Mortality Statistics in Wales

This article was revised on 28 June 2013 due to minor inaccuracies in the data supplied. This affects Figure 3.2, Figure 3.3, Table C2 and Table C3. The impact is small.

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1.0 Introduction

Accurate mortality statistics are a pre-requisite for improvements in survival rates as they enable the monitoring of progress in combating causes of death and facilitate the identification of areas with potential for effective interventions (Rowland, 2003). There are many different users of mortality statistics including government departments, which use data to set and monitor policy, and other public bodies such as local authorities and health agencies, which use data to monitor and improve performance. Academics conducting research and private sector organisations with risk estimation models such as banks and insurance companies also require mortality data (ONS, 2012a).

Published mortality statistics tend to be measures based on deaths in whole populations (or sub-populations) but there is also a demand from people working in and using health care for mortality measures based on deaths in hospitals only. Florence Nightingale helped to pioneer statistics on hospital mortality in the late 1850s when she found that the variation of hospital death rates in London could not be explained by differences in the health of local populations alone, raising concerns of differences in the quality of medical care at different hospitals (Dr Foster Intelligence, 2012).

Concerns over variations in care still exist today. The public inquiry into the failings of the Mid-Staffordshire NHS Foundation Trust, led by Robert Francis QC, found that a lack of understanding of the hospital statistics available contributed to a failure to take action. One of the recommendations made by the inquiry was therefore that patient outcome statistics be reviewed and that efforts were made to ensure that clinicians and the public have a better understanding of hospital statistics (Francis, 2013a & 2013b).

This statistical article contributes to the need to increase understanding of hospital mortality measures and initiates a debate on the future of hospital mortality statistics in Wales. Section two provides an introduction to general measures of mortality in the population and presents death rates in Wales at health board level.

Section three shows hospital death rates in Wales at health board level before describing more complex hospital mortality measures and their associated quality issues, including the importance of clinical coding. The Welsh Government is developing a new statistical publication on mortality, which will cover both population mortality and hospital mortality. The next steps involved in developing this publication are outlined in section four.
2.0 Population Mortality

2.1 Measuring Population Mortality

The simplest measure of mortality is the number of deaths but this is of not much practical use because it is heavily influenced by the number of people at risk of dying, therefore mortality is commonly measured as a number of different rates:

- crude death rate
- age specific death rates
- standardised death rates
- infant mortality rates

2.1.1 Crude Death Rate

The simplest death rate is the *crude death rate* and is usually calculated for periods of one year. Often the rate is expressed as the number of deaths per thousand of the population to avoid very small rates.

\[
\text{crude death rate} = \frac{\text{total number of deaths in a given year}}{\text{total mid-year population}} \times 1000
\]

The size of populations varies over the year so traditionally demographers use the population at mid-year (30 June) as the denominator. The crude death rate is not a good measure to compare mortality in different populations because mortality levels vary considerably with age and the rate does not account for this variation (Hinde, 1998). This can cause more developed countries to have higher crude death rates than less developed ones (Rowland, 2003).

Official statistics use ONS *mid-year population estimates* for the denominator which, as the name indicates, are only estimates of the mid-year population, so published statistics are only approximations to the true figures.

2.1.2 Age Specific Death Rates

*Age specific death rates* can be calculated for single years of age or for age groups and are more useful than crude death rates to compare mortality levels in different populations because they account for the variation in levels of mortality by age. Like the crude death rate, they are sometimes expressed as the rate per thousand.

\[
\text{age-specific death rate at } x \text{ years} = \frac{\text{number of deaths of people aged } x \text{ years}}{\text{mid-year population aged } x \text{ years}} \times 1000
\]

There are some inaccuracies in age specific death rates. A person who dies before mid-year is included in the numerator but not in the denominator. A person whose birthday occurs after mid-year and who dies after their birthday but before the next calendar year is aged \( x \) at mid-year but aged \( x+1 \) when they die so is included in the denominator for the age specific death rate at age \( x \) but the numerator for age specific rate aged \( x+1 \).

\(^2\) A more thorough discussion of crude death rates and standardised rates can be found in both Hinde (1998) and Rowland (2003). Rowland also describes different infant mortality measures and relative risks.
An alternative is to calculate age specific rates based on the exact period of exposure at each age during the year for each person but data is often not available at this detail so statistics are only an approximation to the correct figures.\(^3\) However, in large populations this approximation is usually close (Hinde, 1998) and so the impact in official statistics is small.

### 2.1.3 Standardised Death Rates

It can be time consuming to compare mortality levels between populations using age specific death rates because a high number of rates need comparison. Standardisation involves giving a population some attributes of another and can make comparison easier by only needing to compare one rate for each population being compared. It can be undertaken on one or more factors that influence mortality levels including age, sex, education, occupation, income and religion (Hinde, 1998; Rowland, 2003).

Standardisation by age is common because of its high influence on mortality. Age standardised death rates can be calculated using either direct standardisation or indirect standardisation.\(^4\)

#### 2.1.3a Direct Standardisation by Age

Direct age standardisation involves applying a set of age specific death rates to a standard population structure to calculate the number of expected deaths for each single year of age or age group. The number of expected deaths for a given age is estimated by multiplying the age specific death rate in the population by the number of people at that age in the standard population.

The *directly standardised death rate* is obtained by summing the number of expected deaths for each age or age group and dividing the result by the total standard population.\(^3\) Again, the rate may be expressed as the rate per thousand (Rowland, 2003).

\[
\text{directly standardised death rate} = \frac{\text{total expected deaths}}{\text{total standard population}} \times 1000 \quad (3)
\]

The result can be interpreted as the death rate that would occur if the population had the same age structure as the standard population. The directly standardised rate for the standard population is the same as its crude death rate.

Directly age standardised rates are artificial constructs which vary according to the standard population chosen and therefore they should be used in conjunction with crude death rates, rather than instead of them (Rowland, 2003). For instance, a common standard population structure used in official statistics is the fictitious European Standard Population. Wales does not have the same population structure as the European Standard Population as Wales has an older age structure and more females than males in older age bands.

---

\(^3\) The inaccuracies described mean that age specific death rates violate the principle of correspondence, discussed by Hinde (1998). The relationship between these death rates, based on a specific calendar period, and death rates based on the experience of a specific cohort of people can be explored using Lexis charts, also discussed by Hinde.

\(^4\) There is no clear reason for the choice of adjectives (Rowland, 2003).
2.1.3b Indirect Standardisation by Age

Direct standardisation requires data on deaths by age for each population to be compared but this data may not be available or may be subject to large errors in some age groups if it is based on a small population (Hinde, 1998). Indirect standardisation is less data intensive as it involves applying a set of age specific death rates for a standard population to each population structure being compared.

