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EXECUTIVE SUMMARY

This report brings together the results of studies completed by NCHOD over the last three years and makes recommendations about the most robust methods for calculating for acute myocardial infarction (AMI):

- Case-fatality rates (CFR).
- Population-based mortality measures.
- Incidence measures.

Case fatality rate

It is proposed that to calculate a ‘basic’ CFR for AMI the following should be noted:

- For the number of admissions to be used as denominator:
  - continuous in-patient spell to be counting unit
  - only emergency admissions to be included
  - diagnostic code to be used I21 in ICD 10
  - diagnostic code to be included if appearing as principal diagnosis.

- For the number of deaths to be used as numerator:
  - source of data to be death certification
  - all causes of death to be included not just AMI either as underlying cause or mention anywhere on the certificate
  - location of death to be anywhere not solely hospital
  - time interval from admission to death to be 30 days.

- For comparative review CFRs should be age standardised and presented separately for each sex.

- Given current admission rates to a hospital of typical size, annual information will only detect differences between hospitals for a relative risk of 1.5. Information will probably need to be calculated for three-year periods to provide useful comparisons.

The most clinically relevant way of compiling CFRs for comparative hospital performance is probably to start with the basic CFR and then exclude:

- admissions misdiagnosed as AMI
- deaths occurring on day 0.

Whilst gaining understanding of these issues it is useful to compare CFRs calculated as:

- basic CFR
- basic CFR less misdiagnosed admissions
- basic CFR less misdiagnosed admissions and deaths occurring on day 0.
Population based mortality

It is proposed that to calculate a ‘basic’ population-based mortality rate for AMI the following should be noted:

- ICD codes to be used I21 and I22 in ICD 10.
- As there were few deaths for which AMI was not the underlying cause, diagnosis could be either underlying cause or mention anywhere on the certificate. However, a calculation using AMI as underlying cause is to be preferred.
- Rates should be age standardised and presented separately for each sex.

The preferred way of presenting population-based mortality rates is to show deaths in hospital and outside hospitals separately.

Incidence measures

It is proposed that to calculate a ‘basic’ admission-based incidence rate for AMI the following should be noted:

- Multiple admissions in the year account for only a small proportion of total admissions so person-based data add little extra information.
- Rates should be age standardised and presented separately for each sex.

It should be noted that hospital admissions and the deaths outside hospital contributed most to the overall incidence of AMI.

The preferred way of calculating incidence is thus to:

- include hospital admissions and deaths outside hospital
- exclude admissions occurring within 30 days of a previous admission, as these are commonly attributed to being associated with the initial admission.

Conclusion

These studies using linked HES/mortality data show the difficulties of calculating AMI outcome indicators and interpreting what the comparative information derived from them means. From these studies it is clear that to compare hospital performance using a single indicator of AMI case fatality rates will be unhelpful and, in many cases, misleading.

These studies have not addressed the important issue of the use of troponins as a diagnostic test. This change, which is being implemented in an increasing number of hospitals, is also having major effects on the interpretation of comparative information about acute myocardial infarction.
1. OVERVIEW

Introduction

Over the last three years the National Centre for Health Outcomes Development (NCHOD) has been commissioned by the Department of Health to carry out a number of studies on the calculation and use of health outcome indicators for acute myocardial infarction (AMI) derived from hospital episode statistics (HES) and data on death certificates.

This report brings together the results of those studies completed by July 2000 and makes recommendations about the most robust methods for calculating for AMI:

- Case-fatality rates (CFR).
- Population-based mortality measures.
- Incidence measures.

Case-fatality rates

Superficially, acute myocardial infarction case-fatality rates are a leading candidate for a comparative health outcome indicator. The condition is common, treatable and there are a considerable number of deaths associated with it.

In practice calculating a clinically relevant CFR for AMI is extremely difficult because of issues relating to:

- compilation of a CFR for any condition
- issues specific to AMI.

The issues common to the compilation of any CFR relate to:

- The definition of admission used for the denominator:
  - finished consultant episodes or continuous in-patient spells
  - emergency, elective or all admissions
  - diagnostic codes to be used
  - principal diagnosis only or diagnosis anywhere on admission record.

- The definition of death used for the numerator:
  - source of data, HES or death certification
  - diagnostic coding, underlying cause or anywhere on the certificate
  - diagnostic codes to be used
  - location of death, in hospital or outside
  - time interval from start of admission to death.

- Need to consider the effect of statistical confounders.
- Need to consider issues of statistical power.
The issues specific to the compilation of a CFR for AMI relate to:

- The diagnosis of AMI:
  - Recent adoption of a new enzyme test, troponin, has led to a significant increase in the diagnosis of AMI with the additional patients having a much milder condition and thus lower risk of death than those diagnosed with the old test.
  - Significant numbers of patients thought originally to have had a clinical AMI on admission may not have had one.

- The deaths to be included:
  - Death from AMI may happen quickly after the onset of symptoms, occurring before arriving at hospital.
  - Death may occur in hospital before a record has been entered on the patient administration system.

The natural history of death from AMI shows that between 50 and 70% of all people who die in the acute attack die outside hospital. An individual hospital’s CFR rates are thus greatly influenced by:

- referral patterns
- speed with which patients are transported to hospital
- speed with which they are formally admitted and thus appear on HES.

NCHOD has been engaged on an extensive programme to research those issues that can be resolved by the use of the Oxford Record Linkage Study (ORLS) database.

From the work done to date, it is proposed that to calculate a ‘basic’ CFR for AMI the following should be noted:

- For the number of admissions to be used as denominator:
  - continuous in-patient spell to be counting unit
  - only emergency admissions to be included
  - diagnostic code to be used I21 in ICD 10
  - diagnostic code to be included if appearing as principal diagnosis on record.

- For the number of deaths to be used as numerator:
  - source of data to be death certification (see Study 1)
  - all causes of death to be included not just AMI either as underlying cause or mention anywhere on the certificate (see Studies 2 and 3)
  - location of death to be anywhere not solely hospital (see Study 4)
  - time interval from admission to death to be 30 days (see Study 4).

- For comparative review CFRs should be age standardised and presented separately for each sex (see Study 5).

- Given current admission rates to a hospital of typical size, annual information will only detect differences between hospitals for a relative risk of 1.5 (see Study 6). Information will probably need to be calculated for three year periods to provide useful comparisons.
Work has also been done on some of the CFR issues specific to AMI and information has been produced to show the effect of:

- Removing from the basic CFR definition (see Study 7):
  - admissions misdiagnosed as AMI
  - deaths occurring early in the stay that might not be attributable to the hospital care.

- Adding to the definition of the basic CFR indicator (see Study 8):
  - deaths of patients arriving at the hospital but dying before being admitted.

