

health

Outcome

indicators

USING CASE FATALITY RATES AS A HEALTH OUTCOME INDICATOR: STATISTICAL EXEMPLARS

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USING CASE FATALITY RATES AS A HEALTH OUTCOME INDICATOR

Statistical exemplars

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2. Myocardial infarction
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1. INTRODUCTION

Background

Over the last ten years there has been increasing interest in using case fatality rates as an outcome indicator to make comparisons over time and between hospitals. Case fatality was considered to be a potential indicator in five of the ten health outcome indicator reports published by NCHOD in 1999. Case fatality is one of the measures used in the NHS performance indicators published in 2000.

In view of the increasing importance that information about case fatality rates is likely to have, the Department of Health commissioned NCHOD (Oxford) to prepare a digest of statistical exemplars based on the recommendations about case fatality indicators included in the condition specific reports.

This report contains statistical exemplars of case fatality rates for:

- myocardial infarction
- coronary heart disease (not subject of a report but NSF topic)
- stroke
- fractured femur
- diabetes
- asthma.

The illustrative values have been derived from the Oxford Record Linkage Database. The definition descriptions are taken from the relevant condition specific reports.

Objective

The objective of producing these exemplars has been, for each condition, to show:

- age/sex group differences
- comparisons between hospitals
- effects for hospital comparisons of changes in the indicator definitions for place of death, time interval before death and cause of death recorded and its position on the death certificate.

2. MYOCARDIAL INFARCTION ILLUSTRATIVE VALUES

Methods

The indicator definition recommended in the Report is: *the number of patients registered as having died from any cause within a specified interval following admission with a diagnosis of MI to the given unit in the given year, divided by the total number of patients admitted with a diagnosis of MI to the given unit in the given year.* The suggested time periods were 30 days and one year after admission. The ICD code used was ICD-9 410.

The objectives of the study were to:

- Analyse using the recommended indicator specification:
 - age/sex group differences
 - differences between hospital trusts.
- Identify the specific effect of changing the indicator definition on hospital comparisons.

The illustrative indicator values are based on the Oxford Record Linkage Study data for the five years starting 1 January 1994, except for the 365 day case fatality rates for which the period ended 31 March 1998.

For the purposes of this analysis data have been obtained for the eight major trusts (A to H) and a residual category containing the data for smaller trusts (I) on the system. The admissions included are all those with myocardial infarction (MI) listed anywhere in the hospital admission record.

The case fatality rate (CFR) has been calculated 18 different ways using cases that died:

- in hospital or those that died anywhere
- within 30, 90 or 365 days of admission
- from all causes, with MI as underlying cause of death or MI anywhere on the death certificate.

For the trust comparisons logistic regression modelling has been used to adjust for age group and sex. Resultant odds ratios of trusts B to I relative to a reference trust A are presented together with 95% confidence intervals and indicators of statistical significance.

Results

Table 2.1 shows age/sex breakdowns for myocardial infarction CFRs for all causes of death calculated in four different ways. Almost two thirds of the 18,000 admissions were male. The total case fatality rates were higher in women than men. The age-specific rates increased sharply with age for both sexes. For each of the four methods of calculating case fatality rates, the figures tended to be higher in women than men, except for the oldest age group.

Table 2.1 Case fatality rates by age group and sex: admissions for myocardial infarction, all causes of death (1994-1998)

Age	Deaths in hospital	Deaths anywhere			Total admissions
	CFR (30 days)	CFR (30 days)	CFR (90 days)	CFR (365 days)	
Men:					
< 40	2.4%	3.1%	3.8%	4.6%	287
40-44	1.0%	2.1%	2.1%	1.6%	288
45-49	3.0%	4.3%	5.4%	7.4%	691
50-54	3.2%	4.0%	5.8%	7.9%	991
55-59	4.9%	6.4%	7.6%	10.4%	1,250
60-64	8.6%	11.1%	12.6%	16.0%	1,473
65-69	11.5%	14.6%	16.4%	20.9%	1,717
70-74	17.0%	20.7%	23.4%	29.9%	1,751
75-79	20.5%	25.8%	31.4%	42.6%	1,467
80-84	27.3%	32.3%	38.6%	50.6%	1,035
85-89	30.6%	35.9%	42.3%	57.0%	523
90 +	49.6%	54.9%	62.4%	67.9%	133
All ages	13.4%	16.5%	19.4%	30.4%	11,606
Women:					
< 40	2.4%	4.9%	3.8%	4.6%	41
40-44	9.6%	13.5%	13.5%	18.2%	52
45-49	4.6%	5.5%	6.4%	6.9%	109
50-54	3.3%	3.8%	3.8%	4.6%	183
55-59	6.5%	9.0%	9.6%	10.6%	323
60-64	9.2%	11.9%	14.0%	19.6%	513
65-69	15.7%	20.1%	22.0%	27.1%	785
70-74	18.9%	22.9%	25.7%	33.0%	1,043
75-79	25.0%	29.4%	34.1%	42.8%	1,173
80-84	31.6%	35.4%	40.3%	50.3%	1,092
85-89	35.9%	39.9%	46.8%	57.5%	757
90 +	42.6%	48.5%	55.4%	64.6%	336
All ages	22.8%	26.6%	30.4%	37.8%	6,407

Table 2.2 shows myocardial infarction CFRs and Odds Ratios (OR) to Trust A for all causes of death, calculated in four different ways.

Table 2.3 shows myocardial infarction CFRs and ORs when MI is recorded anywhere on the death certificate, calculated in four different ways

Table 2.4 shows myocardial infarction CFRs and ORs when MI is only recorded as the underlying cause of death, calculated in four different ways.

Hospital case fatality rates for admissions due to myocardial infarction, irrespective of cause of death, are presented in Table 2.2 for nine hospital trusts in the Oxford Region. At 30 days, for all deaths, the CFRs showed some variation ranging from 17.1% for trust C up to 23.9% for trust D. At 90 days and 365 days, similar degrees of variation in the rates are apparent with trust C still exhibiting the lowest CFR, and trust D the highest.

For in-hospital deaths, trust C still has the lowest CFR and D the highest, although it should be noted that the extremely low in-hospital fatality rate in trust C (7.8%) is due to hospital coding inaccuracy, a problem particular to this trust.

Any interpretation of hospital trust performance, based upon the above crude hospital CFRs, may well be grossly misleading since they take no account of any possible age and sex differentials in the populations of patients admitted to the respective trusts. It is important, therefore, that known confounding factors such as age group and sex are accounted for in any comparative analysis of hospital CFRs.

In this study logistic regression modelling has been employed to control for age group and sex. The results of fitted models for each of the CFRs are presented in terms of odds ratios of trusts B, C, D, E, F, G, H and I relative to a baseline or reference category, trust A. In other words, the odds ratios illustrate any increased or decreased fatality risk, after taking into account age group and sex differentials in patients admitted, that is associated with the various trusts relative to the index trust A.

The results in Table 2.2 show that, for deaths anywhere at 30 days, only two trusts (B and D) fared significantly worse than the reference trust A. Trust B exhibited a case fatality odds ratio of 1.35, relative to A, with a 95% confidence interval of (1.09-1.67), while the odds ratio for trust D was 1.37 (95% confidence interval=1.18-1.60). By 90 days, the results show that there were three trusts (B, D and F) which had significantly increased CFRs when compared to the reference trust A. After one year of follow-up, while trust B no longer had significantly elevated mortality compared to A, trusts D and F had now been joined by E as the trusts with increased fatality rates. For in-hospital mortality B, C and D were the three trusts with significantly increased fatality rates relative to trust A.

Hence, the analysis of four different definitions of a hospital CFR have led to the identification of different groups of trusts which perform significantly worse than the reference trust. It should be remembered that the in-hospital mortality findings for trust C are inaccurate. It would seem important to recognize, therefore, that the results of a comparative analysis of hospitals or trusts can be dependent on the particular definition of a hospital CFR that is used as the measure of performance.

Table 2.3 shows the results when the CFR is calculated using those cases where myocardial infarction is listed anywhere on the death certificate. The four hospitals (B, D, E, F) had significantly raised CFRs at 30 and 90 days and after one-year of follow-up there were six trusts with significantly increased mortality when compared with trust A.

Table 2.4 shows that similar findings emerge for CFRs where myocardial infarction constitutes the underlying cause of death. In this case, while the same four trusts (B, D, E and F) were shown to have significantly increased CFRs at 30 and 90 days, by one year there were seven trusts with increased mortality. The comparison of in-hospital mortality identified five trusts with elevated CFRs relative to trust A.

Clearly, these results demonstrate that the findings from this comparison of CFRs due to myocardial infarction vary according to the definition of the case fatality rates. Not only do the findings differ according to the length of follow-up, or whether deaths outside hospital are traced and included with those inside, but also according to whether deaths from all causes are included or whether the definition is based only upon myocardial infarction as the underlying or any cause of death on the death certificate.