The number of expected deaths for a given age is estimated by multiplying the number of people at that age in the population by the age specific death rate in the standard population. The standardised mortality ratio is the sum of the number of observed deaths for each age or age group divided by the number of expected deaths (4).

\[
\text{standardised mortality ratio} = \frac{\text{observed deaths}}{\text{expected deaths}} \quad (4)
\]

The ratio can be multiplied by 100 to be expressed as a percentage. A ratio equal to one is obtained if the number of observed deaths is equal to the number of expected deaths. A ratio equal to 1.1, for example, can be interpreted as meaning that observed deaths are 10 per cent higher than the number of expected deaths (the number of deaths there would be if the population experienced the same age specific death rates as those in the standard population) (Rowland, 2003).

An indirectly age standardised rate can be obtained by multiplying the standardised mortality ratio by the crude death rate of the standard population (5).

\[
\text{indirectly standardised death rate} = \text{standardised mortality ratio} \times \text{crude death rate std. pop.} \quad (5)
\]

The main disadvantage of an indirectly standardised rate is that its components, the standard mortality ratio and the crude death rate of the standard population, are not derived using the same population structures, so a comparison of different indirectly standardised rates involves making comparisons between rates derived from a mixture of age structures (Rowland, 2003).

A comparison of standardised mortality ratios would also involve comparing measures calculated using different age structures. This causes problems when using indirect standardisation measures for comparison. Flowers et al. (2010) provide a fictitious example of one area having higher age specific death rates than another but having a lower standardised mortality ratio whilst Schoenbach (1999) provides an example of two areas experiencing the same age specific death rates but different standardised mortality ratios.

It is therefore not advisable to use indirect standardisation measures for comparison between populations or over time – it is only appropriate to use them in comparison to the standard population.

2.1.4 Infant Mortality Rates

Levels of mortality in infants aged less than one year are relatively high compared with mortality rates of slightly older children therefore a number of different rates have been developed to measure infant mortality, the most common being the infant mortality rate (6). The denominator is not the mid-year population because infant deaths are not evenly distributed over the year but mostly occur within the first few days and weeks of life. Migration of infants
under one year old will cause some infants to be excluded from the numerator and included in the denominator, or vice versa, but the impact is small at a national level (Rowland, 2003).

\[
\text{infant mortality rate} = \frac{\text{deaths under one year of age}}{\text{total live births in a calendar year}} \times 1000
\]

There are three other infant mortality rates that use the number of live births as the denominator:

- the *early neonatal mortality rate* (deaths under seven days),
- the *neonatal mortality rate* (deaths under 28 days), and
- the *post-neonatal mortality rate* (deaths between 28 days and one year).

Two infant mortality rates use the sum of live and stillbirths as the denominator:

- the *stillbirth rate* (deaths from 24 weeks gestation) and
- the *perinatal mortality rate* (stillbirths and early neonatal deaths) (ONS, 2013).

International comparisons of infant mortality rates can be made difficult by different countries adopting different definitions. For instance, the perinatal mortality rate in England and Wales includes deaths between 24 weeks gestation and deaths occurring under seven days after birth but Australia includes all deaths in the first 28 days of life whilst Canada only includes deaths from 28 weeks gestation.

### 2.1.5 Other Mortality Measures

There are other measures that are sometimes used to measure population mortality:

- Cause specific death rates are used to identify specific health problems and are conventionally expressed as rates per 100,000 due to small numbers.
- Sex ratios of male to female age specific death rates can be used to identify excess male mortality (females tend to have a higher life expectancy than males).
- Relative risks are used to examine the presumed causes of disease by dividing a mortality (or incidence) rate for a given disease exposed to a risk factor (such as smoking) by the rate for the given disease of people not exposed to the risk factor.
- Life tables can be used to measure life expectancy (Rowland, 2003).

### 2.1.6 Population Mortality Statistics Available for Wales

Data on population mortality in England and Wales is published by the Office for National Statistics and includes numbers of deaths, standardised death rates, and data on cause specific and infant mortality. A statistical article by the Welsh Government is available detailing the published population mortality statistics for Wales; it includes a list of the main outputs, information on the timing of publication and links to the outputs on the ONS website.\(^5\) It also provides links to additional background information on the quality and methodology of the data.

2.2 Death Rates by Health Board (Area of Residence)

The crude death rate for Wales in 2011 was 9.9 per 1,000. The crude death rate for England in 2011 was lower at 8.5 per 1,000 but more deaths would be expected in Wales as it has a slightly older population than England – 18.5 per cent of the population in Wales in 2011 were aged 65 or over compared with 16.4 per cent in England.

Figure 2.1 shows that crude death rates vary at health board level in Wales from 10.8 per 1,000 (Hywel Dda) to 7.9 (Cardiff and Vale University). The rates shown in the chart do not take into account the different population structures in each health board. Hywel Dda and Powys Teaching health boards have, respectively, 21 and 23 per cent of their population aged 65 or over. It is unsurprising that their crude rates are higher than those from the other health boards which have a lower age population structure – for instance, only 15 per cent of people living in the Cardiff and Vale health board area are aged 65 or over.

Figure 2.1: Crude Death Rates (per 1,000) for 2011, by Health Board (Area of Residence) a, b

Source: WG, calculated using data from ONS (deaths data and mid-year population estimates)

a Crude death rates do not take into account varying age structures in different populations.

b Figures are residence based, not provider based. Welsh residents dying in England are therefore included. Deaths from non-residents of England and Wales are excluded.

Table B1 (Appendix B) provides a time series of crude death rates at health board level from 2001 to 2011. The table shows that levels of mortality in Wales have fallen over time.

Figure 2.2 shows directly standardised death rates in 2011 by health board. These were calculated by applying age specific death rates for each health board to the European Standard Population and can be interpreted as the death rate that each health board would experience if it had the same population structure as the European Standard Population. Wales has an older age structure than the European Standard Population and therefore the directly standardised rates are lower than the crude rates.

6 A map of health boards is provided in Appendix A.

7 Population figures calculated using ONS mid-year population estimates for 2011. Death rates for England calculated using ONS deaths data and 2011 mid-year population estimates. A standardised death rate for England was calculated using ten year age bands unlike the rates presented for Wales which used five year age bands.
The directly standardised rate for Wales is 5.6 per 1,000. This is slightly higher than the standardised rate for England, which is 5.3 per 1,000. The standardised rates are closer for the two countries than the crude rates as the age structures of the countries have been accounted for.

After standardising by age, the health board for Powys has the lowest death rate (4.9 per 1,000) and Cwm Taf the highest (6.5 per 1,000). Table B2 (Appendix B) provides a time series of directly standardised rates at health board level from 2001 to 2011. The table shows that Cwm Taf and Powys have consistently had the highest and lowest standardised death rates respectively. The table shows that levels of mortality have fallen over the past decade.