From the work to date, the most clinically relevant way of compiling CFRs for comparative hospital performance is probably to start with the basic CFR and then exclude:

- admissions misdiagnosed as AMI
- deaths occurring on day 0.

Whilst gaining understanding of these issues it is useful to compare CFRs calculated as:

- basic CFR
- basic CFR less misdiagnosed admissions
- basic CFR less misdiagnosed admissions and deaths occurring on day 0.

**Population-based mortality**

A population-based indicator of mortality can be used to monitor the overall effectiveness of health services serving a specific population. Methods of calculation of a measure for AMI must take into account issues relating to:

- compilation of mortality rates for any condition
- issues specific to AMI.

The issues common to the compilation of any population-based mortality relate to:

- Diagnostic coding from death certificates:
  - ICD codes to be used
  - use of underlying cause only or include diagnosis mentioned anywhere on the certificate
- Need to consider the effect of statistical confounders.

In addition to the general issues relevant to CFRs, those specific to the compilation of incidence or population-based mortality rates for AMI relate to:

- about 30% of cases have no symptoms
- most sudden deaths outside hospital are due to AMI
- significant numbers of patients admitted to hospital with other conditions who die in hospital have AMI put on their death certificate.
NCHOD has been engaged on an extensive programme to research those issues that can be resolved by the use of the Oxford Record Linkage Study (ORLS) database. From the work done to date, it is proposed that to calculate a ‘basic’ population-based mortality rate for AMI the following should be noted:

- ICD codes to be used I21 and I22 in ICD 10.
- As there were few deaths for which AMI was not the underlying cause, diagnosis could be either underlying cause or mention anywhere on the certificate. However, a calculation using AMI as underlying cause is to be preferred (see Study 9).
- Rates should be age standardised and presented separately for each sex.

Work has also been done on some of the mortality issues specific to AMI and information has been produced to show that:

- About half of all deaths recorded on the death certificate as occurring from AMI occurred in hospital (see Study 10).
- Of the deaths occurring in hospital (see Study 11):
  - 45% were in an admission with a diagnosis of AMI
  - 25% were in an admission for IHD, rising to 28% in those 75 and over
  - 14% were in an admission for conditions other than AMI or IHD
  - 16% were in people who had not been formally admitted, rising to 23% of those under 75.
- Of the deaths occurring outside hospital (see Study 12):
  - 95% were deaths in people with no admission in the previous 30 days
  - 5% were due to people with an admission in the previous 30 days.

From the work done to date, the preferred way of presenting population-based mortality rates is to show deaths in hospital and outside hospitals separately.

**Incidence**

An indicator of AMI occurrence can be used to monitor the effectiveness of health promotion and preventative measures. For many conditions needing hospital admission their incidence can be calculated from the number of hospital admissions. This can be in terms of:

- first-ever admissions for an individual
- first admissions during a year for an individual (person-based admission rates)
- all admissions in a year made for the condition (event-based admission rates).

In addition to the general issues relevant to the determination of incidence, those specific to the compilation of incidence for AMI relate to events other than admissions for AMI:

- Deaths due to AMI occurring in hospital before a record has been entered on the patient administration system.
- Sudden deaths outside hospital due to AMI.
- Patients admitted with other conditions have their deaths in hospital recorded as AMI.
NCHOD has been engaged on an extensive programme to research those issues that can be resolved by the use of the Oxford Record Linkage Study (ORLS) database.

From the work done to date (see Study 13), it is proposed that to calculate a ‘basic’ admission-based incidence rate for AMI the following should be noted:

- Multiple admissions in the year account for only a small proportion of total admissions so person-based data add little extra information.
- Rates should be age standardised and presented separately for each sex.

Information has been produced (see Study 14) to show the effect of adding the additional events suggestive of the occurrence of AMI to the hospitalised incidence calculated from admission rates. The events are:

- Hospital-associated deaths. These are identified from death certificates that specify that a death from AMI occurred in hospital but there is no corresponding record for the admission. This is a measure of the patients arriving at the hospital but dying of AMI before being formally admitted.
- Deaths in hospital as identified from death certificates due to AMI with a corresponding admission for a condition other than AMI. This is a measure of patients admitted to hospital with another condition but dying of AMI.
- Deaths outside hospital as identified from death certificates due to AMI without an admission for AMI in the previous 30 days. This is a measure of the sudden deaths from AMI who never reach hospital.

From the work done to date, it should be noted that hospital admissions and the deaths outside hospital contributed most to the overall incidence of AMI.

The preferred way of calculating incidence is thus to:

- include hospital admissions and deaths outside hospital
- exclude admissions occurring within 30 days of a previous admission, as these are commonly attributed to being associated with the initial admission.
2. CASE FATALITY RATES: STUDIES 1-8

Study 1: AMI death counts from HES and certification

In this study for each hospital in the database comparisons were made between:

- deaths due to AMI recorded on HES
- deaths due to AMI occurring in the hospital as shown by death certificates.

The number of people who died from AMI in each hospital as recorded in HES was expressed as a percentage of the number certified as dying on a death certificate. The ratio of HSE:death certificate recording for each hospital is shown in Exhibit 1 and it varied between 37.7 and 60.0%. Also shown in Exhibit 1 are the case fatality rates and subsequent hospital rankings for:

- CFR 1 with HES deaths as numerator and HES deaths plus live discharges as denominator
- CFR 2 with certificate deaths as numerator and deaths on certificates and live discharges as denominator.

The hospital rankings varied considerably depending on the CFR measure used.

As certification is the more robust method of data collection, the preferred method of calculating CFRs for AMI should involve deaths recorded on death certificates.

Exhibit 1 Ratio of HES: death certificates and CFRs calculated in two different ways

<table>
<thead>
<tr>
<th>Hospital trust</th>
<th>HES/DC %</th>
<th>CFR 1 and rank</th>
<th>CFR 2 and rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>All 8 hospital trusts</td>
<td>45.0</td>
<td>17.2</td>
<td>31.6</td>
</tr>
<tr>
<td>Oxford Radcliffe</td>
<td>44.8</td>
<td>16.8 (2)</td>
<td>31.0 (4)</td>
</tr>
<tr>
<td>Kettering GH</td>
<td>37.8</td>
<td>11.0 (1)</td>
<td>24.6 (1)</td>
</tr>
<tr>
<td>Northampton</td>
<td>42.3</td>
<td>19.6 (7)</td>
<td>36.6 (8)</td>
</tr>
<tr>
<td>Amersham &amp; Wycombe</td>
<td>56.7</td>
<td>22.0 (8)</td>
<td>33.2 (6)</td>
</tr>
<tr>
<td>Stoke Mandeville</td>
<td>60.0</td>
<td>18.2 (6)</td>
<td>27.0 (2)</td>
</tr>
<tr>
<td>Milton Keynes GH</td>
<td>43.6</td>
<td>17.0 (3)</td>
<td>32.0 (5)</td>
</tr>
<tr>
<td>Royal Berks &amp; Battle</td>
<td>48.4</td>
<td>17.6 (5)</td>
<td>30.6 (3)</td>
</tr>
<tr>
<td>Heatherwood &amp; Wexham Park</td>
<td>37.7</td>
<td>17.2 (4)</td>
<td>35.5 (7)</td>
</tr>
</tbody>
</table>

