHS inpatient episodes of care (excluding day cases), with a mention of PE (ICD-10 codes 26.0 and 26.9) in any diagnosis field, between financial years 1996/7 and 2005/6 were extracted from the hospital episodes database. As there can be more than one episode of care in any admission (sometimes called a spell), these episodes were linked with any others occurring within the same admission. Two classes of admissions were identified. The first class, deemed as primary PE, consisted of non-elective admissions with a primary diagnosis of PE. The second class, deemed as secondary PE, consisted of any admission (elective or non-elective) with a secondary diagnosis of PE or a diagnosis of PE in any episode subsequent to the episode of care containing the main diagnosis.

Directly standardised admission rates were calculated by year to establish trends (standardised to the 1996/7 English population). The trend was assessed for linearity through weighted least squares regression. The proportion of all inpatient admissions with a secondary diagnosis of PE was also calculated by year with trends assessed through Poisson regression because these proportions were all very small. Binary logistic regression was used to calculate the odds of death following PE in both classes using age group, sex and year (as a continuous variable) as factors. All analysis was carried out in SPSS version 12.0.

Results

In total, there were 251,449 inpatient admissions (0.3% of all 76,295,078 admissions during the study

period) with a diagnosis of pulmonary embolus between 1996/7 and 2005/6 (Table 1). Within this total, 59.4% (149,447) were non-elective and had a primary diagnosis of pulmonary embolus and 39.3% (98,739) had a pulmonary embolus recorded as a secondary diagnosis. Of all records 3,263 (1.3%) had a primary diagnosis and were admitted as an elective. Further examination of this small group of patients suggested that a large proportion of these had been admitted for diagnostic procedures or treatments to remove emboli and they were not included in the rest of this analysis. Directly standardised primary PE admission rates rose slightly from 28.0 per 100,000 population in 1996/7 to 32.1 per 100,000 in 2005/6, an average increase of 0.3 per 100,000 per year (p=0.005) equivalent to an increase of 11% over the 10 years. There was also a significant increase of 1.9 per 100,000 in secondary diagnosis rates (p=<0.001) with 123.0 per 100,000 admissions in 1996/97 and 140.8 per 100,000 in 2005/6 (Fig 1), an increase of 15% over the 10 years. There was a clear seasonal pattern in admissions for primary pulmonary emboli, with peaks in the winter months (Fig 2).

Table 1. Admissions for pulmonary embolism by elective/non-elective and by whether primary or secondary diagnosis. Hospital Episode Statistics inpatient admissions 1996/7–2005/6.

	Main diagnosis (%)	Secondary diagnosis (%)	Total
Elective	3,263 (2.1)	13,818 (14.0)	17,081
Non-elective	149,447 (97.9)	84,921 (86.0)	234,368
Total	152,710 (100)	98,739 (100)	251,449