Standardised mortality ratios are also provided in Appendix B (Table B3). As discussed in Section 2.1.3b, these should not be used to compare levels of mortality between populations or over time because they are formed using different population structures. The ratios show that, after accounting for age, mortality is consistently lower than expected in Cardiff and Vale, Powys and Hywel Dda, and is consistently higher than expected in Abertawe Bro Morgannwg and Cwm Taf. Mortality was 14 per cent higher than expected in Cwm Taf in 2011 when compared with the Wales average. In Powys, mortality was 11 per cent lower than expected.

Some of the difference in mortality levels between health boards may be explained by differences in the levels of deprivation. The Welsh Index of Multiple Deprivation is a measure of deprivation for small areas, known as lower super output areas, each containing about 1,500 people. The index is constructed from different types of deprivation including income, housing,
employment, education and health. Table 2.1 shows, for each health board, the percentage of lower super output areas in the most deprived fifth of Wales.

**Table 2.1: Percentage of Lower Super Output Areas in Most Deprived Fifth of Wales**

<table>
<thead>
<tr>
<th>Health Board</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cwm Taf</td>
<td>36</td>
</tr>
<tr>
<td>Abertawe Bro Morgannwg University</td>
<td>27</td>
</tr>
<tr>
<td>Aneurin Bevan</td>
<td>24</td>
</tr>
<tr>
<td>Cardiff and Vale University</td>
<td>23</td>
</tr>
<tr>
<td>Betsi Cadwaladr University</td>
<td>12</td>
</tr>
<tr>
<td>Hywel Dda</td>
<td>9</td>
</tr>
<tr>
<td>Powys Teaching</td>
<td>1</td>
</tr>
</tbody>
</table>

Source: Welsh Index of Multiple Deprivation 2011, WG

There is a correlation between the mortality levels and deprivation; the three health boards with the highest directly standardised death rates are also the three areas with the highest levels of deprivation. Just one per cent of the areas in Powys, which has the lowest standardised death rate, are in the most deprived fifth of Wales. Cardiff and Vale has a relatively low standardised death rate and has 23 per cent of areas in the most deprived fifth of Wales. However, it also has 37 per cent of areas in the least deprived fifth, the highest percentage of any health board.

---

8 There is a small dependency between the standardised rates and the Welsh Index of Multiple Deprivation as one of the components of the index is health deprivation, which is partly formed using death rates. Further information on the 2011 index is at [http://wales.gov.uk/topics/statistics/theme/wimd/wimd2011/?lang=en](http://wales.gov.uk/topics/statistics/theme/wimd/wimd2011/?lang=en).
3.0 Hospital Mortality

3.1 Proportion of Deaths in Hospital by Health Board (Area of Residence)

Figure 3.1 shows the proportion of in and out of hospital deaths by health board for 2011. Overall, 58% of deaths of Welsh residents died in hospital but this varied at health board level between 65% (Cwm Taf) and 55% (Powys and Hywel Dda).\(^9\)

**Figure 3.1: Percentage of In Hospital and Out of Hospital Deaths for 2011, by Health Board (Area of Residence)** \(^a, b\)

The percentage of deaths in hospital is affected by the local service provision and is higher in areas with less care home and hospice provision. For instance, Marie Curie run a hospice in Cardiff and some deaths are occurring in the hospice that would otherwise have occurred in hospital. The percentage of deaths in care homes and hospices is 21 per cent in Cardiff and Vale (and Betsi Cadwaladr), which is nearly twice the percentage in Cwm Taf, as Table 3.1 shows. There is less variation between health boards when considering the combined percentage of deaths in hospitals, care homes and hospices than the percentage of deaths in hospitals alone.

Table C1 (Appendix C) shows a time series of the percentage of deaths in hospital from 2001 to 2011 by health board. There has been little change over the past decade but nationally the percentage has fallen slightly for the past three years.

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\(^9\) England has a lower percentage of deaths in hospital than Wales. In 2011, 51.0 per cent of deaths in England occurred in hospitals, 19.5 per cent in care homes and 5.6 per cent in hospices.
Table 3.1: Percentage of Deaths in Hospitals, Care Homes and Hospices, 2011\textsuperscript{a, b}

<table>
<thead>
<tr>
<th>Health Board</th>
<th>Hospital</th>
<th>Care Home</th>
<th>Hospice</th>
<th>Total\textsuperscript{c}</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cardiff and Vale University</td>
<td>58.1</td>
<td>14.0</td>
<td>7.2</td>
<td>79.3</td>
</tr>
<tr>
<td>Betsi Cadwaladr University</td>
<td>56.5</td>
<td>17.0</td>
<td>4.1</td>
<td>77.6</td>
</tr>
<tr>
<td>Cwm Taf</td>
<td>65.0</td>
<td>8.0</td>
<td>2.6</td>
<td>75.6</td>
</tr>
<tr>
<td>Abertawe Bro Morgannwg University</td>
<td>61.2</td>
<td>12.4</td>
<td>0.1</td>
<td>73.6</td>
</tr>
<tr>
<td>Hywel Dda</td>
<td>55.3</td>
<td>16.8</td>
<td>1.1</td>
<td>73.2</td>
</tr>
<tr>
<td>Aneurin Bevan</td>
<td>58.5</td>
<td>12.2</td>
<td>2.2</td>
<td>72.9</td>
</tr>
<tr>
<td>Powys Teaching</td>
<td>54.7</td>
<td>16.1</td>
<td>1.9</td>
<td>72.7</td>
</tr>
<tr>
<td>Wales</td>
<td>58.5</td>
<td>14.0</td>
<td>2.7</td>
<td>75.2</td>
</tr>
</tbody>
</table>

Source: ONS

\textsuperscript{a} Hospital deaths includes deaths in NHS and non-NHS hospitals. In Wales, 0.1 per cent of hospital deaths are in non-NHS hospitals.

\textsuperscript{b} Figures are residence based, not provider based. Welsh residents dying in hospitals in England are therefore included. Deaths from non-residents of England and Wales are excluded.

\textsuperscript{c} Total may not equal the sum of the components due to rounding.

3.2 Difference Between Residence and Provider Based Measures

Patients are sometimes admitted to a hospital in a different health board to the one in which they live. Table 3.2 shows the number of hospital admissions in 2011/12 by health board for one residence based measure and two provider based measures:

- **Welsh Residents & LHB of Residence** is residence based. All Welsh residents admitted to hospital are included. Some Welsh residents are admitted to hospital in England.

- **Welsh Residents & Hospital Providers** is provider based. All Welsh residents admitted to hospital are included. As this is provider based, Welsh residents admitted to an English hospital are shown separately.

- **Welsh Providers & Hospital Providers** is provider based. Only patients admitted to hospital in Wales are included. Some English residents are admitted to hospital in Wales.