Note: Analyses of all causes of death minus AMI for the corresponding time period and hospitals showed that there were 71,799 deaths from hospital statistics and 77,627 from death certificate data (HS/DC, % = 92.5%).
Study 2: AMI CFRs calculated using underlying cause of death or mention anywhere on death certificate

In this study 30-day CFRs for AMI were calculated using:

- all deaths with AMI as the underlying diagnosis on the certificate
- all deaths with AMI mentioned anywhere on the certificate
- deaths from all causes.

To compare fatality rates between trusts, logistic regression was used to adjust for age and sex differences in the populations. Odds ratios and their 95% confidence intervals were calculated relative to a reference trust A and are shown with the 30-day CFRs in Exhibit 2.

The rank order of the trusts was broadly the same whatever the method of calculation. Four trusts had odds ratios significantly higher than the reference trust for the CFRs when death was due to AMI. When the CFR was calculated for all deaths only two trusts had values significantly higher than the reference trust.

It does not greatly matter whether 30-day CFRs are calculated using those deaths with AMI as the underlying cause or those with AMI mentioned anywhere on the certificate or deaths from all causes. However, the preferred option is using death from all causes.
### Exhibit 2  AMI case fatality rates, AMI as underlying cause of death and mentioned anywhere and deaths from all causes 1994-98

<table>
<thead>
<tr>
<th>Trust</th>
<th>AMI mentioned anywhere</th>
<th>AMI underlying cause of death</th>
<th>Death from all causes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CFR (30 days)</td>
<td>Odds ratio to A (95% CI) [Rank]</td>
<td>CFR (30 days)</td>
</tr>
<tr>
<td>A</td>
<td>16.0% Reference</td>
<td>14.3% Reference [2]</td>
<td>19.1% Reference [2]</td>
</tr>
<tr>
<td>B</td>
<td>21.2% 1.46*** (1.17-1.83) [8]</td>
<td>19.9% 1.54*** (1.22-1.93) [9]</td>
<td>23.5% 1.35*** (1.09-1.67) [8]</td>
</tr>
<tr>
<td>C</td>
<td>14.0% 0.95 (0.80-1.13) [1]</td>
<td>13.1% 1.00 (0.83-1.19) [1]</td>
<td>17.1% 0.97 (0.83-1.14) [1]</td>
</tr>
<tr>
<td>D</td>
<td>21.7% 1.51*** (1.28-1.77) [9]</td>
<td>19.5% 1.50*** (1.27-1.77) [8]</td>
<td>23.9% 1.37*** (1.18-1.60) [9]</td>
</tr>
<tr>
<td>E</td>
<td>19.7% 1.32** (1.08-1.62) [7]</td>
<td>17.8% 1.33** (1.08-1.63) [7]</td>
<td>21.7% 1.20 (0.99-1.46) [7]</td>
</tr>
<tr>
<td>F</td>
<td>18.1% 1.27** (1.09-1.48) [6]</td>
<td>16.8% 1.32*** (1.13-1.55) [6]</td>
<td>19.9% 1.15 (0.99-1.33) [6]</td>
</tr>
<tr>
<td>G</td>
<td>17.0% 1.13 (0.97-1.32) [5]</td>
<td>15.5% 1.15 (0.98-1.35) [5]</td>
<td>19.8% 1.10 (0.95-1.28) [5]</td>
</tr>
<tr>
<td>H</td>
<td>17.0% 1.11 (0.94-1.30) [4]</td>
<td>15.7% 1.14 (0.97-1.34) [4]</td>
<td>19.3% 1.03 (0.89-1.20) [3]</td>
</tr>
<tr>
<td>I</td>
<td>17.4% 1.07 (0.89-1.27) [3]</td>
<td>15.6% 1.07 (0.98-1.28) [3]</td>
<td>20.4% 1.05 (0.89-1.24) [4]</td>
</tr>
</tbody>
</table>

### 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
Study 3: Diagnoses on death certificates used to calculate AMI CFRs

In this study the underlying cause of death for those who died at varying times after admission were recorded and are shown in Exhibit 3. For people dying within 30 days, 84% had underlying cause of AMI. At 30 days, other ischaemic heart disease accounted for only 5% but over time increased to 27% of underlying causes of death at 365 days.

There has been considerable debate about the extent to which deaths following AMI are certified as AMI. In this study the great majority of deaths within 30 days were classified as AMI.

Exhibit 3: Causes of death following admission for AMI 1990-1998

<table>
<thead>
<tr>
<th>Cause (ICD9 code)</th>
<th>Time from admission to death</th>
<th>&lt; 30 days</th>
<th>30-89 days</th>
<th>90-364 days</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No.</td>
<td>%</td>
<td>No.</td>
<td>%</td>
</tr>
<tr>
<td>Myocardial infarction (410)</td>
<td>4082</td>
<td>84.1</td>
<td>402</td>
<td>57.1</td>
</tr>
<tr>
<td>Old M.I. (412)</td>
<td>1</td>
<td>&lt;0.1</td>
<td>1</td>
<td>0.1</td>
</tr>
<tr>
<td>Angina pectoris (413)</td>
<td>1</td>
<td>&lt;0.1</td>
<td>1</td>
<td>0.1</td>
</tr>
<tr>
<td>Other ischaemic heart disease (414)</td>
<td>276</td>
<td>5.7</td>
<td>149</td>
<td>0.2</td>
</tr>
<tr>
<td>Heart dysrhythmias (427)</td>
<td>7</td>
<td>0.1</td>
<td>2</td>
<td>0.3</td>
</tr>
<tr>
<td>Heart failure (428)</td>
<td>13</td>
<td>0.3</td>
<td>13</td>
<td>1.8</td>
</tr>
<tr>
<td>Cerebrovascular disease (430-8)</td>
<td>78</td>
<td>1.6</td>
<td>22</td>
<td>3.1</td>
</tr>
<tr>
<td>Diabetes mellitus (250)</td>
<td>93</td>
<td>1.9</td>
<td>9</td>
<td>1.3</td>
</tr>
<tr>
<td>Chronic airways disease (496)</td>
<td>29</td>
<td>0.6</td>
<td>12</td>
<td>1.7</td>
</tr>
<tr>
<td>Cancer of the lung (162)</td>
<td>11</td>
<td>0.2</td>
<td>9</td>
<td>1.3</td>
</tr>
<tr>
<td>Other</td>
<td>262</td>
<td>5.4</td>
<td>84</td>
<td>11.9</td>
</tr>
<tr>
<td>Total</td>
<td>4853</td>
<td>100.0</td>
<td>704</td>
<td>100.0</td>
</tr>
</tbody>
</table>
Study 4: Timing and place of death from AMI

In this study CFRs for AMI were calculated for three time periods using:

- Different locations of death:
  - death in same continuous spell of hospital care
  - death in same hospital/trust but in a subsequent admission
  - death in a different hospital/trust.