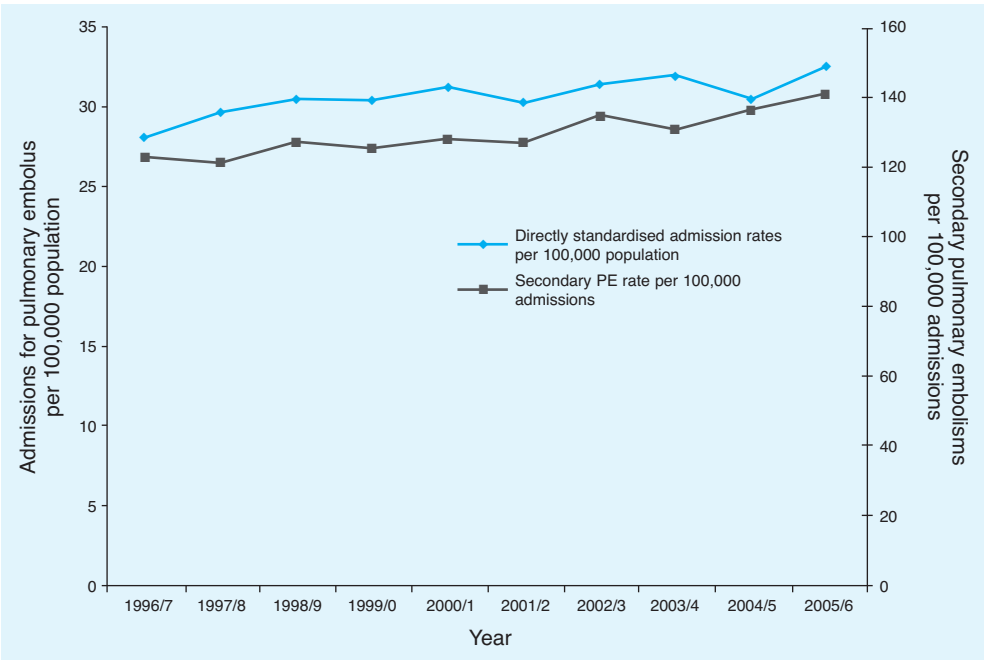
Overall hospital mortality for all years for primary PE was 13% and for secondary PE 31%. For primary PE , there was no significant difference in hospital mortality by sex, but mortality increased by age (2% in the under 45s increasing to 41% in patients aged 90 and over) with the odds of death increasing significantly for each age group compared with the baseline (under 45s). A similar trend for increasing mortality by age group was found for secondary emboli (8% in the under 45s increasing to 59% in 90+). Within this group, mortality was also significantly higher for non-elective cases (odds ratio (OR)=1.91 p<0.001) compared to elective and lower for women (OR=0.94 p<0.001) compared to men.

For primary PE, hospital mortality decreased over time from 16% in 1996/7 to 10% in 2005/6, with a significant decrease in the odds of death of 7% per year. A significant change in mortality over time was also found in secondary PE with a fall from 36% in 1996/7 to 27% in 2005/6, with a significant decrease in the odds of death of 4% per year. For primary PE, the absolute number of deaths fell.

Discussion

Admission rates for primary PE have risen by 11% over the study period. The Oxford group also suggested increasing admission rates for thromboembolic disease from 1990 onwards, consistent with these results.[10] There are several potential explanations for this. The first is that the increase may be due to better coding. Clinical coding has been improving steadily and with the advent of the new payments system based on activity, one might expect to see further improvements, particularly in secondary coding.[11] The incidence of PE as a secondary diagnosis also rose by 15%, which may also be an indication of better coding.

Fig 1. Primary and secondary pulmonary emboli (PE) rates per 100,000 by year.