Table 3.2: Hospital Admissions by Health Board, 01 Apr 2011 – 31 Mar 2012\textsuperscript{a, b}

<table>
<thead>
<tr>
<th>Health Board</th>
<th>Welsh Residents &amp; LHB of Residence</th>
<th>Welsh Residents &amp; Hospital Providers</th>
<th>Welsh Providers &amp; Hospital Providers</th>
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<tbody>
<tr>
<td></td>
<td>Num</td>
<td>%</td>
<td>Num</td>
</tr>
<tr>
<td>Betsi Cadwaladr University</td>
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</tr>
<tr>
<td>Hywel Dda</td>
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<td>12.5</td>
<td>91,263</td>
</tr>
<tr>
<td>Abertawe Bro Morgannwg University</td>
<td>139,791</td>
<td>17.4</td>
<td>155,880</td>
</tr>
<tr>
<td>Cwm Taf</td>
<td>82,062</td>
<td>10.2</td>
<td>84,009</td>
</tr>
<tr>
<td>Aneurin Bevan</td>
<td>158,313</td>
<td>19.8</td>
<td>135,481</td>
</tr>
<tr>
<td>Cardiff and Vale University</td>
<td>111,534</td>
<td>13.9</td>
<td>126,687</td>
</tr>
<tr>
<td>English NHS Trust</td>
<td>.</td>
<td>.</td>
<td>52,102</td>
</tr>
<tr>
<td>Velindre NHS Trust\textsuperscript{c}</td>
<td>.</td>
<td>.</td>
<td>4,388</td>
</tr>
<tr>
<td><strong>Total (All Welsh Providers)</strong></td>
<td>801,481</td>
<td>100.0</td>
<td>749,379</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>801,481</td>
<td>801,481</td>
<td>760,763</td>
</tr>
</tbody>
</table>

Source: Patient Episode Database for Wales, NWIS

\textsuperscript{a} Admissions includes inpatients, day cases and women using delivery facilities.

\textsuperscript{b} Patients transferred from another NHS provider are counted as a new admission.

\textsuperscript{c} National NHS trust for Wales providing specialist cancer services.
The table shows that there is considerable variation between where patients live and the location of the hospital they are admitted to. The effect is largest in Powys where only 4,000 of the 32,000 residents admitted to hospital were treated in Powys.

There are ten community hospitals in Powys but there is no district general hospital because the size and distribution of the population make one unviable. Patients living in Powys are therefore often admitted to a hospital in another health board in Wales or are admitted to a hospital in England such as Hereford Hospital. Figure D1 (Appendix D) shows that some parts of Powys are closer to hospitals in England than in Wales.

The Countess of Chester Hospital also treats some patients living in Wales. Over 52,000 (6.5 per cent) of Welsh residents were admitted to hospital in England in 2011/12 but the table also shows that over 11,000 non-Welsh residents (the majority of which are likely to be English) were admitted to hospital in Wales. Many of these are treated in Betsi Cadwaladr, which provides services for people in north Wales, parts of mid Wales, Cheshire and Shropshire. In addition, Cardiff and Vale admits patients living in south and mid Wales and Abertawe Bro Morgannwg also serves a wider community.

3.3 In-Hospital Death Rates by Health Board

Figure 3.2 shows that the crude in-hospital death rate for Wales for the financial year 2011/12 was 31.7 per 1,000 but varied at health board level between 35.6 (Hywel Dda) and 26.1 (Cardiff and Vale). These figures do not take into account the different hospital admission population structures in the different health boards. Cardiff and Vale is the only health board where significantly less than a third (26 per cent) of the patients admitted in 2011/12 were aged 65 or over. In comparison, 39 per cent of the patients admitted to Hywel Dda in 2011/12 were aged 65 or over and 37 per cent in Betsi Cadwaladr.

Table C2 (Appendix C) provides a time series of crude death rates at health board level from 2001 to 2011. The table shows that hospital mortality has been falling in Wales since 2007/08.

Figure 3.3 shows directly standardised rates in 2011/12 by health board. These were calculated by applying age specific death rates for admissions in each health board to the hospital admission population of Wales. They can be interpreted as the rate that the health board would experience if it had the population structure of hospital admissions in Wales.

After standardising by age, Aneurin Bevan has the lowest hospital death rate (29.6 per 1,000) and Cwm Taf the highest (34.9 per 1,000). These figures only account for the age of patients. There are other factors that affect a patient’s probability of dying including their sex and the presence of other diseases, which these rates do not adjust for.

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10 Powys only treats around 4,000 residents (see Section 3.2). Figures for Powys Teaching Health Board are therefore not presented in this section as they are based on small numbers and there are concerns over their robustness.

11 Figures exclude admissions from day cases but include maternity admissions. Abertawe Bro Morgannwg - 33 per cent; Aneurin Bevan - 33 per cent; Cwm Taf - 32 per cent; Wales - 33 per cent. Source: WG, calculated using data from NWIS.
Figure 3.2: Crude In-Hospital Death Rates (per 1,000) for 01 Apr 2011 – 31 Mar 2012, by Health Board (r) \(^a, b, c\)

Source: WG, calculated using data from NWIS

(r) Revised 28 June 2013 due to minor inaccuracies in the data supplied.

\(^a\) Crude death rates do not take into account varying age structures in different populations.

\(^b\) Figures exclude admissions from day cases. The risk of death in day case patients is low. Figures include maternity admissions.

\(^c\) Figures are provider based and include non-Welsh residents being treated in Wales. NWIS are currently investigating whether possible improvements to the methodology used to calculate provider spells from hospital spells can be made.

Figure 3.3: Directly Age Standardised In-Hospital Death Rates (per 1,000) for 01 Apr 2011 – 31 Mar 2012 (r), by Health Board \(^a, b, c\)

Source: WG, calculated using data from NWIS

(r) Revised 28 June 2013 due to minor inaccuracies in the data supplied.

\(^a\) Age specific death rates for each health board have been applied to the hospital admission population of Wales 2011/12.

\(^b\) Figures exclude admissions from day cases. The risk of death in day case patients is low. Figures include maternity admissions.

\(^c\) Figures are provider based and include non-Welsh residents being treated in Wales. NWIS are currently investigating whether possible improvements to the methodology used to calculate provider spells from hospital spells can be made.
Section 2.2 discussed the link between levels of population mortality and the deprivation of an area. There is also a link between deprivation and hospital mortality as the characteristics of patients admitted to hospital are likely to vary according to the level of deprivation in the area the hospital is situated.

Table 2.1 showed the percentage of lower super output areas (small geographical areas with about 1,500 people in each) in the most deprived fifth of Wales for each health board. Cwm Taf and Abertawe Bro Morgannwg have the highest percentage of areas in the most deprived fifth of Wales and are also the health boards with the two highest directly standardised rates for population and hospital mortality.

The directly standardised rates will also be influenced by service provision. As discussed in Section 3.1, the provision of care homes and hospices varies between health boards. Health boards with less provision of care homes and hospices will have a hospital population that is slightly more at risk of death than areas with higher provision of care homes and hospices. Cwm Taf and Abertawe Bro Morgannwg have the highest proportion of deaths in hospital.