- Different time periods after admission:
  - within 30 days
  - within 90 days
  - within 365 days.

The number and percentage of deaths by place of death for the three time periods are shown in Exhibit 4. The great majority of deaths occurred within 30 days. Of the 30-day deaths about 86% occurred in the same episode as the original hospital admission.

The choice of location and time period associated with death can influence comparative performance information. Exhibit 5 shows odds ratios, 95% confidence intervals and rankings for trusts for CFRs with AMI as the underlying cause of death calculated for different time periods and locations.

The in-hospital 30-day mortality showed four trusts (B, D, E and F) higher than the reference trust and one lower (C). The 30-day mortality anywhere showed the same four trusts higher than the reference trust but none lower.

*CFRs should be calculated at 30 days from admission and for deaths occurring anywhere.*
### Exhibit 4  Deaths from AMI within 30, 90 and 365 days of admission tabulated by place of death

<table>
<thead>
<tr>
<th></th>
<th>Same admission as AMI</th>
<th>Same hospital/trust, subs. admission</th>
<th>Different hospital/trust</th>
<th>Outside hospital</th>
<th>All deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Within 30 days</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1979-1986</td>
<td>5082</td>
<td>249</td>
<td>160</td>
<td>305</td>
<td>5796</td>
</tr>
<tr>
<td>1987-1993</td>
<td>3529</td>
<td>187</td>
<td>223</td>
<td>194</td>
<td>4133</td>
</tr>
<tr>
<td>1994-1998</td>
<td>1717</td>
<td>118</td>
<td>35</td>
<td>112</td>
<td>1982</td>
</tr>
<tr>
<td><strong>Within 90 days</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1979-1976</td>
<td>5319</td>
<td>484</td>
<td>306</td>
<td>567</td>
<td>6676</td>
</tr>
<tr>
<td>1987-1993</td>
<td>3632</td>
<td>390</td>
<td>339</td>
<td>382</td>
<td>4743</td>
</tr>
<tr>
<td>1994-1998</td>
<td>1755</td>
<td>245</td>
<td>65</td>
<td>199</td>
<td>2264</td>
</tr>
<tr>
<td><strong>Within 365 days</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1979-1986</td>
<td>5397</td>
<td>910</td>
<td>604</td>
<td>1013</td>
<td>7924</td>
</tr>
<tr>
<td>1987-1993</td>
<td>3650</td>
<td>716</td>
<td>543</td>
<td>709</td>
<td>5618</td>
</tr>
<tr>
<td>1994-1998</td>
<td>1756</td>
<td>532</td>
<td>130</td>
<td>402</td>
<td>2820</td>
</tr>
</tbody>
</table>
## Exhibit 5  CFRs: admissions for AMI, with AMI as the underlying cause of death 1994-1998

<table>
<thead>
<tr>
<th>Trust</th>
<th>CFR (30 days)</th>
<th>Odds Ratio to A (95% CI)</th>
<th>CFR (90 days)</th>
<th>Odds Ratio to A (95% CI)</th>
<th>CFR (365 days)</th>
<th>Odds Ratio to A (95% CI)</th>
<th>CFR (30 days)</th>
<th>Odds ratio to A (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>14.3% (Reference)</td>
<td>15.7% (Reference)</td>
<td>17.4% (Reference)</td>
<td>12.8% (Reference)</td>
<td>18.3% (Reference)</td>
<td>14.1% (Reference)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>19.9% 1.54*** (1.22-1.93)</td>
<td>21.8% 1.56*** (1.25-1.95)</td>
<td>23.2% 1.49*** (1.20-1.85)</td>
<td>21.8% 1.56*** (1.25-1.95)</td>
<td>23.2% 1.49*** (1.20-1.85)</td>
<td>21.8% 1.56*** (1.25-1.95)</td>
<td>23.2% 1.49*** (1.20-1.85)</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>13.1% 1.00 (0.83-1.19)</td>
<td>14.0% 0.98 (0.82-1.16)</td>
<td>15.4% 0.97 (0.81-1.16)</td>
<td>15.4% 0.97 (0.81-1.16)</td>
<td>15.4% 0.97 (0.81-1.16)</td>
<td>15.4% 0.97 (0.81-1.16)</td>
<td>15.4% 0.97 (0.81-1.16)</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>19.5% 1.50*** (1.27-1.77)</td>
<td>21.6% 1.54*** (1.31-1.80)</td>
<td>23.4% 1.50*** (1.27-1.76)</td>
<td>17.7% 1.51*** (1.27-1.79)</td>
<td>15.9% 1.32* (1.06-1.64)</td>
<td>14.7% 1.28** (1.09-1.52)</td>
<td>15.9% 1.32* (1.06-1.64)</td>
<td></td>
</tr>
<tr>
<td>E</td>
<td>17.8% 1.33*** (1.08-1.63)</td>
<td>19.2% 1.31*** (1.07-1.61)</td>
<td>23.0% 1.48*** (1.21-1.81)</td>
<td>15.9% 1.32* (1.06-1.64)</td>
<td>14.7% 1.28** (1.09-1.52)</td>
<td>15.9% 1.32* (1.06-1.64)</td>
<td>14.7% 1.28** (1.09-1.52)</td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>16.8% 1.32*** (1.13-1.55)</td>
<td>18.7% 1.36*** (1.17-1.58)</td>
<td>22.0% 1.50*** (1.26-1.72)</td>
<td>14.7% 1.28** (1.09-1.52)</td>
<td>14.0% 1.16 (0.98-1.37)</td>
<td>14.1% 1.15 (0.97-1.36)</td>
<td>14.0% 1.16 (0.98-1.37)</td>
<td></td>
</tr>
<tr>
<td>G</td>
<td>15.5% 1.15 (0.98-1.35)</td>
<td>16.8% 1.14 (0.98-1.34)</td>
<td>19.1% 1.20* (1.03-1.41)</td>
<td>14.0% 1.16 (0.98-1.37)</td>
<td>14.1% 1.15 (0.97-1.36)</td>
<td>14.0% 1.16 (0.98-1.37)</td>
<td>14.1% 1.15 (0.97-1.36)</td>
<td></td>
</tr>
<tr>
<td>H</td>
<td>15.7% 1.14 (0.97-1.34)</td>
<td>17.2% 1.14 (0.98-1.34)</td>
<td>20.4% 1.26** (1.07-1.47)</td>
<td>14.1% 1.15 (0.97-1.36)</td>
<td>14.1% 1.15 (0.97-1.36)</td>
<td>14.1% 1.15 (0.97-1.36)</td>
<td>14.1% 1.15 (0.97-1.36)</td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>15.6% 1.07 (0.89-1.28)</td>
<td>17.3% 1.09 (0.91-1.30)</td>
<td>20.4% 1.18*** (0.97-1.44)</td>
<td>13.7% 1.03 (0.85-1.25)</td>
<td>13.7% 1.03 (0.85-1.25)</td>
<td>13.7% 1.03 (0.85-1.25)</td>
<td>13.7% 1.03 (0.85-1.25)</td>
<td></td>
</tr>
</tbody>
</table>