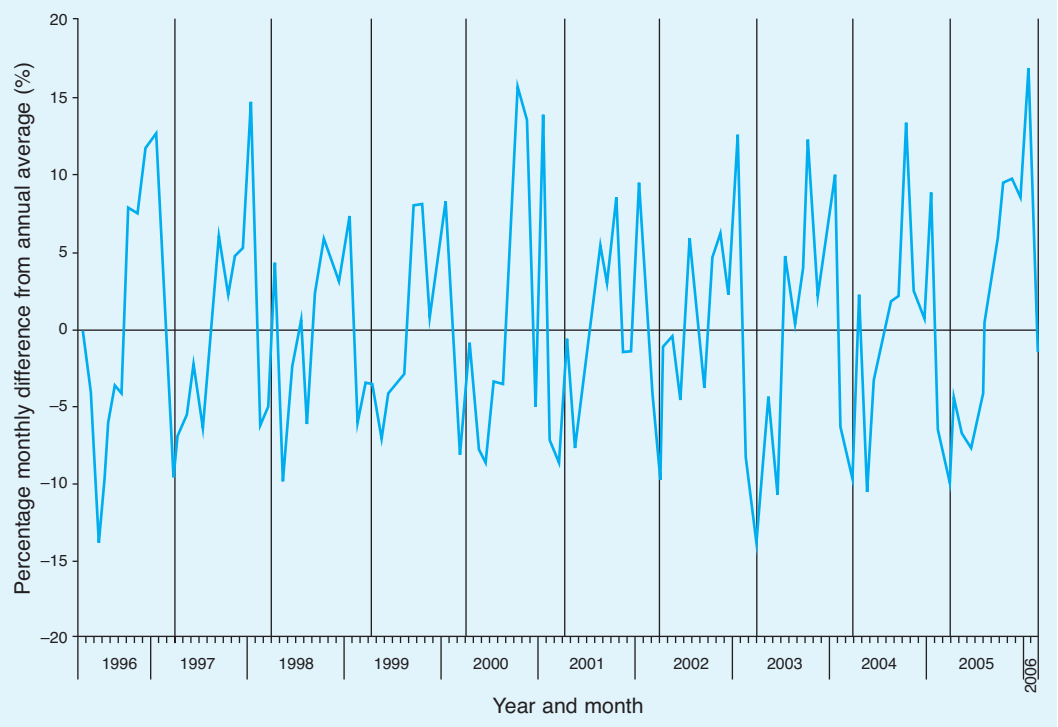


Fig 2. Monthly percentage variations in non-elective hospital admissions with a primary diagnosis of pulmonary embolism (PE) (0 represents the sum of monthly variations) based on Hospital Episode Statistics 1996/7–2005/6.

A second explanation is that overall admission rates for all diagnoses have been increasing over the past 10 years by 13%, and the rise in primary PE (11%) may merely reflect general changes in practice resulting in lower non-elective admission thresholds. Thirdly, the increase may reflect increased use of clinical guidelines, improved access to diagnostic tests, and better diagnostic techniques.[4,5,6,7]

Another interesting finding in our data, consistent with a previous large French study of DVT and pulmonary embolus, and using a similar analysis, is a marked monthly variation in admissions for pulmonary embolus, with the greatest number of admission occurring in the winter months.[12] This differs from previous international studies which have not shown seasonal variation and this potential phenomena merits further investigation perhaps through linkage of detailed meteorological data to patient records.[13,14] One potential explanation for the seasonal data may relate to changes in thrombotic tendency related to seasonal changes or infection.[15]

Our data show that PE is a condition with significant in-hospital mortality for primary (13%) and secondary diagnosis (31%). Compared to an earlier prospective study which had a mortality of 2.5% these figures appear high.[16] This study had a number of exclusion criteria including those who were deemed haemodynamically unstable ie the most sick subgroup of patients. Two more prospective studies one of pulmonary embolus[17] and one of venous thromboembolism[18] including sicker patients quote mortalities of 15% at three months and 12.5% respectively. Our study included patients with significant co-morbidities which might have contributed to the higher mortality found in our study but this represents the population of patients in acute hospitals in England. It is impossible to determine whether PE was the underlying cause of death, as only fact of death was recorded in our data. It is therefore impossible to exclude those patients who died with, rather than of, their PE. On a positive note, hospital mortality has fallen significantly for both groups over the period of the study (primary falling from 16% to 10% secondary falling from 36% to 27%). The higher mortality in the secondary group further emphasises the importance of prophylaxis in higher risk patients. The overall decline in mortality is also consistent with previously published data[10] although this also included DVT, and suggests a continuing improvement in outcome in England. Similar data from North America also suggested a decreasing mortality between 1979 and 1996 for PE.[19]

Mortality may have decreased because of a change in admission threshold leading to less severe cases being diagnosed as pulmonary emboli, and hence diluting the death rate. However, the falls in mortality are much greater than the increase in incidence. A decrease in numbers of deaths in the primary group was also noted suggesting a real decrease in mortality. This trend may represent a changing natural history of the disease or improved management, possibly related to earlier diagnosis and more consistent treatment plans in line with current guidelines, including prophylaxis.[5,6]