Aneurin Bevan has the lowest standardised rate but relatively high levels of deprivation and a relatively high percentage of deaths occurring in hospital. This may be partly explained by the differences in deprivation within the health board – whilst 24 per cent of areas are in the most deprived fifth of Wales, 19 per cent are in the least deprived fifth.

Table C3 (Appendix C) shows directly standardised rates for each health board from 2001/02 to 2011/12. These figures should only be used to compare mortality levels between health boards within the same year. The figures should not be used to compare mortality between years because the standard population used – hospital admissions in Wales – varies each year.

The European Standard Population would have been an alternative standard population but this was not used because it is very different from the population of admissions into hospitals, which is older than the general population. Whilst 36 per cent of patients admitted into hospital in Wales in 2011/12 were aged 65 or over, only 11 per cent of the European Standard Population are in this age group. Standardising to the European Standard Population may lead to misleading standardised rates because considerable emphasis would have been placed on deaths in younger age groups when calculating them.

3.4 Introduction to Risk Adjusted Mortality Measures

The concept of avoidable mortality is described by the ONS (2012b, p. 3) as “deaths caused by certain conditions, for which effective public health and medical interventions are available, should be rare, and ideally should not occur”. The existence of avoidable harm and avoidable mortality is not disputed although its extent is; studies from the UK, US, Europe and Australia have suggested that roughly 10 per cent of patients experience an adverse event during a hospital stay whilst up to one in three hundred patients die as a result of treatment deficiencies, although the British Medical Journal has argued that this figure is overstated (Robinson, 2013; 1000 Lives, 2010).
The existence of avoidable mortality has driven the development of hospital mortality measures. There are three ways hospital mortality tends to be measured. Firstly, case notes of all deaths can be reviewed. This enables levels of avoidable mortality to be assessed. Secondly, crude mortality rates can be used to monitor mortality levels over time. These are easy to calculate but do not take into account risk factors that influence death and cannot be used to assess avoidable mortality. Thirdly, risk adjusted mortality measures can be calculated that account for variables that influence the risk of dying such as age and sex (1000 Lives, 2010).

Risk adjusted measures attempt to quantify the number of unexpected deaths but should not be interpreted as the number of avoidable deaths. A common analogy used is that of a smoke alarm; if a smoke alarm goes off, it does not necessarily mean there is a fire. Similarly, a high risk adjusted measure should not be ignored as it indicates a possible problem in the quality of care but more often is a result of factors unrelated to quality of care (Raleigh, 2011; Flowers et al., 2010) such as configuration of services or data recording issues (NHS Information Centre, 2010). Furthermore, these measures cannot be used as a league table because they use indirect standardisation and, as discussed in Section 2.1.3b, erroneous conclusions can be drawn when comparing indirectly standardised mortality measures as values are formed using different population structures.

Three risk adjusted measures have been developed: Risk Adjusted Mortality Index (RAMI), Hospital Standardised Mortality Ratios (HSMRs) and the Summary Hospital-level Mortality Indicator (SHMI). These measures involve predicting the probability of a patient dying based on a set of characteristics; these vary between measures but can include age, sex, admission method, socio-economic information and data on comorbidity (the presence of other diseases). The number of predicted deaths is compared to the number of observed deaths.

RAMI was developed in the 1990s and is the measure currently used in Wales to monitor hospital mortality at a national and organisational level (Robinson, 2013). The amount of information published on the details of how the index is calculated is limited as it is managed by a private company, Caspe Healthcare Knowledge Systems (CHKS), and is therefore a commercial product.

HSMRs have been published each year since 2001 and were developed by Imperial College, London – they are now managed by the Dr Foster Unit at the College. HSMRs are used by a number of countries including the US, Canada and the Netherlands (Dr Foster Intelligence, 2012). SHMI was borne out of a review by the Department of Health on HSMRs. It was first published in 2011 and is now the official, NHS hospital-wide mortality indicator for acute trusts in England (Raleigh, 2011). HSMR and SHMI are not currently produced for Wales.
Regression is a statistical technique that is used to predict the value of one variable from the values of one or more other variables. Logistic regression is used when the variable that is being predicted has two categories. Logistic regression models predict probabilities for each record which can be used to determine the predicted category. The risk adjusted mortality measures introduced in Section 3.4 use logistic regression to predict the probability of a patient’s death.

The process of calculating the HSMR and SHMI is as follows:

1. Each patient has a diagnosis group based on the 10th revision of the International Classification of Diseases (ICD-10) (e.g. cancer of bladder, acute myocardial infection). A logistic regression model is fitted for each diagnosis group using data on the hospitalised population for England. HSMR and SHMI use 56 and 138 diagnosis groups respectively.

2. Indirect standardisation (described in Section 2.1.3b) by age group, sex and diagnosis group is then applied. For each age-sex-diagnosis group, the predicted probabilities of death for patients output from the regression models are totalled to obtain the number of predicted (or expected) deaths in the group.

   The risk of death in England for each age-sex-diagnosis group is calculated by dividing the number of observed deaths by the number of predicted deaths obtained from the models.

3. For each age-sex-diagnosis group, the risk of death in England is applied to the total admissions for the given group in each hospital. This obtains the number of expected deaths in the hospital for the given group.

4. The total number of expected deaths in each hospital is obtained by summing all the expected deaths in the given hospital for all the age-sex-diagnosis groups.

5. The risk adjusted measure for each hospital is calculated by dividing the number of actual deaths by the number of expected deaths, in the same way as the standardised mortality ratio (4). Risk adjusted measures are sometimes multiplied by 100 and can be interpreted in the same way as the standardised mortality ratio.

6. Risk adjusted measures are often plotted on funnel plots, where the y-axis is the value of the risk adjusted measure and the x-axis is the expected number of deaths. The plots contain a centre horizontal line drawn at the national baseline (normally either 1.0 or 100) and two lines referred to as upper and lower control limits, which reflect the expected variation in the data due to random or chance variation. Data points falling outside the control limits are unlikely to be caused by chance.

   (Campbell et al., 2011; Campbell et al., 2012; Dr Foster Intelligence, 2012; Flowers et al., 2010; NHS Information Centre, 2013a)

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12 An accessible introduction to regression techniques can be found in Field (2005).
13 Very little information on the methodology used to calculate RAMI is published. It is unknown how similar the methodology used to calculate RAMI is to that used to calculate HSMRs and SHMI.
3.6 Differences Between Risk Adjusted Mortality Measures

There are a number of differences between the three risk adjusted measures which affect their values. Campbell et al. (2012) have summarised the differences between HSMR and SHMI, which include the following:

- SHMI includes deaths that occur up to 30 days after discharge from hospital whereas HSMR uses in-hospital deaths only. This increases the number of deaths used in the calculation on average (in England) by about 35 per cent (CHKS, 2011a).
  
  The 30 day time frame was thought to be a suitable compromise between using a short time frame to make it more likely that a death is connected to the quality of hospital care as opposed to later interventions such as social and community care, and a long time frame to catch the late effects of care (Campbell et al., 2012).