### 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
Study 5: Statistical confounders for AMI CFR

In this study the effect of the confounders age, sex, social class and marital status were examined.

Exhibit 6 shows the effect of age group on survival after AMI, using the CFR definition with linked data and excluding those discharged within three days and day-0 deaths. The odds ratios show that relative to the reference group aged under 45, a patient aged 75-79 years was over nine times more likely to die within 30 days of an AMI.

Exhibit 7 shows a similar analysis for the effect of the sex of the patient. Women were 1.27 times more likely to die within 30 days of admission.

Similar analyses were done for the social class and marital status of the patient. On the rather more limited evidence no significant differences were detected.

*This study shows that it is essential to take into account the effect of age group and sex on CFRs and the importance of age-standardising any measures used for comparative purposes.*
Exhibit 6  The effect of age group on survival after AMI, 1994-1998. CFRs and odds ratios after adjusting for hospital of admission and sex

<table>
<thead>
<tr>
<th>Age group</th>
<th>No of admissions</th>
<th>No. of deaths - 30 days (%)</th>
<th>Odds ratio - 30 days (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 45</td>
<td>500</td>
<td>14 (2.9%)</td>
<td>Reference</td>
</tr>
<tr>
<td>45-49</td>
<td>613</td>
<td>22 (3.6%)</td>
<td>1.26 (0.64 - 2.49)</td>
</tr>
<tr>
<td>50-54</td>
<td>837</td>
<td>31 (3.7%)</td>
<td>1.33 (0.70 - 2.53)</td>
</tr>
<tr>
<td>55-59</td>
<td>1,213</td>
<td>58 (4.8%)</td>
<td>1.72 (0.95 - 3.12)</td>
</tr>
<tr>
<td>60-64</td>
<td>1,513</td>
<td>128 (8.5%)</td>
<td>3.11 (1.77 - 5.46)</td>
</tr>
<tr>
<td>65-69</td>
<td>1,861</td>
<td>235 (12.6%)</td>
<td>4.79 (2.76 - 8.29)</td>
</tr>
<tr>
<td>70-74</td>
<td>2,031</td>
<td>319 (15.7%)</td>
<td>6.07 (3.51 - 10.47)</td>
</tr>
<tr>
<td>75-79</td>
<td>1,899</td>
<td>443 (23.3%)</td>
<td>9.70 (5.63 - 16.69)</td>
</tr>
<tr>
<td>80-84</td>
<td>1,470</td>
<td>391 (26.6%)</td>
<td>11.31 (6.55 - 19.52)</td>
</tr>
<tr>
<td>85-89</td>
<td>849</td>
<td>283 (33.3%)</td>
<td>15.39 (8.86 - 26.76)</td>
</tr>
<tr>
<td>90+</td>
<td>295</td>
<td>110 (37.3%)</td>
<td>17.35 (9.67 - 31.16)</td>
</tr>
<tr>
<td>Total</td>
<td>13,081</td>
<td>2,034 (15.5%)</td>
<td></td>
</tr>
</tbody>
</table>

Exhibit 7  The effect of sex on survival after AMI, 1994-1998. CFRs and odds ratios after adjusting for hospital of admission and age group

<table>
<thead>
<tr>
<th>Sex</th>
<th>No. of admissions</th>
<th>No. of deaths - 30 days (%)</th>
<th>Odds ratio - 30 days (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Men</td>
<td>8,516</td>
<td>1,062 (12.5%)</td>
<td>Reference</td>
</tr>
<tr>
<td>Women</td>
<td>4,565</td>
<td>972 (21.3%)</td>
<td>1.27 (1.15 - 1.41)</td>
</tr>
<tr>
<td>Total</td>
<td>13,081</td>
<td>2,034 (15.5%)</td>
<td></td>
</tr>
</tbody>
</table>
**Study 6: Statistical power of AMI CFR**

For AMI case-fatality rate to be a useful hospital comparator it must have adequate statistical power.

To calculate the number of admissions/length of study time needed the following assumptions were made:

- required statistical level 5%
- statistical power 80%
- relative risk 1.5 and 1.25.
- hospitals admitting about 300 patients with AMI per year.

The study size calculations are shown in Exhibit 8. To detect a relative risk of 1.5 needs a study size of 293 and a time period of just under a year. For a 1.25 risk to be detected 1,094 admissions are required and thus a period of nearly four years.

*Given the assumptions, annual information will only detect differences between hospitals for a relative risk of 1.5.*

### Exhibit 8  Study size calculations for AMI case fatality rates at 30 days

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Case-fatality rate</th>
<th>Relative risk (B:A)</th>
<th>Study size</th>
<th>Length of study (months)</th>
</tr>
</thead>
<tbody>
<tr>
<td>30-day CFR</td>
<td>20%</td>
<td>30%</td>
<td>1.50</td>
<td>293</td>
</tr>
<tr>
<td>30-day CFR</td>
<td>20%</td>
<td>25%</td>
<td>1.25</td>
<td>1,094</td>
</tr>
</tbody>
</table>

**Notes:**

1. Study size calculations are based upon statistical power of 90% (1-β = 0.90) and statistical significance at the 5% level (α=0.05)
2. Length of study is based upon a hospital with 300 admissions per year for myocardial infarction
Study 7: Admission and deaths excluded from AMI CFR

In this study particular admissions and deaths were excluded:

- Admissions misdiagnosed as AMI (those discharged alive after three days or less) from the denominator.
- Deaths occurring early in the stay that might not be attributable to the hospital care (those occurring on day of admission, day 0, and further analyses involving days one and two) from the numerator.