Despite this beneficial trend towards improved outcome for patients with PE there are some important considerations for patients and medical staff. Firstly, age carries a significantly increased risk of death, being markedly higher in the over 75s with a primary diagnosis and at all ages when given as a secondary diagnosis. All patients in which PE is a secondary diagnosis have a much greater hospital mortality. Much of this increased risk, however, is in the non-elective subgroup suggesting that co-morbidity

Table 2. Mortality for pulmonary embolism (PE). Hospital Episode Statistics inpatient admissions 1996/7–2005/6.

		Non-elective admission for PE					Secondary diagnosis of PE				
		Cases	Deaths	Mortality (%)	OR (95% CI)	p	Cases	Deaths	Mortality (%)	OR (95% CI)	p
Sex	Male	65,053	7,716	12	–	–	44,198	13,366	30	–	–
	Female	84,394	11,502	14	0.98 (0.95–1.02)	0.34	54,541	17,725	32	0.94 (0.91–0.96)	<0.001
Age	<45	23,042	500	2	–	–	8,685	728	8	–	–
	45–59	28,277	1,459	5	2.42 (2.18–2.69)	<0.001	13,819	2,514	18	2.46 (2.26–2.69)	<0.001
	60–64	13,676	1,039	8	3.66 (3.28–4.08)	<0.001	8,018	1,817	23	3.27 (2.98–3.58)	<0.001
	65–74	35,517	4,115	12	5.83 (5.31–6.41)	<0.001	24,208	6,883	28	4.37 (4.03–4.74)	<0.001
	75–84	35,255	7,308	21	11.81 (10.77–12.96)	<0.001	29,903	11,546	39	6.82 (6.30–7.38)	<0.001
	85–89	9,475	3,071	32	21.73 (19.79–24.10)	<0.001	9,330	4,777	51	11.12 (10.20–12.13)	<0.001
	90+	4,205	1,726	41	32.73 (29.37–36.47)	<0.001	4,776	2,826	59	15.42 (14.01–16.97)	<0.001
Elective	Elective	–	–	–	-	–	13,818	2,565	19	–	–
	Non-elective	–	–	–	-	–	84,921	28,526	34	1.91 (1.82–2.00)	<0.001
Year	1996/7	13,213	2,162	16	–	–	8,879	3,196	36	–	–
	1997/8	14,114	2,095	15			8,732	2,907	33		
	1998/9	14,614	2,188	15			9,491	3,237	34		
	1999/0	14,662	2,071	14			9,288	3,033	33		
	2000/1	15,158	1,917	13	0.93 (0.93–0.94)	<0.001	9,426	3,005	32	0.96 (0.96–0.97)	<0.001
	2001/2	14,728	1,813	12	per year		9,312	2,938	32	per year	
	2002/3	15,432	1,881	12			10,189	3,082	30		
	2003/4	15,861	1,797	11			10,352	3,210	31		
	2004/5	15,227	1,662	11			11,130	3,282	29		
	2005/6	16,438	1,632	10			11,940	3,201	27		
Total	Total	149,447	19,218	13	–	–	98,739	31,091	31	–	–

CI = confidence interval; OR = odds ratio.

is an important factor in this group of patients. These are important findings which should influence discussions with patients regarding prognosis, prophylaxis and treatment. These data must be considered in relation to acute treatment strategies, including the development of ambulatory care programmes, particularly in older patients and those with co-morbidities and appropriate risk stratification and clinical protocols implemented.[20]

In summary, PE remains a common clinical problem and when confirmed is still associated with high mortality which is perhaps underestimated by clinicians. Overall trends in mortality have shown improvement in England in recent years. These outcome results and the impact of age and co-morbidities must be considered when developing guidelines and individual treatment plans.