- Only about 83% of in-hospital deaths are included in HSMR because it only uses 56 diagnosis groups.

- The variables used in the model vary but both use the Charlton comorbidity index\(^1\) to measure comorbidity. HSMR uses a backwards elimination stepwise procedure for variable selection (Dr Foster Intelligence, 2012) but SHMI uses a full model (NHS Information Centre, 2013a).\(^2\)

- Some patients die after a transfer to another hospital. SHMI only includes the death in the statistics for the last admitting hospital whereas HSMR includes the death in the statistics for all hospitals involved.

  There are theoretical concerns about only assigning the death to the last admitting hospital as, for example, poor quality care in an earlier hospital may lead to an emergency transfer, with the potential for death in the receiving hospital. However, admissions spanning several hospitals account for less than one per cent of admissions in England (Campbell et al., 2012) so the impact on measures is small.

Table 3.3, adapted from Campbell et al. (2012), summarises these differences. The methodology for RAMI is less transparent due to the commercial nature of the measure but the table includes a column for RAMI for completeness. RAMI only includes in-hospital deaths, uses the highest risk diagnosis in the spell to represent comorbidity rather than the Charlson comorbidity index and, unlike SHMI, RAMI excludes palliative care cases. Hospital mortality levels are affected by whether there are on-site hospice services but palliative care cases are currently included in SHMI (with no adjustment made for them) because of variations in palliative care coding (NHS Information Centre, 2010).

RAMI also excludes zero length emergency admissions (patients admitted and discharged on the day). SHMI excludes zero length emergency admissions to calculate expected deaths but includes deaths from this group in the number of observed deaths (NHS Information Centre, 2010).\(^3\) There is evidence that different hospitals have different admissions policies which affect the percentage of emergency patients they admit and discharge on the same day and

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\(^1\) See Charlson et al. (1987) for details.
\(^2\) A full model is one that includes all the variables. A backwards elimination stepwise procedure is a type of automated procedure that can be used to select a subset of variables for use in a final model. Field (2005) provides a discussion on stepwise methods.
\(^3\) SHMI also excludes day cases to calculate expected deaths but includes day case deaths in the number of observed deaths (NHS Information Centre, 2010).
therefore the relationship between admission method and risk of death may vary across hospitals (Mohammed et al., 2009). However, as SHMI does not include zero length emergency admissions to calculate expected deaths, the impact is small because this group of patients have a low risk of death.

Table 3.3: Differences Between SHMI, HSMR and RAMI (Adapted from Campbell et al., 2012)

<table>
<thead>
<tr>
<th>Properties</th>
<th>SHMI</th>
<th>HSMR</th>
<th>RAMI</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Indicator</strong></td>
<td>In-hospital mortality and mortality up to 30 days after discharge</td>
<td>In-hospital mortality</td>
<td>In-hospital mortality</td>
</tr>
<tr>
<td>Proportion of deaths reported</td>
<td>100% of deaths</td>
<td>Approximately 83% of in-hospital deaths</td>
<td>..</td>
</tr>
<tr>
<td>Excluded admissions</td>
<td>Day cases</td>
<td>Day cases</td>
<td>..</td>
</tr>
<tr>
<td>Variables</td>
<td>Age, sex, type of admission (emergency / elective / missing), comorbidity, year of discharge</td>
<td>Age, sex, type of admission, month of admission, year of discharge, deprivation, comorbidity, number of emergency admissions in previous 12 months, palliative care, ethnicity, source of admission</td>
<td>Age, sex, race, diagnosis related groups, presence or absence of comorbidity, presence of any secondary diagnosis</td>
</tr>
<tr>
<td>Missing values</td>
<td>No exclusions (ensures 100% of deaths are included)</td>
<td>Exclusion of episodes with missing age, sex, type of admission and year of discharge</td>
<td>..</td>
</tr>
<tr>
<td>Deaths in admissions spanning hospitals</td>
<td>Assigned to last admitting hospital</td>
<td>Assigned to all hospitals involved in admission</td>
<td>..</td>
</tr>
<tr>
<td>Palliative Care</td>
<td>Included</td>
<td>Included</td>
<td>Excluded</td>
</tr>
<tr>
<td>Zero length of stay emergencies</td>
<td>Included in observed deaths, excluded in expected deaths</td>
<td>..</td>
<td>Excluded</td>
</tr>
</tbody>
</table>

Sources: SHMI and HSMR information: Campbell et al. (2012) & NHS Information Centre (2013a) [variable list only] RAMI information: 1000 Lives (2010) [variable list only] & CHKS (2011a)

* Ethnicity was removed from HSMR in 2011 (Dr Foster Intelligence, 2012).

3.7 Issues Affecting the Usage of Risk Adjusted Mortality Measures

The NHS Information Centre (2010) has described six issues that affect the usage of SHMI:

1. There is no gold standard quality of care indicator and no perfect method of deriving it.
2. SHMI used on its own as a quality of care measure does not have face validity.
3. SHMI is complex and open to misunderstanding and misinterpretation.
4. Deaths following admission to hospital may fall into a number of categories.
5. Attributing deaths to specific NHS Trusts is complex.
6. Data quality and coding issues impact on the ability to use SHMI to assess differences over time and between hospitals.

These issues apply to all risk adjusted measures including RAMI in Wales.
3.7.1 Lack of a Gold Standard

There are different methods that can be used to derive risk adjusted measures, as previously discussed in Section 3.6. No method can be considered to be the most appropriate and therefore none of the indicators developed can be considered as a gold standard. However, this does not prevent using a risk adjusted measure to monitor hospital mortality levels although their methodologies need to be borne in mind when interpreting the measures and any differences between them.

3.7.2 Face Validity

Views vary as to the levels of confidence that can be placed in risk adjusted measures and whether it is sensible to use hospital-wide mortality as a measure of care quality as most hospital deaths are unavoidable or inevitable (Raleigh, 2011).

Some objections to risk adjusted measures are made on the basis of the signal to noise ratio (Hawkes, 2013); as the percentage of avoidable deaths is very low, it is difficult when analysing the measures to distinguish between useful information (the number of deaths due to poor quality of care) and background information (the number of deaths due to factors unrelated to poor quality of care). Whilst members of the technical group that reviewed HSMRs differed in their level of confidence in SHMI as an indicator of care quality, all agreed that SHMI “can and should be used as a trigger to ask hard questions” (NHS Information Centre, 2010, p. 10).

There is a recognition that risk adjusted measures can not be used on their own as a measure of care quality and accordingly a number of contextual indicators (such as palliative care, admission method and social deprivation) are published alongside SHMI to aid interpretation of the measure (NHS Information Centre, 2013a).

3.7.3 Interpretation

Risk adjusted measures are open to misunderstanding and misinterpretation due to their complexity. Flowers et al. (2010) describe four areas of consideration when interpreting risk adjusted measures:

1. Often the measures are interpreted as the number of avoidable deaths but this is not a valid interpretation as the measures attempt to quantify unexpected deaths, not preventable deaths. The term excess deaths is not a synonym for avoidable deaths.