Table 2.2 Case fatality rates: admissions for myocardial infarction, all causes of death (1994-1998)

Trust	Died anywhere				Died in hospital			
	CFR (30 days)	Odds Ratio to A (95% CI)	CFR (90 days)	Odds Ratio to A (95% CI)	CFR (365 days)	Odds Ratio to A (95% CI)	CFR (30 days)	Odds ratio to A (95% CI)
A	19.1%	(Reference)	22.1%	(Reference)	28.4%	(Reference)	17.0%	(Reference)
B	23.5%	1.35** (1.09-1.67)	26.6%	1.32** (1.07-1.62)	31.6%	1.20 (0.98-1.46)	21.2%	1.35** (1.08-1.69)
C	17.1%	0.97 (0.83-1.14)	19.7%	0.97 (0.83-1.13)	25.4%	0.98 (0.84-1.14)	7.8%	0.44*** (0.36-0.53)
D	23.9%	1.37*** (1.18-1.60)	27.8%	1.41*** (1.22-1.64)	33.2%	1.30*** (1.13-1.51)	21.3%	1.37*** (1.16-1.60)
E	21.7%	1.20 (0.99-1.46)	24.4%	1.16 (0.97-1.40)	32.2%	1.24* (1.03-1.50)	19.1%	1.18 (0.96-1.44)
F	19.9%	1.15 (0.99-1.33)	23.7%	1.20** (1.05-1.38)	30.6%	1.23** (1.07-1.41)	17.2%	1.10 (0.94-1.28)
G	19.8%	1.10 (0.95-1.28)	22.6%	1.09 (0.94-1.25)	28.7%	1.10 (0.96-1.26)	17.1%	1.06 (0.91-1.23)
H	19.3%	1.03 (0.89-1.20)	22.4%	1.04 (0.90-1.20)	30.2%	1.13 (0.98-1.30)	16.8%	1.01 (0.86-1.18)
I	20.4%	1.05 (0.89-1.24)	23.7%	1.05 (0.89-1.23)	29.1%	0.98 (0.82-1.18)	17.3%	0.98 (0.82-1.16)

Notes

All case fatality rates are unadjusted for sex and age group

All odds ratios are adjusted for sex and age group

* denotes a significant odds ratio at the 5% level, ** at the 1% level and *** at the 0.1% level

Table 2.3 Case fatality rates: admissions for myocardial infarction, myocardial infarction as any cause of death (1994-1998)

Trust	Died anywhere				Died in hospital			
	CFR (30 days)	Odds Ratio to A (95% CI)	CFR (90 days)	Odds Ratio to A (95% CI)	CFR (365 days)	Odds Ratio to A (95% CI)	CFR (30 days)	Odds ratio to A (95% CI)
A	16.0%	(Reference)	17.4%	(Reference)	19.3%	(Reference)	14.3%	(Reference)
B	21.2%	1.46*** (1.17-1.83)	23.1%	1.49*** (1.19-1.85)	24.7%	1.42** (1.15-1.76)	19.5%	1.51*** (1.19-1.90)
C	14.0%	0.95 (0.80-1.13)	15.0%	0.93 (0.79-1.10)	16.5%	0.93 (0.78-1.10)	6.2%	0.42*** (0.34-0.52)
D	21.7%	1.51*** (1.28-1.77)	24.1%	1.58*** (1.35-1.85)	26.0%	1.53*** (1.31-1.79)	19.7%	1.53*** (1.30-1.81)
E	19.7%	1.32** (1.08-1.62)	21.3%	1.33** (1.09-1.61)	25.1%	1.47*** (1.21-1.79)	17.4%	1.30* (1.06-1.61)
F	18.1%	1.27** (1.09-1.48)	20.1%	1.32*** (1.14-1.53)	23.5%	1.41*** (1.22-1.64)	15.9%	1.24** (1.06-1.46)
G	17.0%	1.13 (0.97-1.32)	18.4%	1.13 (0.97-1.32)	20.9%	1.19* (1.02-1.38)	15.2%	1.13 (0.96-1.33)
H	17.0%	1.11 (0.94-1.30)	18.7%	1.12 (0.96-1.31)	22.3%	1.24** (1.06-1.45)	15.4%	1.13 (0.96-1.33)
I	17.4%	1.07 (0.89-1.27)	19.2%	1.09 (0.92-1.30)	22.4%	1.17 (0.97-1.42)	15.3%	1.05 (0.87-1.26)

Notes

All case fatality rates are unadjusted for sex and age group

All odds ratios are adjusted for sex and age group

* denotes a significant odds ratio at the 5% level, ** at the 1% level and *** at the 0.1% level

Table 2.4 Case fatality rates: admissions for myocardial infarction, myocardial infarction as the underlying cause of death (1994-1998)

Trust	Died anywhere				Died in hospital			
	CFR (30 days)	Odds Ratio to A (95% CI)	CFR (90 days)	Odds Ratio to A (95% CI)	CFR (365 days)	Odds Ratio to A (95% CI)	CFR (30 days)	Odds ratio to A (95% CI)
A	14.3%	(Reference)	15.7%	(Reference)	17.4%	(Reference)	12.8%	(Reference)
B	19.9%	1.54*** (1.22-1.93)	21.8%	1.56*** (1.25-1.95)	23.2%	1.49*** (1.20-1.85)	18.3%	1.58*** (1.24-2.00)
C	13.1%	1.00 (0.83-1.19)	14.0%	0.98 (0.82-1.16)	15.4%	0.97 (0.81-1.16)	5.9%	0.46*** (0.36-0.57)
D	19.5%	1.50*** (1.27-1.77)	21.6%	1.54*** (1.31-1.80)	23.3%	1.50*** (1.27-1.76)	17.7%	1.51*** (1.27-1.79)
E	17.8%	1.33** (1.08-1.63)	19.2%	1.31** (1.07-1.61)	23.0%	1.48*** (1.21-1.81)	15.9%	1.32* (1.06-1.64)
F	16.8%	1.32*** (1.13-1.55)	18.7%	1.36*** (1.17-1.59)	22.0%	1.47*** (1.26-1.72)	14.7%	1.28** (1.09-1.52)
G	15.5%	1.15 (0.98-1.35)	16.8%	1.14 (0.98-1.34)	19.1%	1.20* (1.03-1.41)	14.0%	1.16 (0.98-1.37)
H	15.7%	1.14 (0.97-1.34)	17.2%	1.14 (0.98-1.34)	20.4%	1.26** (1.07-1.47)	14.1%	1.15 (0.97-1.36)
I	15.6%	1.07 (0.89-1.28)	17.3%	1.09 (0.91-1.30)	20.4%	1.18*** (0.97-1.44)	13.7%	1.03 (0.85-1.25)

Notes

All case fatality rates are unadjusted for sex and age group

All odds ratios are adjusted for sex and age group

* denotes a significant odds ratio at the 5% level, ** at the 1% level and *** at the 0.1% level

3. CORONARY HEART DISEASE ILLUSTRATIVE VALUES

Methods

The indicator definition used is: *the number of patients registered as having died from any cause within a specified interval following admission with a diagnosis of CHD to the given unit in the given year, divided by the total number of patients admitted with a diagnosis of CHD to the given unit in the given year.* The ICD codes used were ICD-9 410-414.

The objectives of the study were to:

- Analyse using the recommended indicator specification:
 - age/sex group differences
 - differences between hospital trusts.
- Identify the specific effect of changing the indicator definition on hospital comparisons.

The illustrative indicator values are based on the Oxford Record Linkage Study data for the five years starting 1 January 1994, except for the 365 day case fatality rates for which the period ended 31 March 1998.

For the purposes of this analysis data have been obtained for the eight major trusts (A to H) and a residual category containing data for the smaller trusts (I) on the system. The admissions included are all those with coronary heart disease (CHD) listed anywhere in the hospital admission record.

The case fatality rate (CFR) has been calculated 18 different ways using cases that died:

- in hospital or those that died anywhere
- within 30, 90 or 365 days of admission
- from all causes, with CHD as underlying cause of death or CHD anywhere on the death certificate.

For the trust comparisons logistic regression modelling has been used to adjust for age group and sex. Resultant odds ratios of trusts B to I relative to a reference trust A are presented together with 95% confidence intervals and indicators of statistical significance.

Results

Table 3.1 shows age/sex breakdowns for coronary heart disease CFRs for all causes of death calculated in four different ways. Almost two thirds of the 95,000 admissions were male. The total case fatality rates were higher in women than men, while the age-specific rates also increased with age. While the age-specific rates were higher among women in the younger age groups, a crossover arose around 70 when CFRs became higher among men

Table 3.1 Case fatality rates by age group and sex: admissions for coronary heart disease, all causes of death (1994-1998)

Age	Deaths in hospital	Deaths anywhere			Total admissions
	CFR (30 days)	CFR (30 days)	CFR (90 days)	CFR (365 days)	
Men:					
< 40	0.8%	1.3%	2.1%	3.3%	1,460
40-44	0.7%	1.5%	1.8%	2.9%	1,530
45-49	1.2%	1.7%	2.4%	4.2%	3,755
50-54	1.3%	1.9%	2.7%	4.6%	5,566
55-59	1.8%	2.4%	3.5%	5.7%	7,607
60-64	3.1%	4.3%	5.7%	8.5%	9,034
65-69	4.7%	6.6%	9.0%	14.4%	9,977
70-74	8.3%	11.2%	14.8%	22.4%	8,982
75-79	12.0%	15.7%	21.2%	32.4%	7,014
80-84	17.9%	22.5%	30.2%	44.2%	4,682
85-89	23.0%	28.2%	36.0%	53.9%	2,305
90 +	31.4%	39.6%	48.8%	60.5%	611
All ages	6.7%	8.8%	11.7%	17.6%	62,653
Women:					
< 40	2.3%	3.0%	4.3%	6.3%	302
40-44	2.6%	3.9%	4.9%	6.3%	308
45-49	1.2%	1.3%	1.6%	2.0%	768
50-54	0.9%	1.1%	1.7%	4.5%	1,493
55-59	2.1%	3.6%	4.3%	6.4%	2,097
60-64	3.6%	5.1%	6.7%	10.5%	3,295
65-69	6.5%	9.0%	11.1%	15.6%	4,307
70-74	8.7%	11.1%	14.0%	20.8%	5,339
75-79	12.8%	15.9%	20.4%	29.2%	5,543
80-84	17.7%	20.9%	27.0%	39.0%	4,722
85-89	22.1%	25.7%	33.1%	45.8%	3,402
90 +	26.9%	32.1%	41.4%	54.4%	1,512
All ages	11.0%	13.6%	17.4%	24.8%	33,088

Table 3.2 shows coronary heart disease CFRs and Odds Ratios (OR) to Trust A for all causes of death, calculated in four different ways.

Table 3.3 shows coronary heart disease CFRs and ORs when CHD is recorded anywhere on the death certificate, calculated in four different ways.

Table 3.4 shows coronary heart disease CFRs and ORs when CHD is only recorded as the underlying cause of death, calculated in four different ways.

In all logistic regression models, irrespective of the definition of the case fatality rate employed, significantly increased levels of mortality were apparent for each of trusts B, C, D, E, F, G and H relative to trust A. Trust I was found to exhibit significantly reduced CFRs.