Competing interest

PA, AB and GK are employed within the Dr Foster Unit at Imperial College London. The unit is funded by a grant from Dr Foster Intelligence (an independent health service research organisation).

Contributors

PA and DB were involved in the original research question. PA and GK carried out the data extract and analyses. PA, AB, GK and DB drafted the paper. All investigators contributed comments on drafts.

References

1 Goldhaber SZ. Pulmonary embolism. *Lancet* 2004;363:1295–305.
2 Wells PS, Anderson DR, Rodger M *et al.* Derivation of a simple clinical model to categorize patients probability of pulmonary embolism: increasing the models utility with the SimpliRED D-dimer. *Thromb Haemost* 2000;83:416–20.
3 Wicki J, Perneger TV, Junod AF *et al.* Assessing clinical probability of pulmonary embolism in the emergency ward: a simple score. *Arch Intern* 2001;161:92–7.
4 British Thoracic Society Standards of Care Committee. Suspected acute pulmonary embolism – a practical approach. *Thorax* 1997; 52(Suppl 4):S1–S24.
5 American Thoracic Society guidelines: the diagnostic approach to acute venous thrombo-embolism. *Am J Resp Care* 1999;160:1043–66.
6 British Thoracic Society guidelines for the management of suspected acute pulmonary embolism. *Thorax* 2003;58:470–83.
7 Scottish Intercollegiate Guidelines Network. *Prophylaxis of venous thromboembolism – national clinical guideline.* Edinburgh: SIGN, 2002.
8 National Institute for Health and Clinical Excellence. Venous thromboembolism. www.nice.org.uk/page.aspx?o=63366
9 Lapostle F, Surget V, Borron SW *et al.* Severe pulmonary embolism associated with air travel. *N Engl J Med* 2001;345:779–83.
10 Goldacre MJ, Roberts S, Yeates D Griffith M. Hospital admission and mortality rates for venous thromboembolism in Oxford region UK, 1975–1998. *Lancet* 2000;355:1968–9.
11 Hansell A, Bottle A, Shurlock L, Aylin P. Accessing and using hospital activity data. *J Publ Hlth Med* 2001;23:51–6.
12 Boulay F, Berthier F, Schoukroun G *et al.* Seasonal variations in hospital admission for deep vein thrombosis and pulmonary embolism: analysis of discharge data. *BMJ* 2001;323:601–2.
13 Bounameaux H, Hicklin L, Desmarais S. Seasonal variation in deep vein thrombosis. *BMJ* 1996;312:284–5.
14 Stein PD, Kayali F, Olson RE. Analysis of occurrence of venous thromboembolic disease in the four seasons. *Am J Cardiol* 2004;93: 511–3.
15 Horan JT, Francis CW, Falsey AR *et al.* Prothrombotic changes in haemostatic parameters and C – reactive protein in the elderly with winter acute respiratory tract infections. *Thromb Haemost* 2001;85: 245–9.
16 Worsley DF, Alavi A. Comprehensive analysis of the results of the PIOPED study. *J Nuclear Med* 1995;12:2380–7.
17 Goldhaber SZ, Visani L, De Rosa M. Acute pulmonary embolism: clinical outcomes in the International Cooperative Pulmonary Embolism Registry (ICOPER). *Lancet* 1999;353:1386–9.
18 Arcelus JI, Caprini JA, Monreal M, Suarez C, Gonzalez-Fajardo J. The management and outcome of acute venous thromboembolism: a prospective registry including 4011 patients. *J Vascular Surgery* 2003; 38(5):916–22.
19 Lilienfeld DE. Decreasing mortality form pulmonary embolism in the United States 1979–1996. *Int J Epidemiol* 2000;29:465–9
20 Beer JH, Burger M, Gretener S, Bernard-Bagattini S, Bounameaux H. Out-patient treatment of pulmonary embolismis feasible and safe in a substantial proportion of patients. *J Thrombosis and Haemostasis* 2003; 1:186–7