The 30-day CFRs were calculated in six different ways, the numbers refer to the definition used:

- Using unlinked HES data:
  - all lengths of stay included (1)
  - less those discharged alive after three days or less from denominator (2).
- Using linked HES and death registration data:
  - less those discharged alive after three days or less from denominator (3)
  - less deaths on day of admission (day 0) from numerator (4)
  - less deaths on days 0 and 1 from numerator (5)
  - less deaths on days 0, 1 and 2 from the numerator (6).

To compare fatality rates between trusts, logistic regression was used to adjust for age and sex differences in the populations. Odds ratios and their 95% confidence intervals were calculated relative to a reference trust A.

Using definition 1, there were 14,041 admissions, 2,224 deaths and a CFR of 15.8%.

Using definition 2 that excludes the misdiagnosed AMIs, there were 13,081 admissions and thus an increased CFR of 17.0%.

Using definition 3 that excludes the misdiagnosed AMIs and uses linked data there were 2,558 deaths and thus an increased CFR of 19.6%.

Using definition 4 that excludes deaths occurring on the day of admission (0), there were 2,034 deaths and a lowered CFR of 15.5%.

Using definition 5 that excludes deaths occurring on days 0 and 1, there were 1,491 deaths and a CFR further lowered to 11.4%.

Using definition 6 that excludes deaths occurring on days 0, 1 and 2, there were 1,230 deaths and a further lowering of the CFR to 9.4%.

Exhibit 9 shows the CFRs for the eight participating trusts calculated in the six different ways. It should be noted that:

- Trust B had low CFRs explained by the fact that it did not code many of its deaths as such and probably omitted some of its fatal cases altogether.
- Apart from B the other trusts did not show striking differences in their CFRs.
Exhibit 10 shows the odds ratios of the trusts relative to the reference trust A (odds ratio=1). It should be noted that:

- For all definitions, trust B had a lower CFR than reference trust A.
- Using definition 1 involving unlinked data, Trusts C and F had significantly higher CFRs than reference trust A.
- Using definitions 2 and 3, only trust C had a significantly higher CFR than A.
- Using definitions 4-6, no trust had a significantly higher CFR than A.

This study shows that the removal of the misdiagnosed cases and the deaths occurring early in the admission makes significant differences to the comparative performance of trusts as measured by CFRs for AMI.
<table>
<thead>
<tr>
<th>Trust</th>
<th>CFR 1</th>
<th>CFRs 2-6</th>
<th>No. of deaths - 30 days (%)</th>
<th>CFR 2</th>
<th>No. of deaths - 30 days (%)</th>
<th>CFR 3</th>
<th>No. of deaths - 30 days (%)</th>
<th>CFR 4</th>
<th>No. of deaths - 30 days (%)</th>
<th>CFR 5</th>
<th>No. of deaths - 30 days (%)</th>
<th>CFR 6</th>
<th>No. of deaths - 30 days (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>2,954</td>
<td>2,818</td>
<td>502 (17.0%)</td>
<td>502</td>
<td>(17.8%)</td>
<td>562</td>
<td>(19.9%)</td>
<td>468</td>
<td>(16.6%)</td>
<td>328</td>
<td>(11.6%)</td>
<td>278</td>
<td>(9.9%)</td>
</tr>
<tr>
<td>B</td>
<td>1,767</td>
<td>1,564</td>
<td>117 (6.6%)</td>
<td>117</td>
<td>(5.7%)</td>
<td>195</td>
<td>(12.5%)</td>
<td>138</td>
<td>(8.8%)</td>
<td>108</td>
<td>(6.9%)</td>
<td>92</td>
<td>(5.9%)</td>
</tr>
<tr>
<td>C</td>
<td>1,684</td>
<td>1,617</td>
<td>346 (20.4%)</td>
<td>346</td>
<td>(21.4%)</td>
<td>386</td>
<td>(23.9%)</td>
<td>288</td>
<td>(17.8%)</td>
<td>201</td>
<td>(12.4%)</td>
<td>160</td>
<td>(9.9%)</td>
</tr>
<tr>
<td>D</td>
<td>1,344</td>
<td>1,301</td>
<td>224 (16.7%)</td>
<td>224</td>
<td>(17.2%)</td>
<td>251</td>
<td>(19.3%)</td>
<td>206</td>
<td>(15.8%)</td>
<td>161</td>
<td>(12.4%)</td>
<td>139</td>
<td>(10.7%)</td>
</tr>
<tr>
<td>E</td>
<td>736</td>
<td>702</td>
<td>126 (17.1%)</td>
<td>126</td>
<td>(17.9%)</td>
<td>142</td>
<td>(20.2%)</td>
<td>115</td>
<td>(16.4%)</td>
<td>87</td>
<td>(12.4%)</td>
<td>67</td>
<td>(9.5%)</td>
</tr>
<tr>
<td>F</td>
<td>950</td>
<td>908</td>
<td>161 (16.9%)</td>
<td>161</td>
<td>(17.7%)</td>
<td>177</td>
<td>(19.5%)</td>
<td>143</td>
<td>(15.7%)</td>
<td>105</td>
<td>(11.6%)</td>
<td>82</td>
<td>(9.0%)</td>
</tr>
<tr>
<td>G</td>
<td>2,433</td>
<td>2,144</td>
<td>378 (15.5%)</td>
<td>378</td>
<td>(17.6%)</td>
<td>432</td>
<td>(20.1%)</td>
<td>337</td>
<td>(15.7%)</td>
<td>252</td>
<td>(11.8%)</td>
<td>211</td>
<td>(9.8%)</td>
</tr>
<tr>
<td>H</td>
<td>2,163</td>
<td>2,027</td>
<td>370 (17.0%)</td>
<td>370</td>
<td>(18.3%)</td>
<td>413</td>
<td>(20.4%)</td>
<td>339</td>
<td>(16.7%)</td>
<td>249</td>
<td>(12.3%)</td>
<td>201</td>
<td>(9.9%)</td>
</tr>
<tr>
<td>All 8 Trusts</td>
<td>14,041</td>
<td>13,081</td>
<td>2,224 (15.8%)</td>
<td>2,224 (17.0%)</td>
<td>2,558 (19.6%)</td>
<td>2,034 (15.5%)</td>
<td>1,491 (11.4%)</td>
<td>1,230 (9.4%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Exhibit 10  Odds ratios, adjusted for age group and sex, for trusts, 1994-1998