However, the magnitude of many of the case fatality odds ratios with reference to trust A varied according to the particular definition of the hospital CFR. For example, some trusts showed evidence of increasing mortality risks over time, relative to trust A, while others showed relative improvements over time.

Table 3.2 Case fatality rates: admissions for coronary heart disease, all causes of death (1994-1998)

Trust	Died anywhere				Died in hospital			
	CFR (30 days)	Odds Ratio to A (95% CI)	CFR (90 days)	Odds Ratio to A (95% CI)	CFR (365 days)	Odds Ratio to A (95% CI)	CFR (30 days)	Odds ratio to A (95% CI)
A	7.5%	(Reference)	9.8%	(Reference)	14.6%	(Reference)	5.9%	(Reference)
B	15.1%	1.63*** (1.42-1.86)	18.7%	1.55*** (1.37-1.76)	26.5%	1.61*** (1.44-1.80)	13.3%	1.78*** (1.54-2.06)
C	14.4%	1.69*** (1.54-1.86)	17.7%	1.61*** (1.47-1.75)	23.5%	1.51*** (1.40-1.64)	5.5%	0.70*** (0.62-0.80)
D	12.6%	1.32*** (1.21-1.44)	16.9%	1.38*** (1.28-1.49)	25.5%	1.54*** (1.44-1.65)	10.7%	1.40*** (1.27-1.54)
E	14.2%	1.39*** (1.25-1.55)	18.4%	1.40*** (1.27-1.55)	27.4%	1.59*** (1.45-1.74)	11.9%	1.44*** (1.28-1.62)
F	11.5%	1.16*** (1.07-1.26)	15.7%	1.24*** (1.15-1.33)	24.2%	1.45*** (1.36-1.54)	9.2%	1.15** (1.05-1.26)
G	13.7%	1.55*** (1.42-1.69)	16.9%	1.47*** (1.35-1.59)	23.7%	1.50*** (1.39-1.62)	11.5%	1.62*** (1.47-1.79)
H	18.8%	2.19*** (2.00-2.40)	22.2%	2.00*** (1.84-2.18)	29.6%	1.96*** (1.81-2.12)	16.7%	2.42*** (2.19-2.67)
I	5.2%	0.70*** (0.64-0.76)	7.6%	0.77*** (0.72-0.83)	11.5%	0.80*** (0.74-0.85)	4.0%	0.68*** (0.61-0.74)

Notes

All case fatality rates are unadjusted for sex and age group

All odds ratios are adjusted for sex and age group

* denotes a significant odds ratio at the 5% level, ** at the 1% level and *** at the 0.1* level

Table 3.3 Case fatality rates: admissions for coronary heart disease, coronary heart disease as any cause of death (1994-1998)

Trust	Died anywhere				Died in hospital			
	CFR (30 days)	Odds Ratio to A (95% CI)	CFR (90 days)	Odds Ratio to A (95% CI)	CFR (365 days)	Odds Ratio to A (95% CI)	CFR (30 days)	Odds ratio to A (95% CI)
A	6.5%	(Reference)	8.2%	(Reference)	11.5%	(Reference)	5.1%	(Reference)
B	13.5%	1.29*** (1.17-1.41)	15.8%	1.55*** (1.36-1.77)	21.4%	1.57*** (1.39-1.76)	12.0%	1.87*** (1.59-2.19)
C	13.1%	1.77*** (1.61-1.96)	15.5%	1.67*** (1.53-1.83)	19.3%	1.56*** (1.43-1.70)	4.8%	0.76*** (0.66-0.88)
D	10.7%	1.68*** (1.46-1.93)	13.7%	1.32*** (1.22-1.44)	19.6%	1.41*** (1.31-1.53)	9.3%	1.31*** (1.18-1.47)
E	12.2%	1.37*** (1.22-1.54)	15.2%	1.36*** (1.22-1.51)	21.1%	1.42*** (1.28-1.56)	10.5%	1.27*** (1.11-1.46)
F	9.8%	1.14** (1.04-1.24)	12.7%	1.18*** (1.09-1.28)	17.9%	1.25*** (1.17-1.34)	8.2%	1.13** (1.02-1.26)
G	12.7%	1.68*** (1.53-1.84)	15.3%	1.61*** (1.48-1.75)	20.4%	1.58*** (1.46-1.72)	10.8%	1.72*** (1.54-1.92)
H	17.7%	2.40*** (2.18-2.64)	20.3%	2.20*** (2.01-2.40)	25.6%	2.10*** (1.93-2.28)	16.0%	2.49*** (2.23-2.78)
I	4.5%	0.70*** (0.64-0.77)	6.2%	0.76*** (0.70-0.82)	8.6%	0.75*** (0.70-0.81)	3.5%	0.65*** (0.58-0.73)

Notes

All case fatality rates are unadjusted for sex and age group

All odds ratios are adjusted for sex and age group

* denotes a significant odds ratio at the 5% level, ** at the 1% level and *** at the 0.1* level

Table 3.4 Case fatality rates: admissions for coronary heart disease, coronary heart disease as underlying cause of death (1994-1998)

Trust	Died anywhere				Died in hospital			
	CFR (30 days)	Odds Ratio to A (95% CI)	CFR (90 days)	Odds Ratio to A (95% CI)	CFR (365 days)	Odds Ratio to A (95% CI)	CFR (30 days)	Odds ratio to A (95% CI)
A	5.4%	(Reference)	6.8%	(Reference)	9.5%	(Reference)	4.4%	(Reference)
B	11.9%	1.75*** (1.50-2.03)	13.9%	1.64*** (1.42-1.88)	18.7%	1.66*** (1.25-1.95)	10.5%	1.87*** (1.59-2.19)
C	11.2%	1.77*** (1.59-0.57)	13.2%	1.68*** (1.53-1.86)	16.7%	1.62*** (1.47-1.78)	4.3%	0.76*** (0.66-0.88)
D	8.8%	1.25*** (1.13-1.38)	11.1%	1.26*** (1.15-1.38)	15.8%	1.36*** (1.25-1.48)	7.6%	1.31*** (1.18-1.47)
E	9.2%	1.20** (1.05-1.36)	11.9%	1.18** (1.05-1.32)	15.6%	1.21*** (1.09-1.36)	8.0%	1.27*** (1.11-1.46)
F	8.1%	1.12* (1.02-1.23)	11.3%	1.14** (1.05-1.24)	14.4%	1.21*** (1.12-1.30)	6.8%	1.13* (1.02-1.26)
G	10.7%	1.65*** (1.50-1.83)	12.9%	1.61*** (1.46-1.76)	16.9%	1.56*** (1.43-1.70)	9.1%	1.72*** (1.54-1.92)
H	14.5%	2.25*** (1.50-1.83)	16.5%	2.05*** (1.87-2.26)	21.2%	2.00*** (1.83-2.18)	13.1%	2.49*** (2.23-2.78)
I	3.6%	0.67*** (2.03-2.49)	4.8%	0.70*** (0.65-0.77)	6.4%	0.68*** (0.63-0.74)	2.8%	0.65*** (0.58-0.73)

Notes

All case fatality rates are unadjusted for sex and age group

All odds ratios are adjusted for sex and age group

* denotes a significant odds ratio at the 5% level, ** at the 1% level and *** at the 0.1% level

4. STROKE ILLUSTRATIVE VALUES

Methods

The indicator definition recommended in the Report is: *the number of patients registered as having died from any cause within 30 days of an admission (to a given unit in a given year) containing one or more episodes with a diagnosis of stroke, divided by the total number of admissions (to a given unit in a given year) containing one or more episodes with a diagnosis of stroke.* The ICD codes used were ICD-9 431-438.

The objectives of the study were to:

- Analyse using the recommended indicator specification:
 - age/sex group differences
 - differences between hospital trusts.
- Identify the specific effect of changing the indicator definition on hospital comparisons.

The illustrative indicator values are based on the Oxford Record Linkage Study data for the five years starting 1 January 1994, except for the 365 day case fatality rates for which the period ended 31 March 1998.

For the purposes of this analysis data have been obtained for the eight major trusts (A to H) and a residual category containing the data for smaller trusts(I) on the system. The admissions included are all those with stroke listed anywhere in the hospital admission record.

The case fatality rate (CFR) has been calculated 18 different ways using cases that died:

- in hospital or those that died anywhere
- within 30, 90 or 365 days of admission
- from all causes, with stroke as underlying cause of death or stroke anywhere on the death certificate.

For the trust comparisons logistic regression modelling has been used to adjust for age group and sex. Resultant odds ratios of trusts B to I relative to a reference trust A are presented together with 95% confidence intervals and indicators of statistical significance.

Results

Table 4.1 shows age/sex breakdowns for stroke CFRs for all causes of death calculated in four different ways. The 35,000 admissions were equally divided between the sexes. The total case fatality rates were higher among women than men. The age-specific rates in the younger age groups were higher in men. After about 50 the rates were higher for women.

Table 4.1 Case fatality rates by age group and sex: admissions for stroke, all causes of death (1994-1998)

Age	Deaths in hospital	Deaths anywhere			Total admissions
	CFR (30 days)	CFR (30 days)	CFR (90 days)	CFR (365 days)	
Men:					
< 40	8.0%	10.8%	11.3%	13.7%	462
40-44	9.9%	9.9%	10.4%	14.6%	182
45-49	6.3%	8.2%	10.1%	15.0%	426
50-54	7.5%	9.6%	12.6%	17.0%	571
55-59	7.7%	9.9%	12.2%	18.3%	1,040
60-64	8.7%	11.1%	13.7%	21.1%	1,590
65-69	10.8%	13.8%	17.9%	25.9%	2,083
70-74	13.4%	15.9%	22.2%	33.4%	2,976
75-79	16.5%	19.9%	28.0%	40.3%	3,226
80-84	18.7%	23.0%	32.8%	46.5%	2,949
85-89	24.6%	29.7%	42.2%	63.7%	1,565
90 +	26.1%	31.7%	43.4%	62.3%	578
All ages	14.7%	17.9%	24.6%	35.9%	17,648
Women:					
< 40	3.7%	4.1%	5.4%	8.0%	410
40-44	3.8%	6.7%	9.6%	10.7%	104
45-49	4.9%	7.1%	8.3%	12.8%	266
50-54	9.7%	11.1%	17.0%	21.6%	352
55-59	11.3%	12.1%	15.2%	22.9%	462
60-64	13.4%	16.4%	21.6%	27.2%	792
65-69	15.0%	18.2%	22.1%	32.5%	1,310
70-74	15.0%	17.8%	23.4%	33.9%	2,260
75-79	16.8%	20.2%	27.2%	37.8%	3,187
80-84	22.2%	25.9%	34.9%	47.1%	3,712
85-89	25.7%	29.7%	41.3%	55.8%	3,010
90 +	29.5%	35.5%	47.4%	62.5%	1,511
All ages	19.2%	22.7%	30.5%	41.7%	17,376

Table 4.2 shows stroke CFRs and Odds Ratios (OR) to Trust A for all causes of death, calculated in four different ways.