2. Risk adjusted measures can not be used to compare between hospitals or trusts. It was mentioned in Section 2.1.3b that standardised mortality ratios (and indirectly standardised death rates) could not be used to compare levels of mortality between populations because they are calculated using different population structures. Risk adjusted measures use indirect standardisation. It is therefore inappropriate to rank values of risk adjusted measures and use the results as league tables – it is only appropriate to compare the value with the national average (the standard population).\(^{17}\)

3. Risk adjusted measures are relative measures to the national population so a risk-adjusted value for a hospital may fall but the crude death rate may have increased.

\(^{17}\) Flowers et al. (2010) provide a fictitious example of one trust having higher mortality rates than another but having a lower standardised mortality ratio.
4. Expected mortality in the national population is normally set at 100. This baseline needs to be consistent. The number of expected deaths will be overestimated if the model used to calculate them is based on data from previous years because mortality rates are currently falling over time.

SHMI is rebased on a quarterly basis meaning that if the overall average for England (the baseline) has improved and the performance of a hospital has improved by the same scale, the value of SHMI for a given hospital changes little (NHS Information Centre, 2013b).

A further factor that needs to be considered when interpreting risk adjusted measures is that service configuration differs between areas. People may die at home, in hospitals, hospices or care homes, and the level of provision of these facilities affects the numbers of hospital deaths and therefore affects hospital mortality measures. The higher the proportion of deaths in hospitals compared with the national average, the higher the mortality ratio is (Flowers et al., 2010).

Furthermore, pathways of care also vary between areas. For instance, a stroke pathway in London means patients are first admitted into Hyper Acute Stroke Units to receive emergency treatment before being transferred to a local hospital within around 72 hours. The patients admitted into the stroke units are likely to vary in terms of their risk of death to the patients admitted into the local hospital and therefore different pathways can affect the number of observed and expected hospital deaths (CHKS, 2011b).

Also, differences in the methods used – such as whether the measures include palliative care cases, emergency admissions of zero length and out of hospital deaths – affect the values of the measures and therefore need to be considered when interpreting them.

3.7.4 Categorisation of Deaths

Risk adjusted measures cannot distinguish between different types of death, such as inevitable or expected deaths, potentially avoidable deaths or deaths that are not potentially avoidable, as not all of the required information is recorded in the data. Furthermore, different measures have different approaches to where a death is counted when a patient has been transferred (see Table 3.3).

3.7.5 Attributing Deaths to NHS Trusts

SHMI includes deaths occurring 30 days after discharge from hospital but this may add some bias effects into the measure according to discharge policies or opportunities available. For example, hospitals treating deprived, socially isolated populations may find it harder to discharge patients than hospitals treating less deprived populations (Campbell et al., 2012).

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18 If the information was recorded that could distinguish between these different categories of death then the numbers of preventable deaths could be obtained directly from the recorded data and therefore there would be no need for risk adjusted measures.
3.7.6 Data Quality and Coding

The accuracy and completeness of coded clinical data about diagnoses and comorbidities affects the validity of risk adjusted measures. In particular, the coding of palliative care cases and their treatment in the measures is important because a death may be an acceptable and expected outcome when someone is receiving palliative care.\(^\text{19}\)

Palliative care cases are treated in different ways in risk adjusted measures; RAMI excludes them (CHKS, 2011a), HSMRs include them and also include a palliative care predictor variable (Campbell et al., 2012), whilst SHMI includes palliative care cases but currently makes no adjustment for them (NHS Information Centre, 2010). It has been suggested that some hospitals increased their levels of palliative care coding to reduce the value of their RAMI or HSMR measure (Hawkes, 2013).

Current guidance on the coding of palliative care cases (in England) is that any patient who has any contact with a member of the palliative care team, regardless of the type of activity, should be coded as receiving palliative care. However, other hospital trusts only use a palliative care code if a patient has been seen by a palliative care consultant whilst a few trusts only code patients as receiving palliative care if the patient is under the care of a palliative care consultant or in a hospice facility (NHS Information Centre, 2013c). Inconsistencies in the definition used have an impact on the values of risk adjusted measures.

There is likely to be variation in the coding on admissions, which will bias results. Risk adjusted measures are also affected by the number of secondary diagnoses coded as these are used to form the comorbidity predictor variable in the model. The average number of diagnoses per patient is referred to as the depth of coding and data quality audits have demonstrated that the depth of coding varies between hospitals. An increased depth of coding has the potential to reduce the value of the risk adjusted measure (Flowers et al., 2010).

There are limitations in using comorbidity measures in the models predicting the probability of death. It would be preferable to be able to differentiate between conditions present on admission and those on discharge but this information is not available in the hospital episode statistics database (Campbell et al., 2012). Furthermore, measures of comorbidity can only be a proxy measure for how ill a patient is.

There are also data quality issues surrounding timing and completeness of coding. There is a target in Wales that 95 per cent of all episodes of care are coded within three months of discharge but there is variable success in meeting this. Even if met, uncoded episodes still represent thousands of records. It is also possible that uncoded episodes are the hardest to code and bias may be introduced as a result. The length of time it takes to code cases affects when risk adjusted measures can be produced and therefore when an indication of a possible problem in the quality of care is available.

\(^{19}\) There is a difference between palliative care and end of life care although it is not easy from a clinical perspective to separate them (NHS Information Centre, 2010).
4.0 Conclusion and Next Steps

This article has shown that there are a number of measures used to monitor levels of mortality and that they vary in their complexity. Population mortality is often measured using a combination of crude and standardised death rates whereas hospital mortality tends to be monitored using risk adjusted measures, which are estimated using both indirect standardisation and logistic regression methods.

Mortality measures estimated using indirect standardisation can not be compared with each other because they are calculated using different population structures, meaning risk adjusted measures can not be used as a league table for hospitals.

The Welsh Government is developing a new statistical publication on mortality, which will cover both population mortality and hospital mortality. This statistical article is the first in a series that publishes the development of work in producing a data series on hospital mortality. This statistical series may include a SHMI-type measure published on a quarterly basis but there are a number of areas of further work that need to be undertaken before a Welsh SHMI measure can be developed:

- The appropriateness of a Welsh SHMI-type measure needs to be considered, including whether the justification for its development in England also applies in Wales and whether other measures (such as HMSR) are more appropriate.

- The impact on SHMI of the health service model in Wales, including the size and structure, needs to be considered. Risk adjusted measures are provider based and only a small minority of patients in Powys are treated inside the health board, meaning a risk adjusted measure for Powys may not be viable.

- If risk adjusted measures are not viable at health board level, a measure based on health conditions rather than health boards may be more appropriate.