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Odds ratio - 30 days (95% CI) [Rank]</td>
<td>Odds ratio - 30 days (95% CI) [Rank]</td>
<td>Odds ratio - 30 days (95% CI) [Rank]</td>
<td>Odds ratio - 30 days (95% CI) [Rank]</td>
<td>Odds ratio - 30 days (95% CI) [Rank]</td>
<td>Odds ratio - 30 days (95% CI) [Rank]</td>
</tr>
<tr>
<td>B</td>
<td>0.38 (0.30-0.47) [1]</td>
<td>0.43 (0.35-0.54) [1]</td>
<td>0.67 (0.56-0.81) [1]</td>
<td>0.56 (0.46-0.69) [1]</td>
<td>0.66 (0.52-0.83) [1]</td>
<td>0.67 (0.52-0.86) [1]</td>
</tr>
<tr>
<td>C</td>
<td>1.35 (1.15-1.59) [8]</td>
<td>1.35 (1.15-1.59) [8]</td>
<td>1.35 (1.16-1.58) [8]</td>
<td>1.14 (0.97-1.35) [8]</td>
<td>1.12 (0.93-1.36) [4]</td>
<td>1.04 (0.84-1.26) [4]</td>
</tr>
<tr>
<td>D</td>
<td>1.06 (0.89-1.28) [4]</td>
<td>1.05 (0.88-1.26) [4]</td>
<td>1.05 (0.88-1.25) [3]</td>
<td>1.03 (0.85-1.24) [4]</td>
<td>1.16 (0.95-1.43) [7]</td>
<td>1.18 (0.95-1.48) [8]</td>
</tr>
<tr>
<td>E</td>
<td>1.08 (0.86-1.35) [5]</td>
<td>1.08 (0.86-1.35) [5]</td>
<td>1.08 (0.87-1.34) [5]</td>
<td>1.04 (0.83-1.31) [5]</td>
<td>1.13 (0.87-1.46) [6]</td>
<td>1.01 (0.76-1.34) [3]</td>
</tr>
<tr>
<td>F</td>
<td>1.23 (1.00-1.51) [7]</td>
<td>1.22 (0.99-1.50) [7]</td>
<td>1.18 (0.97-1.44) [7]</td>
<td>1.13 (0.91-1.39) [7]</td>
<td>1.18 (0.93-1.50) [8]</td>
<td>1.07 (0.82-1.39) [7]</td>
</tr>
<tr>
<td>G</td>
<td>0.97 (0.83-1.13) [2]</td>
<td>1.03 (0.89-1.21) [3]</td>
<td>1.06 (0.92-1.23) [4]</td>
<td>0.97 (0.83-1.14) [2]</td>
<td>1.06 (0.88-1.26) [3]</td>
<td>1.04 (0.86-1.26) [5]</td>
</tr>
<tr>
<td>H</td>
<td>1.09 (0.93-1.27) [6]</td>
<td>1.10 (0.94-1.29) [6]</td>
<td>1.10 (0.94-1.27) [6]</td>
<td>1.07 (0.91-1.26) [6]</td>
<td>1.12 (0.94-1.34) [5]</td>
<td>1.06 (0.87-1.28) [6]</td>
</tr>
</tbody>
</table>
Study 8: Deaths included in the AMI CFR

In this study an additional type of death was considered:

- Hospital-associated deaths. These are identified from death certificates that specify that death occurred in hospital but they do not have a corresponding record for the admission. This is a measure of the patients arriving at the hospital but dying of AMI before being formally admitted.

Two measures were calculated:

- Hospital case-fatality (HCF) in which the denominator was patients admitted formally to hospital, and the numerator was the number who died within 30 days of admission.
- Hospital-associated case-fatality (HACF) in which the hospital associated deaths were added to the HCF numerator and denominator.

The age-standardised values for the two measures over time are shown for men and women in Exhibit 11. HCF rates increased over time in the early years and then fell. HACF rates also rose and more so in the early years.

The six 30-day CFRs calculated in Study 7 were re-calculated with the addition of the hospital-associated deaths to both the numerator and denominator. This addition substantially increased all the CFRs. With the exception of hospital B, whose result was artefactual, there were few differences between the hospitals.

This study shows that the addition of the hospital-associated deaths removes previous differences between hospitals shown by CFRs calculated without them.
Exhibit 11  Standardised hospital case-fatality and hospital-associated case-fatality rates for AMI among men and women
3. POPULATION-BASED MEASURES: STUDIES 9-14

Study 9: AMI mortality rates calculated using underlying cause of death or mention anywhere on death certificate

In this study mortality rates compiled using AMI mentioned anywhere on the certificate have been compared with rates using AMI as the underlying cause of death.

Exhibit 12 shows the standardised mortality rates for men and women when AMI is the underlying cause of death and when it is mentioned anywhere on the certificate. The effect of adding those deaths with AMI not mentioned as underlying cause had little effect on the different mortality rates.

This study shows that:

- There is little difference between rates calculated with AMI as underlying diagnosis and those when AMI is mentioned anywhere on the certificate.

Exhibit 12   Standardised mortality rates for AMI(1968-1998): AMI underlying cause of death and mentioned anywhere on death certificate
Study 10: Location of deaths certified as being due to AMI

In this study the location of death following AMI has been reviewed over time using data recorded on death certificates.

The measures were:

- Overall mortality rate, regardless of location.
- Mortality rates for deaths that occurred in hospital.
- Mortality rates for deaths occurred outside hospital.

Exhibits 13 and 14 show the three measures, standardised for age and sex, from 1968-98 for males and females separately. It should be that noted that:

- Overall rate for men almost halved from 416 to 212 per 100,000 population over the study period. The rates for deaths out of hospital declined far more (273 to 106) than those for deaths in hospital (143 to 107).
- The trends for women were broadly similar although, while the absolute values were much smaller for the women, the percentage decreases in rates from the mid-1970s onwards were not as great as those in the men.

The death certificate certified deaths from AMI were evenly distributed between deaths occurring in hospital and those outside.

*This study shows that half of all the deaths over the period occurred outside hospital. The analysis of death certificate based mortality rates for AMI should be routinely divided into those occurring in and outside hospital.*
Exhibit 13  Standardised mortality rates for AMI among men. Deaths anywhere, deaths in hospital and outside.
Exhibit 14  Standardised mortality rates for AMI among women. Deaths anywhere, deaths in hospital and outside.
Study 11: Deaths in hospital certified as due to AMI

In this study we have measured the various components making up the deaths from AMI recorded on a death certificate and occurring in a hospital.

The measures were death rates from AMI occurring in hospital of:

- patients who had been admitted with AMI.
- patients who had been admitted with IHD.
- patients who had been admitted with other than AMI or IHD.
- patients who had not been formally admitted.