Table 4.3 shows stroke CFRs and ORs when stroke is recorded anywhere on the death certificate, calculated in four different ways.

Table 4.4 shows stroke CFRs and ORs when stroke is only recorded as the underlying cause of death, calculated in four different ways.

From Table 4.2 it is apparent that, at 30 days for in-hospital deaths, two trusts (B and G) had significantly increased fatality rates relative to A, while three (E, F and I; excluding trust C with erroneous in-hospital mortality coding) had reduced mortality. Similar patterns are apparent, for all deaths, at 30 and 90 days while, after one year, trust F no longer had a significantly increased CFR, but trust H had emerged with increased mortality.

Tables 4.3 and 4.4 show a similar pattern. In both cases the three trusts (B, G and H) had a significantly increased mortality for all three time periods. Trusts E, F and I had significantly lower CFRs at 30 days but only trust I had a significantly lower CFR for all time periods. The significant case fatality differences with the reference trust A tended to diminish after longer periods of follow-up.

Table 4.2 Case fatality rates: admissions for stroke, all causes of death (1994-1998)

Trust	Died anywhere				Died in hospital			
	CFR (30 days)	Odds Ratio to A (95% CI)	CFR (90 days)	Odds Ratio to A (95% CI)	CFR (365 days)	Odds Ratio to A (95% CI)	CFR (30 days)	Odds ratio to A (95% CI)
A	24.5%	(Reference)	31.2%	(Reference)	41.1%	(Reference)	21.5%	(Reference)
B	32.9%	1.40*** (1.18-1.66)	39.2%	1.30** (1.10-1.53)	48.4%	1.22* (1.04-1.43)	31.0%	1.53*** (1.29-1.83)
C	29.1%	1.28*** (1.13-1.44)	37.0%	1.32*** (1.17-1.48)	45.5%	1.24*** (1.10-1.40)	10.2%	0.40*** (0.34-0.47)
D	23.5%	0.93 (0.83-1.05)	31.8%	1.02 (0.91-1.13)	40.9%	0.99 (0.89-1.10)	21.1%	0.97 (0.86-1.09)
E	19.1%	0.67*** (0.58-0.78)	27.0%	0.74*** (0.64-0.85)	39.5%	0.85* (0.75-0.98)	17.3%	0.70*** (0.60-0.82)
F	20.8%	0.77*** (0.70-0.86)	28.6%	0.84*** (0.76-0.92)	40.9%	0.94 (0.85-1.03)	18.6%	0.80*** (0.72-0.89)
G	29.9%	1.24*** (1.11-1.38)	37.7%	1.25*** (1.13-1.39)	47.9%	1.23*** (1.11-1.37)	27.9%	1.34*** (1.19-1.49)
H	27.2%	1.09 (0.97-1.22)	34.7%	1.10 (0.99-1.23)	46.8%	1.23** (1.07-1.34)	23.2%	1.05 (0.93-1.18)
I	11.5%	0.38*** (0.34-0.42)	17.9%	0.45*** (0.41-0.49)	29.8%	0.57*** (0.52-0.61)	9.5%	0.37*** (0.33-0.41)

Notes

All case fatality rates are unadjusted for sex and age group

All odds ratios are adjusted for sex and age group

* denotes a significant odds ratio at the 5% level, ** at the 1% level and *** at the 0.1% level

Table 4.3 Case fatality rates: admissions for stroke, stroke as any cause of death (1994-1998)

Trust	Died anywhere				Died in hospital			
	CFR (30 days)	Odds Ratio to A (95% CI)	CFR (90 days)	Odds Ratio to A (95% CI)	CFR (365 days)	Odds Ratio to A (95% CI)	CFR (30 days)	Odds ratio to A (95% CI)
A	20.6%	(Reference)	25.3%	(Reference)	31.0%	(Reference)	18.4%	(Reference)
B	29.7%	1.52*** (1.27-1.82)	34.4%	1.42*** (1.20-1.69)	40.4%	1.38*** (1.16-1.62)	28.3%	1.63*** (1.36-1.95)
C	25.9%	1.36*** (1.20-1.55)	32.2%	1.43*** (1.27-1.62)	36.7%	1.33*** (1.18-1.51)	8.6%	0.40*** (0.34-0.48)
D	21.4%	1.05 (0.93-1.18)	28.3%	1.16* (1.03-1.29)	32.9%	1.09 (0.97-1.21)	19.6%	1.07 (0.94-1.21)
E	17.1%	0.73*** (0.63-0.86)	23.0%	0.80** (0.69-0.93)	30.1%	0.87 (0.76-1.00)	16.0%	0.78** (0.66-0.91)
F	18.9%	0.86** (0.77-0.96)	24.9%	0.94 (0.85-1.04)	33.7%	1.08 (0.98-1.19)	17.1%	0.88* (0.78-0.98)
G	27.8%	1.40*** (1.25-1.57)	33.8%	1.42*** (1.28-1.58)	40.4%	1.41*** (1.27-1.57)	26.4%	1.50*** (1.33-1.68)
H	24.0%	1.15* (1.03-1.31)	29.5%	1.17** (1.04-1.31)	37.0%	1.24*** (1.10-1.39)	20.9%	1.11 (0.98-1.26)
I	9.7%	0.39*** (0.36-0.44)	14.3%	0.46*** (0.42-0.51)	21.8%	0.58*** (0.53-0.64)	8.3%	0.39*** (0.35-0.43)

Notes

All case fatality rates are unadjusted for sex and age group

All odds ratios are adjusted for sex and age group

* denotes a significant odds ratio at the 5% level, ** at the 1% level and *** at the 0.1% level

Table 4.4 Case fatality rates: admissions for stroke, stroke as underlying cause of death (1994-1998)

Trust	Died anywhere				Died in hospital			
	CFR (30 days)	Odds Ratio to A (95% CI)	CFR (90 days)	Odds Ratio to A (95% CI)	CFR (365 days)	Odds Ratio to A (95% CI)	CFR (30 days)	Odds ratio to A (95% CI)
A	16.5%	(Reference)	19.9%	(Reference)	23.6%	(Reference)	15.0%	(Reference)
B	24.4%	1.51*** (1.25-1.82)	28.1%	1.44*** (1.20-1.73)	32.3%	1.41*** (1.19-1.68)	23.5%	1.61*** (1.33-1.95)
C	21.0%	1.35*** (1.18-1.55)	25.4%	1.39*** (1.22-1.59)	28.3%	1.31*** (1.15-1.50)	7.3%	0.43*** (0.36-0.52)
D	17.0%	1.02 (0.90-1.16)	22.4%	1.16* (1.02-1.30)	24.9%	1.06 (0.94-1.20)	15.6%	1.03 (0.90-1.18)
E	11.8%	0.62*** (0.52-0.74)	15.5%	0.67*** (0.57-0.79)	20.1%	0.74*** (0.63-0.86)	10.9%	0.63*** (0.53-0.77)
F	14.6%	0.83** (0.73-0.93)	19.1%	0.90 (0.81-1.01)	25.3%	1.04 (0.93-1.16)	13.5%	0.84** (0.74-0.95)
G	21.9%	1.32*** (1.17-1.50)	26.2%	1.33*** (1.19-1.49)	30.4%	1.31*** (1.16-1.46)	21.0%	1.41*** (1.24-1.59)
H	19.5%	1.16* (1.02-1.32)	23.8%	1.19** (1.05-1.35)	29.5%	1.28*** (1.13-1.43)	17.1%	1.10 (0.96-1.27)
I	7.4%	0.38*** (0.34-0.43)	10.6%	0.46*** (0.41-0.51)	15.4%	0.56*** (0.51-0.61)	6.4%	0.37*** (0.33-0.42)

Notes

All case fatality rates are unadjusted for sex and age group

All odds ratios are adjusted for sex and age group

* denotes a significant odds ratio at the 5% level, ** at the 1% level and *** at the 0.1% level

5. FRACTURED FEMUR ILLUSTRATIVE VALUES

Methods

The indicator definition recommended in the Report is: *the number of patients registered as having died from any cause within a specified interval following admission with a diagnosis of fractured femur to the given unit in the given year, divided by the total number of patients admitted with a diagnosis of fractured femur to the given unit in the given year.* The suggested time periods were 30 and 120 days after admission. The ICD codes used were ICD-9 820-821.

The objectives of the study were to:

- Analyse using the recommended indicator specification:
 - age/sex group differences
 - differences between hospital trusts.
- Identify the specific effect of changing the indicator definition on hospital comparisons.

The illustrative indicator values are based on the Oxford Record Linkage Study data for the five years starting 1 January 1994, except for the 365 day case fatality rates for which the period ended 31 March 1998.

For the purposes of this analysis data have been obtained for the eight major trusts (A to H) and a residual category containing the data for smaller trusts (I) on the system. The admissions included are all those with fractured femur (FF) listed anywhere in the hospital admission record.

The case fatality rate (CFR) has been calculated 18 different ways using cases that died:

- in hospital or those that died anywhere
- within 30, 90 or 365 days of admission
- from all causes, with FF as underlying cause of death or FF anywhere on the death certificate.

For the trust comparisons logistic regression modelling has been used to adjust for age group and sex. Resultant odds ratios of trusts B to I relative to a reference trust A are presented together with 95% confidence intervals and indicators of statistical significance.