- Coding quality in Wales and its impact on SHMI needs to be understood. The quality of coding may affect the form of a new risk adjusted measure – for instance, the English SHMI does not adjust for palliative care cases due to inconsistencies in coding (NHS Information Centre, 2010).

An assessment of these issues will be published in future statistical articles. We welcome feedback on this statistical article and can be contacted at stats.healthinfo@wales.gsi.gov.uk.
5.0 References


Appendix A: Local Authorities and Health Boards in Wales

Figure A1: Map of Local Authorities and Health Boards in Wales

Local Health Boards
- A Betsi Cadwaladr University
- B Hywel Dda
- C Powys Teaching
- D Abertawe Bro Morgannwg University
- E Cwm Taf
- F Cardiff & Vale University
- G Aneurin Bevan

Note: Public Health Wales NHS Trust incorporates the functions and services provided by the National Public Health Service for Wales (NPHS), the Wales Centre for Health, the Welsh Cancer Intelligence and Surveillance Unit (WCISU), the Congenital Anomaly Register and Information Service (CARIS) and Screening Services Wales.

October 2009
**Appendix B: Population Mortality Data**

### Table B1: Crude Death Rates (per 1,000), by Health Board (Area of Residence) and Calendar Year \(^\text{a, b}\)

<table>
<thead>
<tr>
<th>Health Board</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
</tr>
</thead>
<tbody>
<tr>
<td>Betsi Cadwaladr University</td>
<td>11.9</td>
<td>11.8</td>
<td>11.9</td>
<td>11.4</td>
<td>11.4</td>
<td>11.0</td>
<td>11.0</td>
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Source: WG, calculated using data from ONS (deaths data and mid-year population estimates)

\(^{a}\) Crude death rates do not take into account varying age structures in different populations.

\(^{b}\) Figures are residence based, not provider based. Welsh residents dying in England are therefore included. Deaths from non-residents of England and Wales are excluded.

### Table B2: Directly Age Standardised Death Rates (per 1,000), by Health Board (Area of Residence) and Calendar Year \(^\text{a, b}\)

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Source: WG, calculated using data from ONS (deaths data and mid-year population estimates)

\(^{a}\) Age specific death rates for each health board have been applied to the European Standard Population.

\(^{b}\) Figures are residence based, not provider based. Welsh residents dying in England are therefore included. Deaths from non-residents of England and Wales are excluded.

### Table B3: Age Standardised Mortality Ratios, by Health Board (Area of Residence) and Calendar Year \(^\text{a, b, c}\)

<table>
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<tr>
<th>Health Board</th>
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Source: WG, calculated using data from ONS (deaths data and mid-year population estimates)

\(^{a}\) Standardised Mortality Ratios should not be used to compare mortality levels between populations or years.

\(^{b}\) Age specific death rates for Wales have been applied to the populations of health boards.

\(^{c}\) Figures are residence based, not provider based. Welsh residents dying in England are therefore included. Deaths from non-residents of England and Wales are excluded.
Table C1: Percentage of Deaths in Hospital, by Health Board (Area of Residence) and Calendar Year a, b

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Source: ONS

a Hospital deaths includes deaths in NHS and non-NHS hospitals. In Wales, 0.1 per cent of hospital deaths are in non-NHS hospitals.
b Figures are residence based, not provider based. Welsh residents dying in hospitals in England are therefore included. Deaths from non-residents of England and Wales are excluded.

Table C2: Crude In-Hospital Death Rates (per 1,000), by Health Board and Financial Year (r) a, b, c

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Source: WG, calculated using data from NWIS

(r) Revised 28 June 2013 due to minor inaccuracies in the data supplied.
a Crude death rates do not take into account varying age structures in different populations.
b Figures exclude admissions from day cases. The risk of death in day case patients is low. Figures include maternity admissions.
c Figures are provider based and include non-Welsh residents being treated in Wales. NWIS are currently investigating whether possible improvements to the methodology used to calculate provider spells from hospital spells can be made.
d Figures for 2001/02 should be used with caution as coding practices relating to daycases and regular attenders differed in this year.

Table C3: Directly Age Standardised In-Hospital Death Rates (per 1,000), by Health Board and Financial Year (r) a, b, c

<table>
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</table>

Source: WG, calculated using data from NWIS

(r) Revised 28 June 2013 due to minor inaccuracies in the data supplied.
a Age specific death rates for each health board have been applied to the hospital admission population of Wales. Figures should not be used to compare morality between years as the standard population varies in each year.
b Figures exclude admissions from day cases. The risk of death in day case patients is low. Figures include maternity admissions.
c Figures are provider based and include non-Welsh residents being treated in Wales. NWIS are currently investigating whether possible improvements to the methodology used to calculate provider spells from hospital spells can be made.
d Figures for 2001/02 should be used with caution as coding practices relating to daycases and regular attenders differed in this year.
Appendix D: Location of Hospitals with Major A&E Units in Wales and West England

Figure D1: Location of Major A&E Units and Centres of Population

Wales is divided into small geographical areas known as lower super output areas (LSOAs). They contain about 1,500 people in each but vary in geographical size. The yellow dots represent the centre of where the population at census time was spatially distributed and grouped within that LSOA. (Source: ONS)
Notes on the use of statistical articles

Statistical articles generally relate to one-off analyses for which there are no updates planned, at least in the short-term, and serve to make such analyses available to a wider audience than might otherwise be the case. They are mainly used to publish analyses that are exploratory in some way, for example:

- Introducing a new experimental series of data;
- A partial analysis of an issue which provides a useful starting point for further research but that nevertheless is a useful analysis in its own right;
- Drawing attention to research undertaken by other organisations, either commissioned by the Welsh Government or otherwise, where it is useful to highlight the conclusions, or to build further upon the research;
- An analysis where the results may not be of as high quality as those in our routine statistical releases and bulletins, but where meaningful conclusions can still be drawn from the results.

Where quality is an issue, this may arise in one or more of the following ways:

- being unable to accurately specify the timeframe used (as can be the case when using an administrative source);
- the quality of the data source or data used; or
- other specified reasons.

However, the level of quality will be such that it does not significantly impact upon the conclusions. For example, the exact timeframe may not be central to the conclusions that can be drawn, or it is the order of magnitude of the results, rather than the exact results, that are of interest to the audience.

The analysis presented does not constitute a National Statistic, but may be based on National Statistics outputs and will nevertheless have been subject to careful consideration and detailed checking before publication. An assessment of the strengths and weaknesses in the analysis will be included in the article, for example comparisons with other sources, along with guidance on how the analysis might be used, and a description of the methodology applied.

Articles are subject to the release practices as defined by the release practices protocol, and so, for example, are published on a pre-announced date in the same way as other statistical outputs. Missing value symbols used in the article follow the standards used in other statistical outputs, as outlined below.

- The data item is not available
- The data item is not applicable
- The data item is not exactly zero, but estimated as zero or less than half the final digit shown
* The data item is disclosive or not sufficiently robust for publication