Exhibits 15 and 16 show the four measures, standardised for age and sex, from 1968-98 for males and females separately. It should be that noted that:

- Rates for patients with an AMI admission show a larger decline in the 1980s and 1990s in men than in women.
- Rates for patients who had not formally been admitted decreased markedly from the mid-1970s in both sexes.

In the last ten years of the study, of the total deaths:

- 44.8% were in people with an AMI admission
- 24.9% were in people with an admission for IHD
- 14.0% were in people with an admission for other conditions
- 16.3% were in people who had not been formally admitted.

In the last ten years of the study, of the deaths in patients aged 75 and over:

- 45.7% were in people with an AMI admission
- 27.5% were in people with an admission for IHD
- 15.3% were in people with an admission for other conditions
- 11.5% were in people who had not been formally admitted.

In the last ten years of the study, of the deaths in patients aged under 75:

- 43.6% were in people with an AMI admission
- 21.4% were in people with an admission for IHD
- 12.3% were in people with an admission for other conditions
- 22.7% were in people who had not been formally admitted.

In this study it has been shown that under half of patients recorded as dying in hospital from AMI were admitted with AMI. In the under 75 age group 23% of the deaths were in patients who had not been formally admitted. In the 75 and over age group 28% of the deaths were in patients who had been admitted for ischaemic heart disease.
Exhibit 15  Deaths inside hospital. Standardised mortality rates for AMI among men.

![Diagram showing standardised mortality rates for AMI among men over different years.](image-url)
Exhibit 16  Deaths inside hospital. Standardised mortality rates for AMI among women
Study 12: Deaths outside hospital certified as due to AMI

In this study we have measured the various components making up the deaths from AMI recorded on a death certificate and occurring outside hospital, and in particular the effect of patients who had had an admission in the previous 30 days.

The measures were death rates from AMI occurring outside hospital of:

- patients who had been admitted with AMI.
- patients who had been admitted with IHD.
- patients who had been admitted with other than AMI or IHD.

Exhibits 17 and 18 show the four measures, standardised for age and sex, from 1968-98 for males and females separately. It should be noted that:

- Deaths occurring outside hospital in the 30 days following hospital admission for any reason contributed little to overall outside hospital mortality rates.

Considering all out-of-hospital deaths:

- 94.8% occurred in people with no admission in the previous 30 days
- 3.5% in people who had been admitted for conditions other than AMI
- 1.7% in people who had been admitted for AMI.

In this study it has been shown that deaths from AMI occurring outside hospital in people who have had an admission in the previous 30 days contribute little to overall out-of-hospital mortality rates.
Exhibit 17  Deaths outside hospital. Standardised mortality rates for AMI among men.
Exhibit 18  Deaths outside hospital. Standardised mortality rates for AMI among women.
Study 13: Incidence of AMI measured by person-based and event-based admission rates

In this study age/sex specific episode-based and event-based admission rates for AMI have been calculated.

Exhibit 19 shows the age-sex specific admission rates and the ratio of events to people. Both sets of age-sex specific rates increased steadily with increasing age and were higher in men than women. The ratios of the number of events to people were similar for both sexes. For all age groups above 30 years and for men and women the ratios ranged from 1.05 to 1.10. Multiple admissions for AMI for the same individual accounted for a small proportion of total admissions.

In this study it has been shown that:

- Multiple admissions in the year account for only a small proportion of total admissions so person-based data add little extra information.
- Rates should be age-sex standardised.

Exhibit 19  Age group and sex-specific admission rates for AMI 1994-1998

<table>
<thead>
<tr>
<th>Age group</th>
<th>Episode-based (per 100,000)</th>
<th>Person-based (per 100,000)</th>
<th>Ratio of episodes:people</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Men</td>
<td>Women</td>
<td>Men</td>
</tr>
<tr>
<td>&lt; 1</td>
<td>0</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>1 - 4</td>
<td>0</td>
<td>0</td>
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</tr>
<tr>
<td>5 - 9</td>
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<td>0</td>
<td>0</td>
</tr>
<tr>
<td>6 -10</td>
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<td>0</td>
</tr>
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<td>11-14</td>
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</tr>
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<td>15-19</td>
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<td>1</td>
</tr>
<tr>
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<td>2</td>
</tr>
<tr>
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<td>2</td>
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</tr>
<tr>
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</tr>
<tr>
<td>All ages</td>
<td>169</td>
<td>94</td>
<td>157</td>
</tr>
</tbody>
</table>
Study 14: Adding additional AMI events to hospitalised incidence of AMI

In this study we have measured the affect of adding additional AMI events to the commonly used measure of hospitalised incidence.

The first set of measures were:

- Hospitalised incidence (HI) identified from admission records.
- Hospital-associated incidence (HAI). This measure comprises HI plus the hospital-associated deaths (HAD) that are identified from death certificates specifying that death occurred in hospital but they do not have a corresponding record for the admission. The HADs are a measure of the patients arriving at the hospital but dying of AMI before being formally admitted.
- Total identified incidence (TII). This measure comprises HAI plus those deaths outside hospital (DOH) identified from death certificates without an admission for AMI in the previous 30 days. The DOHs are a measure of the people who have died suddenly outside hospital from AMI.

Exhibits 20 and 21 show the three incidence measures, standardised for age and sex, from 1968-98 for males and females separately. It should be that noted that:

- TII for men declined more sharply during the 1980s and 1990s than the other two measures. This reflects a substantial fall in out-of-hospital deaths.
- TII for women also declined more sharply than the other two measures, although while TII declined from the mid-1970s onwards, the other measures did not fall until the 1990s.

Further events, relating to people recorded as dying from AMI in hospital but who were admitted with other conditions, were then added to the measures already described. These new measures were rates of death inside hospital from AMI:

- when admitted for ischaemic heart disease (IHD)
- when admitted for conditions other than AMI and IHD.

Exhibits 22 and 23 show the five measures, standardised for age and sex, from 1968-98 for males and females separately. It should be that noted that:

- In both sexes HI and DOH contributed most to total incidence when broken down into these five components.
- For men there were large decreases in HI and DOH throughout the 1980/1990s.
- For women HI did not fall until the 1990s.
- The standardised rates for the other three components were much smaller and decreases occurred in the latter half of the study.

This study shows that, of the five components that could be included in the calculation of an AMI incidence rate, the two measures that contribute most are the number of admissions for AMI and the number of deaths occurring outside hospital (DOHs) without an admission for AMI in the previous 30 days.
Exhibit 21  Standardised incidence rates for AMI among women. Hospitalised incidence, hospital-associated incidence and total identified incidence.
Exhibit 22  Incidence. Standardised rates for components of incidence for AMI among men.
Exhibit 23  Incidence. Standardised rates for components of incidence for AMI among women.