Results

Table 5.1 shows age/sex breakdowns for fractured femur CFRs for all causes of death calculated in four different ways. Almost three quarters of the 14,000 admissions were female. About 70% of admissions were in patients aged over 75, where the age-specific CFRs were approximately twice as high among men than women.

Table 5.1 Case fatality rates by age group and sex: admissions for fractured femur, all causes of death (1994-1998)

Age	Deaths in hospital	Deaths anywhere			Total admissions
	CFR (30 days)	CFR (30 days)	CFR (90 days)	CFR (365 days)	
Men:					
< 40	0.8%	1.0%	1.0%	1.2%	947
40-44	0.0%	0.0%	2.2%	7.7%	46
45-49	0.0%	1.1%	3.4%	5.3%	89
50-54	0.0%	0.9%	2.8%	3.3%	106
55-59	1.2%	2.4%	4.8%	12.9%	83
60-64	2.5%	2.5%	5.0%	13.5%	121
65-69	2.5%	4.5%	9.4%	16.1%	202
70-74	6.2%	9.6%	17.3%	28.5%	323
75-79	9.5%	12.4%	21.8%	33.5%	444
80-84	12.8%	16.1%	27.3%	39.9%	554
85-89	13.1%	21.6%	36.4%	54.7%	472
90 +	27.1%	35.7%	54.1%	67.8%	255
All ages	7.7%	10.8%	18.1%	26.6%	3,642
Women:					
< 40	1.7%	1.7%	2.0%	2.1%	343
40-44	3.4%	3.4%	3.4%	9.5%	29
45-49	0.0%	2.1%	2.1%	7.3%	48
50-54	0.0%	0.0%	1.1%	5.6%	89
55-59	2.0%	2.0%	2.6%	8.8%	152
60-64	2.7%	3.0%	6.1%	10.5%	264
65-69	2.3%	3.4%	7.8%	16.6%	436
70-74	3.9%	5.5%	9.9%	16.3%	891
75-79	4.4%	5.8%	10.5%	18.6%	1,596
80-84	5.5%	7.6%	13.7%	24.9%	2,315
85-89	8.3%	11.7%	20.4%	34.0%	2,364
90 +	12.0%	16.4%	29.0%	46.0%	1,616
All ages	6.4%	8.8%	15.7%	26.6%	10,143

Table 5.2 shows fractured femur CFRs and Odds Ratios (OR) to Trust A for all causes of death, calculated in four different ways.

Table 5.3 shows fractured femur CFRs and ORs when FF is recorded anywhere on the death certificate, calculated in four different ways.

Table 5.4 shows fractured femur CFRs and ORs when FF is only recorded as the underlying cause of death, calculated in four different ways.

In Table 5.2 the 30 day in-hospital CFRs show that five trusts had significantly reduced mortality when compared to A. However, for all deaths at 30 days all eight trusts had lower fatality rates than A. By 90 and 365 days, only one trust (I) significantly differed from A.

Tables 5.3 and 5.4 show that CFRs with fractured femur as the underlying cause of death or anywhere on the death certificate were much lower than those for mortality due to all causes. It is important to note that the inclusion of fractured femur as a cause of death on death certificates can be somewhat arbitrary and is liable to vary between deaths registering sources and hospital trusts. Hence, even though significant differences between the respective trusts are apparent, this may well be somewhat artefactual.

Table 5.2 Case fatality rates: admissions for fractured femur, all causes of death (1994-1998)

Trust	Died anywhere				Died in hospital			
	CFR (30 days)	Odds Ratio to A (95% CI)	CFR (90 days)	Odds Ratio to A (95% CI)	CFR (365 days)	Odds Ratio to A (95% CI)	CFR (30 days)	Odds ratio to A (95% CI)
A	12.5%	(Reference)	17.8%	(Reference)	28.1%	(Reference)	9.0%	(Reference)
B	10.2%	0.78 (0.57-1.07)	15.6%	0.84 (0.64-1.09)	25.6%	0.86 (0.69-1.08)	9.1%	1.00 (0.71-1.41)
C	8.4%	0.64*** (0.51-0.80)	16.7%	0.94 (0.78-1.12)	25.9%	0.91 (0.77-1.08)	3.1%	0.33*** (0.23-0.46)
D	8.1%	0.61*** (0.49-0.77)	17.3%	0.98 (0.82-1.16)	27.4%	0.99 (0.84-1.16)	6.3%	0.69** (0.54-0.89)
E	9.3%	0.71* (0.54-0.93)	15.5%	0.84 (0.67-1.05)	28.0%	0.98 (0.80-1.20)	7.1%	0.80 (0.58-1.11)
F	9.2%	0.70*** (0.58-0.86)	16.7%	0.92 (0.78-1.09)	26.4%	0.92 (0.79-1.07)	7.4%	0.81 (0.65-1.02)
G	9.0%	0.68*** (0.56-0.83)	16.3%	0.88 (0.75-1.04)	27.9%	0.97 (0.84-1.12)	6.8%	0.75* (0.59-0.94)
H	10.1%	0.76** (0.62-0.94)	17.5%	0.96 (0.81-1.14)	30.6%	1.10 (0.94-1.29)	7.2%	0.77* (0.61-0.99)
I	6.8%	0.50*** (0.41-0.61)	12.3%	0.63*** (0.54-0.74)	21.3%	0.67*** (0.58-0.78)	5.2%	0.63*** (0.48-0.83)

Notes

All case fatality rates are unadjusted for sex and age group

All odds ratios are adjusted for sex and age group

* denotes a significant odds ratio at the 5% level, ** at the 1% level and *** at the 0.1* level

Table 5.3 Case fatality rates: admissions for fractured femur, fractured femur as any cause of death (1994-1998)

Trust	Died anywhere				Died in hospital			
	CFR (30 days)	Odds Ratio to A (95% CI)	CFR (90 days)	Odds Ratio to A (95% CI)	CFR (365 days)	Odds Ratio to A (95% CI)	CFR (30 days)	Odds ratio to A (95% CI)
A	1.8%	(Reference)	2.3%	(Reference)	2.5%	(Reference)	1.0%	(Reference)
B	2.0%	1.13 (0.58-2.24)	2.6%	1.14 (0.63-2.09)	3.3%	1.32 (0.77-2.28)	2.1%	2.10* (1.00-4.39)
C	4.4%	2.64*** (1.77-3.95)	7.7%	3.79*** (2.70-5.33)	8.4%	3.79*** (2.71-5.29)	0.9%	0.95 (0.47-1.90)
D	2.5%	1.47 (0.95-2.27)	5.1%	2.41*** (1.69-3.44)	5.4%	2.30*** (1.62-3.28)	2.1%	2.14** (1.24-3.70)
E	6.7%	4.13*** (2.71-6.29)	9.9%	5.00*** (3.46-7.20)	12.0%	5.52*** (3.87-7.88)	5.1%	5.65*** (3.27-9.76)
F	4.5%	2.69*** (1.85-3.93)	6.4%	3.05*** (2.19-4.26)	8.0%	3.49*** (2.54-4.80)	4.0%	4.19*** (2.57-6.81)
G	6.6%	4.01*** (2.80-5.72)	9.3%	4.60*** (3.36-6.30)	10.4%	4.64*** (3.42-6.30)	5.5%	5.91*** (3.70-9.44)
H	5.5%	3.21*** (2.20-4.69)	7.0%	3.27*** (2.33-4.58)	8.4%	3.51*** (2.53-4.87)	4.2%	4.32*** (2.63-7.09)
I	1.4%	0.78 (0.50-1.21)	2.1%	0.93 (0.63-1.36)	2.7%	1.09 (0.74-1.60)	0.8%	0.87 (0.42-1.77)

Notes

All case fatality rates are unadjusted for sex and age group

All odds ratios are adjusted for sex and age group

* denotes a significant odds ratio at the 5% level, ** at the 1% level and *** at the 0.1* level

Table 5.4 Case fatality rates: admissions for fractured femur, fractured femur as underlying cause of death (1994-1998)

Trust	Died anywhere						Died in hospital	
	CFR (30 days)	Odds Ratio to A (95% CI)	CFR (90 days)	Odds Ratio to A (95% CI)	CFR (365 days)	Odds Ratio to A (95% CI)	CFR (30 days)	Odds ratio to A (95% CI)
A	0.8%	(Reference)	1.0%	(Reference)	1.0%	(Reference)	0.6%	(Reference)
B	0.7%	0.88 (0.30-2.60)	1.1%	1.10 (0.46-2.85)	1.3%	1.28 (0.54-3.01)	0.8%	1.35 (0.43-4.22)
C	1.9%	2.36** (1.31-4.27)	3.1%	3.40*** (2.03-5.69)	3.5%	3.73*** (2.23-6.24)	0.4%	0.78 (0.29-2.10)
D	0.8%	1.01 (0.50-2.03)	1.9%	2.09** (1.21-3.61)	2.0%	2.01* (1.15-3.52)	0.7%	1.17 (0.52-2.67)
E	3.5%	4.45*** (2.47-8.01)	6.1%	6.92*** (4.15-11.6)	7.6%	8.43*** (5.10-13.9)	2.9%	5.49*** (2.68-11.3)
F	2.3%	2.82*** (1.65-4.83)	3.3%	3.57*** (2.19-5.81)	4.2%	4.42*** (2.75-7.12)	2.0%	3.61*** (1.88-6.91)
G	1.9%	2.25** (1.31-3.89)	2.8%	2.94*** (1.80-4.80)	3.1%	3.15*** (1.93-5.12)	1.2%	2.16* (1.09-4.27)
H	2.1%	2.47** (1.41-4.33)	3.0%	3.12*** (1.88-5.18)	3.5%	3.41*** (2.07-5.64)	1.6%	2.76** (1.38-5.50)
I	0.5%	0.55 (0.27-1.11)	0.7%	0.77 (0.42-1.40)	1.1%	1.12 (0.62-2.03)	0.3%	0.65 (0.23-1.85)

Notes

All case fatality rates are unadjusted for sex and age group

All odds ratios are adjusted for sex and age group

* denotes a significant odds ratio at the 5% level, ** at the 1% level and *** at the 0.1% level

6. DIABETES ILLUSTRATIVE VALUES

Methods

The indicator definition recommended in the Report is: *the proportion of in-patients with a diagnosis of diabetes mellitus or manifestation thereof who die within 30 days of admission*. The ICD code used was ICD-9 250.

The objectives of the study were to:

- Analyse using the recommended indicator specification:
 - age/sex group differences
 - differences between hospital trusts.
- Identify the specific effect of changing the indicator definition on hospital comparisons.

The illustrative indicator values are based on the Oxford Record Linkage Study data for the five years starting 1 January 1994, except for the 365 day case fatality rates for which the period ended 31 March 1998.

For the purposes of this analysis data have been obtained for the eight major trusts (A to H) and a residual category containing the data for smaller trusts (I) on the system. The admissions included are all those with diabetes listed anywhere in the hospital admission record.

The case fatality rate (CFR) has been calculated 18 different ways using cases that died:

- in hospital or those that died anywhere
- within 30, 90 or 365 days of admission
- from all causes, with diabetes as underlying cause of death or diabetes anywhere on the death certificate.

For the trust comparisons logistic regression modelling has been used to adjust for age group and sex. Resultant odds ratios of trusts B to I relative to a reference trust A are presented together with 95% confidence intervals and indicators of statistical significance.

Results

Table 6.1 shows age/sex breakdowns for diabetes CFRs for all causes of death calculated in four different ways. About 60 % of the 58,000 admissions were male. The age-specific rates increased sharply with age and tended to be comparable or slightly higher in women than men.

Table 6.1 Case fatality rates by age group and sex: admissions for diabetes, all causes of death (1994-1998)

Age	Deaths in hospital	Deaths anywhere			Total admissions
	CFR (30 days)	CFR (30 days)	CFR (90 days)	CFR (365 days)	
Men:					
< 40	0.1%	0.6%	0.8%	1.6%	3,282
40-44	1.0%	1.4%	4.2%	7.2%	768
45-49	1.3%	2.4%	4.9%	9.2%	1,152
50-54	1.4%	2.7%	4.3%	11.2%	1,601
55-59	2.1%	3.3%	5.5%	11.2%	2,285
60-64	2.6%	4.4%	7.4%	14.0%	2,973
65-69	4.1%	6.6%	12.4%	20.4%	3,693
70-74	5.4%	8.7%	16.9%	30.2%	3,423
75-79	8.2%	10.7%	19.2%	37.1%	2,752
80-84	12.0%	16.3%	28.1%	44.8%	2,026
85-89	13.1%	18.0%	29.3%	48.8%	982
90 +	14.6%	17.4%	32.4%	58.2%	281
All ages	4.5%	6.7%	12.1%	21.5%	35,218
Women:					
< 40	0.3%	0.4%	0.8%	3.3%	3,531
40-44	1.6%	4.1%	9.0%	20.4%	567
45-49	0.4%	1.3%	2.2%	6.8%	767
50-54	2.2%	3.3%	6.5%	12.4%	1,107
55-59	2.5%	4.3%	6.4%	13.3%	1,401
60-64	2.9%	4.7%	7.6%	14.2%	2,317
65-69	5.2%	7.6%	12.1%	21.7%	2,538
70-74	5.5%	7.8%	13.6%	24.8%	2,989
75-79	7.6%	10.0%	16.7%	29.0%	3,014
80-84	10.2%	13.7%	22.7%	38.6%	2,678
85-89	12.3%	17.0%	28.8%	47.1%	1,551
90 +	15.4%	20.7%	33.1%	51.5%	617
All ages	5.3%	7.5%	12.6%	26.6%	23,077

Table 6.2 shows diabetes CFRs and Odds Ratios (OR) to Trust A for all causes of death, calculated in four different ways.

Table 6.3 shows diabetes CFRs and ORs when diabetes is recorded anywhere on the death certificate, calculated in four different ways.

Table 6.4 shows diabetes CFRs and ORs when diabetes is only recorded as the underlying cause of death, calculated in four different ways.

Table 6.2 shows that all causes CFRs for diabetes showed large increases with longer periods of follow-up. At 30 days, for both for in-hospital deaths and all deaths, five of the eight trusts had significantly lower fatality rates than the reference trust A. At 90 days, seven of the eight had lower mortality and after one year all eight had significantly reduced rates compared to trust A.

Tables 6.3 and 6.4 show that the CFRs with diabetes as the underlying cause of death or anywhere on the death certificate were much lower than those for mortality due to all causes. It is apparent that the significant differences in CFRs with the reference trust A become more widespread with increased duration of follow-up. However, the inclusion of diabetes on death certificates can be somewhat arbitrary. All cause mortality may thus form a more reliable basis for calculating diabetes case fatality rates.

Table 6.2 Case fatality rates: admissions for diabetes, all causes of death (1994-1998)

Trust	Died anywhere				Died in hospital			
	CFR (30 days)	Odds Ratio to A (95% CI)	CFR (90 days)	Odds Ratio to A (95% CI)	CFR (365 days)	Odds Ratio to A (95% CI)	CFR (30 days)	Odds ratio to A (95% CI)
A	8.7%	(Reference)	14.4%	(Reference)	25.1%	(Reference)	6.4%	(Reference)
B	9.1%	0.84 (0.69-1.03)	14.9%	0.82* (0.70-0.97)	24.8%	0.75*** (0.65-0.87)	7.0%	0.86 (0.68-1.08)
C	7.3%	0.80** (0.67-0.95)	11.7%	0.75*** (0.66-0.87)	19.3%	0.67*** (0.59-0.75)	2.4%	0.34*** (0.27-0.44)
D	6.2%	0.59*** (0.51-0.69)	11.9%	0.68*** (0.60-0.76)	22.1%	0.70*** (0.63-0.77)	4.4%	0.57*** (0.48-0.68)
E	7.2%	0.68*** (0.56-0.82)	12.6%	0.70*** (0.61-0.82)	21.2%	0.63*** (0.55-0.72)	5.4%	0.68*** (0.55-0.85)
F	6.4%	0.60*** (0.52-0.69)	11.6%	0.64*** (0.57-0.71)	22.1%	0.67*** (0.61-0.73)	4.7%	0.59*** (0.51-0.70)
G	8.8%	0.88 (0.76-1.03)	13.8%	0.82** (0.72-0.93)	23.1%	0.76*** (0.68-0.85)	6.6%	0.88 (0.74-1.05)
H	9.3%	0.95 (0.81-1.11)	15.0%	0.91 (0.80-1.04)	25.5%	0.86** (0.77-0.96)	6.7%	0.91 (0.76-1.09)
I	5.7%	0.54*** (0.46-0.62)	10.3%	0.56*** (0.50-0.63)	18.3%	0.52*** (0.47-0.58)	3.8%	0.48*** (0.40-0.56)

Notes

All case fatality rates are unadjusted for sex and age group

All odds ratios are adjusted for sex and age group

* denotes a significant odds ratio at the 5% level, ** at the 1% level and *** at the 0.1% level

Table 6.3 Case fatality rates: admissions for diabetes, diabetes as any cause of death (1994-1998)

Trust	Died anywhere				Died in hospital			
	CFR (30 days)	Odds Ratio to A (95% CI)	CFR (90 days)	Odds Ratio to A (95% CI)	CFR (365 days)	Odds Ratio to A (95% CI)	CFR (30 days)	Odds ratio to A (95% CI)
A	3.6%	(Reference)	6.8%	(Reference)	13.2%	(Reference)	2.4%	(Reference)
B	3.2%	0.73* (0.53-1.00)	5.2%	0.61*** (0.48-0.79)	9.8%	0.59*** (0.49-0.71)	2.7%	0.89 (0.62-1.27)
C	4.0%	1.11 (0.87-1.40)	6.4%	0.91 (0.76-1.09)	10.0%	0.71*** (0.61-0.83)	1.1%	0.42*** (0.29-0.61)
D	3.0%	0.74** (0.60-0.91)	5.9%	0.76*** (0.65-0.89)	10.9%	0.71*** (0.63-0.80)	2.2%	0.81 (0.63-1.04)
E	4.9%	1.20 (0.94-1.53)	8.2%	1.05 (0.87-1.27)	12.7%	0.81* (0.70-0.95)	3.7%	1.32 (0.99-1.76)
F	2.9%	0.68*** (0.55-0.83)	5.2%	0.64*** (0.55-0.75)	10.2%	0.63*** (0.56-0.71)	2.2%	0.76* (0.60-0.97)
G	4.7%	1.18 (0.95-1.46)	6.9%	0.90 (0.76-1.07)	11.6%	0.77*** (0.67-0.88)	3.4%	1.24 (0.96-1.61)
H	4.2%	1.06 (0.84-1.33)	6.9%	0.91 (0.76-1.08)	11.4%	0.75*** (0.65-0.86)	3.3%	1.21 (0.92-1.58)
I	3.4%	0.82* (0.67-1.00)	5.1%	0.77*** (0.66-0.89)	10.5%	0.66*** (0.58-0.75)	2.3%	0.82 (0.64-1.04)

Notes

All CFRs are unadjusted for sex and age group

All odds ratios are adjusted for sex and age group

* denotes significance at 5% level, ** at 1% level and *** at 0.1* level

Table 6.4 Case fatality rates: admissions for diabetes, diabetes as underlying cause of death (1994-1998)

Trust	Died anywhere			Died in hospital				
	CFR (30 days)	Odds Ratio to A (95% CI)	CFR (90 days)	Odds Ratio to A (95% CI)	CFR (365 days)	Odds Ratio to A (95% CI)	CFR (30 days)	Odds ratio to A (95% CI)
A	1.5%	(Reference)	2.8%	(Reference)	6.0%	(Reference)	1.0%	(Reference)
B	1.2%	0.67 (0.40-1.11)	2.1%	0.62* (0.42-0.91)	3.7%	0.53*** (0.40-0.71)	1.0%	0.88 (0.50-1.57)
C	1.4%	0.89 (0.61-1.29)	2.1%	0.71* (0.53-0.96)	2.9%	0.47*** (0.36-0.60)	0.5%	0.55* (0.32-0.95)
D	0.8%	0.47*** (0.33-0.66)	1.5%	0.48*** (0.38-0.63)	3.2%	0.49*** (0.40-0.59)	0.6%	0.57** (0.38-0.87)
E	1.5%	0.88 (0.59-1.32)	2.6%	0.81 (0.60-1.10)	3.5%	0.50*** (0.39-0.65)	1.3%	1.16 (0.73-1.85)
F	0.9%	0.54*** (0.39-0.75)	1.6%	0.50*** (0.39-0.64)	3.0%	0.45*** (0.37-0.54)	0.7%	0.63* (0.42-0.94)
G	1.6%	1.01 (0.72-1.42)	2.2%	0.71* (0.55-0.93)	3.9%	0.58*** (0.47-0.72)	1.2%	1.15 (0.76-1.73)
H	1.3%	0.81 (0.56-1.17)	2.3%	0.74* (0.56-0.98)	3.6%	0.55*** (0.43-0.68)	1.1%	1.06 (0.69-1.64)
I	0.8%	0.46*** (0.33-0.64)	1.6%	0.49*** (0.38-0.63)	2.5%	0.37*** (0.31-0.46)	0.6%	0.55** (0.37-0.83)

Notes

All case fatality rates are unadjusted for sex and age group

All odds ratios are adjusted for sex and age group

* denotes a significant odds ratio at the 5% level, ** at the 1% level and *** at the 0.1% level

7. ASTHMA ILLUSTRATIVE VALUES

Methods

The indicator definition recommended in the Report is: *the proportion of in-patients with a diagnosis of asthma who die within 30 days of their admission*. The ICD code used was ICD-9 493.

The objectives of the study were to:

- Analyse using the recommended indicator specification:
 - age/sex group differences
 - differences between hospital trusts.
- Identify the specific effect of changing the indicator definition on hospital comparisons.

The illustrative indicator values are based on the Oxford Record Linkage Study data for the five years starting 1 January 1994, except for the 365 day case fatality rates for which the period ended 31 March 1998.

For the purposes of this analysis data have been obtained for the eight major trusts (A to H) and a residual category containing the data for smaller trusts (I) on the system. The admissions included are all those with asthma listed anywhere in the hospital admission record.

The case fatality rate (CFR) has been calculated 18 different ways using cases that died:

- in hospital or those that died anywhere
- within 30, 90 or 365 days of admission
- from all causes, with asthma as underlying cause of death or asthma anywhere on the death certificate.

For the trust comparisons logistic regression modelling has been used to adjust for age group and sex. Resultant odds ratios of trusts B to I relative to a reference trust A are presented together with 95% confidence intervals and indicators of statistical significance.

Results

Table 7.1 shows age/sex breakdowns for asthma CFRs for all causes of death calculated in four different ways. About 60% of the 37,000 admissions were female. Admissions were much more common in the younger age groups. CFRs were comparable or slightly higher among women.

Table 7.1 Case fatality rates by age group and sex: admissions for asthma, all causes of death (1994-1998)

Age	Deaths in hospital	Deaths anywhere			Total admissions
	CFR (30 days)	CFR (30 days)	CFR (90 days)	CFR (365 days)	
Men:					
< 40	0.1%	0.1%	0.1%	0.6%	9,758
40-44	0.2%	1.0%	2.0%	6.6%	408
45-49	1.8%	2.2%	3.0%	5.0%	494
50-54	0.9%	1.3%	2.9%	5.1%	456
55-59	1.2%	2.1%	3.6%	6.9%	563
60-64	1.7%	3.2%	5.2%	9.7%	537
65-69	2.2%	3.7%	6.4%	14.2%	592
70-74	3.9%	5.8%	8.7%	17.8%	620
75-79	2.2%	3.8%	8.0%	18.2%	497
80-84	7.7%	11.5%	16.7%	30.2%	287
85-89	10.6%	17.0%	25.5%	42.2%	141
90 +	6.9%	6.9%	31.0%	57.1%	29
All ages	0.9%	1.3%	2.2%	4.5%	14,382
Women:					
< 40	0.1%	0.1%	0.2%	0.6%	9,514
40-44	0.2%	0.5%	0.8%	1.2%	599
45-49	0.4%	0.9%	1.5%	3.3%	936
50-54	0.6%	0.6%	1.6%	4.1%	889
55-59	0.9%	2.2%	2.8%	6.3%	777
60-64	1.7%	3.5%	5.3%	8.8%	749
65-69	1.3%	2.3%	4.4%	11.7%	815
70-74	2.3%	3.5%	7.0%	17.4%	831
75-79	4.2%	6.2%	10.6%	22.1%	689
80-84	5.8%	9.0%	14.8%	25.3%	500
85-89	7.3%	8.9%	16.9%	32.8%	313
90 +	4.7%	14.1%	23.4%	42.6%	128
All ages	0.9%	1.5%	2.6%	5.5%	16,740

Table 7.2 shows asthma CFRs and Odds Ratios (OR) to Trust A for all causes of death, calculated in four different ways.

Table 7.3 shows asthma CFRs and ORs when asthma is recorded anywhere on the death certificate, calculated in four different ways.

Table 7.4 shows asthma CFRs and ORs when asthma is only recorded as the underlying cause of death, calculated in four different ways.

In Table 7.2 for all cause mortality it is clear that the significant contrasts at 30 and 90 days were different to those after one year.

In Tables 7.3 and 7.4, when asthma is considered as the underlying cause of death or anywhere on the death certificate, the CFRs became extremely low. It is unsurprising, therefore, that significant variations between the respective trusts are difficult to detect.

Table 7.2 Case fatality rates: admissions for asthma, all causes of death (1994-1998)

Trust	Died anywhere			Died in hospital				
	CFR (30 days)	Odds Ratio to A (95% CI)	CFR (90 days)	Odds Ratio to A (95% CI)	CFR (365 days)	Odds Ratio to A (95% CI)	CFR (30 days)	Odds ratio to A (95% CI)
A	2.4%	(Reference)	3.7%	(Reference)	6.4%	(Reference)	1.6%	(Reference)
B	0.4%	0.22* (0.07-0.70)	1.3%	0.47* (0.24-0.93)	2.6%	0.51** (0.31-0.84)	0.1%	0.12* (0.02-0.85)
C	1.9%	1.20 (0.81-1.79)	2.7%	1.12 (0.80-1.57)	5.8%	1.35* (1.04-1.76)	0.9%	0.87 (0.51-1.47)
D	1.5%	0.79 (0.56-1.12)	2.6%	0.91 (0.69-1.20)	4.9%	0.96 (0.76-1.21)	1.1%	0.87 (0.58-1.32)
E	1.5%	0.52* (0.32-0.86)	2.5%	0.56** (0.37-0.83)	4.3%	0.54*** (0.39-0.75)	0.9%	0.48* (0.26-0.90)
F	1.2%	0.51*** (0.36-0.71)	2.0%	0.56*** (0.42-0.73)	4.3%	0.71** (0.58-0.88)	0.6%	0.39*** (0.25-0.60)
G	1.2%	0.73 (0.48-1.13)	1.0%	0.83 (0.58-1.17)	3.7%	0.84 (0.64-1.12)	0.8%	0.77 (0.46-1.30)
H	0.9%	0.55** (0.35-0.85)	1.7%	0.63** (0.44-0.89)	3.8%	0.80 (0.62-1.05)	0.6%	0.54* (0.31-0.93)
I	1.7%	0.54*** (0.37-0.78)	3.2%	0.67** (0.50-0.89)	9.1%	1.14 (0.91-1.43)	1.2%	0.61* (0.40-0.93)

Notes

All case fatality rates are unadjusted for sex and age group

All odds ratios are adjusted for sex and age group

* denotes a significant odds ratio at the 5% level, ** at the 1% level and *** at the 0.1% level

Table 7.3 Case fatality rates: admissions for asthma, asthma as any cause of death (1994-1998)

Trust	Died anywhere			Died in hospital				
	CFR (30 days)	Odds Ratio to A (95% CI)	CFR (90 days)	Odds Ratio to A (95% CI)	CFR (365 days)	Odds Ratio to A (95% CI)	CFR (30 days)	Odds ratio to A (95% CI)
A	0.4%	(Reference)	0.5%	(Reference)	0.8%	(Reference)	0.3%	(Reference)
B	0.4%	1.22 (0.34-4.41)	0.6%	1.71 (0.60-4.86)	0.8%	1.16 (0.46-2.92)	0.1%	0.57 (0.07-4.59)
C	0.6%	2.08 (0.96-4.54)	0.8%	2.35* (1.16-4.74)	0.9%	1.35 (0.72-2.54)	0.3%	1.41 (0.53-3.80)
D	0.3%	0.79 (0.36-1.73)	0.3%	0.83 (0.41-1.69)	0.7%	1.05 (0.61-1.84)	0.2%	0.92 (0.38-2.24)
E	0.2%	0.40 (0.11-1.45)	0.3%	0.57 (0.20-1.62)	0.6%	0.67 (0.30-1.53)	0.1%	0.37 (0.08-1.74)
F	0.3%	0.70 (0.34-1.46)	0.3%	0.71 (0.36-1.38)	0.6%	0.76 (0.45-1.31)	0.2%	0.52 (0.21-1.27)
G	0.5%	1.57 (0.70-3.48)	0.6%	1.80 (0.88-3.69)	1.3%	2.26** (1.30-3.92)	0.4%	1.73 (0.69-4.33)
H	0.2%	0.73 (0.29-1.83)	0.3%	0.85 (0.38-1.92)	0.4%	0.61 (0.30-1.24)	0.2%	0.87 (0.31-2.43)
I	0.2%	0.31* (0.12-0.80)	0.3%	0.52 (0.24-1.12)	0.8%	0.78 (0.43-1.42)	0.1%	0.38 (0.13-1.11)

Notes

All case fatality rates are unadjusted for sex and age group

All odds ratios are adjusted for sex and age group

* denotes a significant odds ratio at the 5% level, ** at the 1% level and *** at the 0.1% level

Table 7.4 Case fatality rates: admissions for asthma, asthma as underlying cause of death (1994-1998)

Trust	Died anywhere					Died in hospital						
	CFR (30 days)	Odds Ratio to A (95% CI)		CFR (90 days)	Odds Ratio to A (95% CI)		CFR (365 days)	Odds Ratio to A (95% CI)		CFR (30 days)	Odds ratio to A (95% CI)	
A	0.2%	(Reference)		0.2%	(Reference)		0.4%	(Reference)		0.2%	(Reference)	
B	0.4%	2.41	(0.57-10.2)	0.5%	2.61	(0.73-9.35)	0.5%	1.33	(0.42-4.22)	0.1%	0.82	(0.10-7.08)
C	0.4%	2.47	(0.84-7.30)	0.6%	2.91*	(1.11-7.64)	0.6%	1.57	(0.70-3.52)	0.2%	0.98	(0.26-3.68)
D	0.1%	0.55	(0.16-1.90)	0.1%	0.53	(0.17-1.65)	0.3%	0.80	(0.36-1.77)	0.1%	0.54	(0.16-1.89)
E	0.1%	0.30	(0.04-2.62)	0.1%	0.52	(0.11-2.58)	0.3%	0.67	(0.21-2.11)	0.1%	0.30	(0.04-2.59)
F	0.2%	1.13	(0.41-3.07)	0.3%	1.11	(0.44-2.77)	0.4%	0.91	(0.45-1.86)	0.1%	0.52	(0.17-1.60)
G	0.3%	1.91	(0.62-5.88)	0.4%	2.41	(0.90-6.47)	0.9%	2.77**	(1.34-5.73)	0.2%	1.71	(0.54-5.42)
H	0.2%	1.11	(0.34-3.67)	0.2%	1.24	(0.43-3.60)	0.3%	0.82	(0.34-1.99)	0.1%	0.93	(0.27-3.25)
I	0.0%	0.20	(0.04-1.05)	0.1%	0.41	(0.13-1.36)	0.5%	1.00	(0.45-2.18)	0.0%	0.21	(0.04-1.08)

Notes

All case fatality rates are unadjusted for sex and age group

All odds ratios are adjusted for sex and age group

* denotes a significant odds ratio at the 5% level, ** at the 1% level and *** at the 0.1% level

8. CONCLUSIONS

Age group/sex analyses

For *myocardial infarction* there were over 18,000 admissions of which 64% were men. CFRs increased sharply with age for both sexes and tended to be higher among women except in the over 90s.

Similar patterns are evident for *coronary heart disease*. Of the 95,000 admissions 65% were male. CFRs also increased sharply with age and tended to be higher among women in the younger age groups under 70.

The 35,000 admissions for *stroke* were evenly divided between the sexes. The total CFRs were higher among women. However, the age-specific CFRs were higher in men in the younger age groups under 50.

Of the 14,000 admissions for *fractured femur*, 74% were for women. Over 70% of admissions were for the over 75s where the age-specific CFRs were about twice as high among men.

For *diabetes* 60% of the 58,000 admissions were for males. The age-specific CFRs increased with age and were comparable or slightly higher among women.

For *asthma* 62% of the 37,000 admissions were for women. The age-specific CFRs were comparable or slightly higher among women.

Hospital comparisons

Hospital comparisons have been made using CFRs calculated in 18 different ways with the factors involved being:

- place of death - in hospital or anywhere
- time interval between admission and death - 30, 90 or 365 days
- cause of death – all causes, condition specific anywhere on the certificate, condition specific being underlying cause of death.

All cause 30 day CFRs for admissions due to *myocardial infarction* ranged from 17.1% for trust C up to 23.9% for trust D. At 90 days and 365 days, similar degrees of variation in fatality rates were apparent with trust C still exhibiting the lowest fatality rate and trust D the highest.

For all cause in-hospital CFRs trust C still had the lowest rate and D the highest, although it should be noted that the extremely low in-hospital fatality rate in trust C (7.8%) was due to hospital coding inaccuracy, a problem particular to this trust.

Any interpretation of trust performance based upon crude CFRs may well be grossly misleading since they take no account of any possible age and sex differentials in the populations of patients admitted to the respective trusts. It is important that known confounding factors such as age group and sex are accounted for in any comparative analysis of trust CFRs.

In this study, logistic regression modelling has been employed to control for age group and sex. The results of fitted models for each of the CFRs are presented in terms of odds ratios of trusts B, C, D, E, F, G, H and I relative to a baseline or reference category, trust A. In other words, the odds ratios illustrate any increased or decreased fatality risk, after taking into account age group and sex differentials in patients admitted, that is associated with the various trusts relative to the index trust A.

For all cause 30 day CFRs only two trusts (B and D) fared significantly worse than the reference trust A. By 90 days the results showed that there were three trusts (B, D and F) which had significantly increased fatality rates when compared to the reference trust A. After one year of follow-up, while trust B no longer had significantly elevated mortality compared to A, trusts D and F had been joined by E as the trusts with increased CFRs. For in-hospital mortality B, C and D were the three trusts with significantly increased fatality rates relative to trust A.

Hence, the analysis using four different definitions of a CFR has led to the identification of different groups of trusts which perform significantly worse than the reference trust. However, it should be remembered that the in-hospital mortality findings for trust C are inaccurate.

Similar findings emerged for the CFRs where myocardial infarction constituted the underlying cause of death. While the same four hospitals trusts (B, D, E and F) were shown to have significantly increased fatality rates at 30 and 90 days, by one year there were seven trusts with increased mortality. The comparison of in-hospital mortality identified five trusts with elevated fatality rates relative to trust A.

Where myocardial infarction was listed anywhere on the death certificate, similar findings to those for MI as underlying cause were apparent although after one year of follow-up there were six, rather than seven trusts, which had significantly increased mortality when compared with trust A.

These results demonstrate that the findings from this comparison of fatality rates due to myocardial infarction vary according to the definition of CFR used. Not only do the findings differ according to the length of follow-up, or whether deaths outside hospital are traced and included with those inside, but also according to whether deaths from all causes are included or whether the definition is based only upon myocardial infarction as the underlying or any cause of death on the death certificate.

This analysis was replicated for *coronary heart disease* (CHD). In this case, the findings, which are based upon a much larger total number of admissions (95,000 in five years), are more consistent. In all logistic regression models, irrespective of the definition of the CFR employed, significantly increased levels of mortality were apparent for each of trusts B, C, D, E, F, G and H relative to trust A, while trust I was found to exhibit significantly reduced case fatality rates.

Nonetheless, the magnitude of many of the case fatality odds ratios with reference to trust A varied according to the particular definition of CFR used. For example, some trusts showed evidence of increasing mortality risks over time relative to trust A, while others showed relative improvements over time.

All cause in-hospital CFRs for *stroke* showed that two trusts (B and G) had significantly

increased fatality rates relative to A, while three (E, F and I; excluding trust C with erroneous in-hospital mortality coding) had reduced mortality. Similar patterns were apparent at 30 and 90 days. After one year, trust F no longer had a significantly increased fatality rate, but trust H had emerged with increased mortality.

A similar pattern occurs for CFRs calculated with stroke anywhere on the death certificate or as the underlying cause. Three trusts (B, G and H) had a significantly increased mortality for all time periods. Trusts E, F and I had significantly lower 30 day CFRs but only trust I had a lower CFR for all time periods. The significant CFR differences tended to decrease with longer periods of follow-up.

All cause in-hospital CFRs for *fractured femur* show that five trusts had significantly reduced mortality when compared to A. The all cause 30 day CFRs show that all eight trusts had lower fatality rates than A. By 90 and 365 days, only one trust (I) differed significantly from A.

The CFRs calculated with fractured femur as the underlying cause of death or anywhere on the death certificate were much lower than for all cause mortality. It is important to note that the inclusion of fractured femur as a cause of death on death certificates can be somewhat arbitrary and is, therefore, liable to vary between deaths registering sources and hospital trusts. Hence, even though significant contrasts between the respective trusts are apparent, this may well be somewhat artefactual.

All cause CFRs for *diabetes* showed large increases with longer periods of follow-up. At 30 days, for both in-hospital deaths and all deaths, five of the eight trusts had significantly lower fatality rates than the reference trust A. Seven had lower mortality at 90 days and after one year all eight had significantly reduced rates in comparison to trust A.

The CFRs calculated with diabetes as the underlying cause of death or anywhere on the death certificate were much lower than for all cause mortality. It is again apparent that significant differences in CFRs with respect to the reference trust A become more widespread with increased duration of follow-up. However, as with fractured femur the inclusion of diabetes on death certificates can be somewhat arbitrary and all cause mortality is likely to form a more reliable basis for defining CFRs for this condition.

The CFRs for *asthma* were much lower than for the other conditions. For all cause mortality, it is clear that the significant differences at 30 and 90 days varied from those after one year. When asthma was considered as the underlying cause of death or anywhere on the death certificate, the CFRs became extremely low and few statistically significant findings were detected.

Summary

This report has presented an analysis of CFRs for six conditions in the Oxford Region over the five year period, 1994 to 1998. Five of the conditions have been the subject of health outcome reports published previously by NCHOD. The main aim of the work has been to illustrate how varying the definition of a case fatality rate can affect the results of a comparative hospital-based mortality analysis.

The CFRs were variably defined on three counts. Firstly, to include only those deaths where the given indicator constituted the underlying cause of death, or those where it was listed anywhere

on the death certificate, or to comprise deaths from all causes. Secondly, the duration of follow-up time subsequent to the hospital admission was varied between 30, 90 and 365 days. Thirdly, since the analysis was based on record linkage data, it was possible to include deaths which arose outside hospital, as well as the in-hospital fatalities upon which hospital fatality rates are normally based.

When comparisons were made between the respective trusts, after adjusting for age and sex differentials, it has been established that the particular definition of the CFR greatly affected which trusts were identified as having significantly increased or decreased fatality rates.

The inclusion of certain conditions, such as fractured femur and diabetes, on death certificates can vary between deaths registering sources and trusts. For such conditions all cause CFRs may be more reliable, particularly in the context of trust-based comparative analyses.