

Statistical bulletin

# Impact of the Implementation of IRIS Software for ICD-10 Cause of Death Coding on Mortality Statistics, England and Wales

The differences produced by categorising deaths using MMDS and IRIS software, and the effect on statistics that use cause of death data of using IRIS software.

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# 1. Main findings

- Dual coding of 38,718 deaths registered in 2012 in England and Wales showed statistically significant percentage increases in the deaths allocated to an underlying cause in seven ICD-10 chapters, and significant decreases for five chapters when coded in ICD-10 v2013 (IRIS). However 95 % of deaths remained in the same chapter.
- A change in the coding of chest infections contributed to a reduction of 2.5% in deaths allocated an underlying cause of respiratory disease and an increase of 7.0% in those allocated to the mental and behavioural disorders chapter, which includes dementia.
- Deaths given an underlying cause of dementia were also increased by a rule change to count aspiration pneumonia as being a consequence of one of a number of other conditions. The total percentage change in deaths attributed to an underlying cause of dementia was 7.1%.
- Deaths allocated certain infectious and parasitic diseases as an underlying cause increased by 4.9% following the transfer of deaths involving sepsis/septicaemia from other chapters.
- A rule change to count diabetes as the underlying cause of certain types of renal disease led to an increase of 5.7 per cent in the chapter on endocrine, nutritional and metabolic diseases. Deaths with an underlying cause of diabetes rose by 6.8%.

## 2. Background

The Office for National Statistics (ONS) code cause of death using the World Health Organization's (WHO) International Classification of Diseases, Tenth Revision (ICD-10). Where possible, deaths are automatically coded using specialist software, with the remaining deaths being manually coded by highly trained coders. ICD-10 was introduced in England and Wales in January 2001. Since then various amendments have been authorised by WHO. Amendments may (for example) correct errors in the software supporting automatic coding, accommodate new codes in response to new conditions, such as the H1N1 virus (swine flu), or incorporate advances in medical knowledge of the relationship between conditions.

Until December 2010, ONS used the Mortality Medical Data System (MMDS) ICD-10 version 2001.2 software provided by the United States National Center for Health Statistics (NCHS) to code cause of death. In January 2011, this was updated to version 2010, which incorporated most of the WHO amendments authorised up to 2009.

On 1 January 2014, ONS changed the software used to code cause of death to a package called IRIS (version 2013). The development of IRIS was supported by Eurostat, the statistical office of the European Union, and is now managed by the IRIS Institute hosted by the German Institute of Medical Documentation and Information in Cologne. IRIS software version 2013 incorporates all official updates to ICD-10 approved by WHO, which were timetabled for implementation before 2014.

## 3. Reason for the change

The IRIS software has been developed to provide a common automated cause of death coding system to code cause of death information provided on death certificates in any language, using ICD mortality coding rules and instructions. The use of the IRIS software will improve the comparability of mortality statistics across Europe and internationally. Currently IRIS uses components of the NCHS MMDS to code the causes of death mentioned on the death certificate, and to allocate the underlying cause of death. These components will be replaced with versions developed by the IRIS Institute in a forthcoming IRIS version.

## 4. Main changes introduced by ONS using IRIS software v2013

- IRIS includes major updates to the ICD-10 approved by WHO. There have been additions to, and deletions from, the tabular list of ICD codes (volume 1); amendments to the selection and modification rules contained in the instruction manual (volume 2); and changes to the alphabetical index (volume 3).
- These updates include significant changes to the use of codes within the neoplasms chapter (ICD-10 codes C00-D48) which includes deaths from cancers (ICD-10 codes C00-C97).
- A small number of changes to the coding of other specific conditions have been made to bring previous coding practice into line with international coding rules.
- For stillbirths and neonatal deaths, any maternal condition mentioned on the death certificate will be coded to the P Chapter (certain conditions originating in the perinatal period) rather than elsewhere in the ICD classification. Previously these deaths may have been coded to the O chapter (pregnancy, childbirth and the puerperium).

## 5. Evaluating the impact of IRIS on mortality statistics

ONS carried out a dual coding study in which a sample of deaths registered throughout 2012, already coded using the ICD-10 v2010 software and rules (NCHS), were recoded using ICD-10 v2013 rules (IRIS).

### Sample

To avoid seasonal influences on causes of death affecting the analysis, records were selected from each quarter of 2012. Weeks containing, or immediately following a bank holiday, were excluded due to the atypical number of death registrations in those weeks. Neonatal deaths (under 28 days) were excluded, and the impact of the coding change on these deaths will be reported separately.

In total 38,718 deaths registered in four weeks (one week in each of January, April, July and October 2012) were dual coded, comprising 7.8% of all non-neonatal deaths registered in 2012.

### Limitations

The sample size of 38,718 deaths does not give enough statistical power to analyse the impact of changing from ICD-10 v2010 (NCHS) to ICD-10 v2013 (IRIS) for less common categories of cause of death, such as diseases of the skin and subcutaneous tissue or very specific causes of death, such as malignant neoplasm of the palate, as there are very few deaths from these causes in the sample. The small sample size is also a problem in those cases where the changes between the ICD-10 versions are relatively small.

As the sample of records was dual coded in a test environment, there were a small number of differences in the coding practices used compared with the live coding environment. For example, in the live coding environment, a special on-screen browser is used to assist manual coding, but this browser was not available for the dual coding. It is anticipated that these processing differences will have a minimal impact on coding for the majority of deaths. The biggest impact of these differences in the coding process will be on deaths that are certified by a coroner following an inquest (for example, deaths from external causes such as drug poisoning), as these deaths are always manually coded. However, the impact of slight methodological differences is likely to be small, even with these manually coded deaths.

## 6. Results

The results reported here are based on the underlying cause of death. This is defined by the WHO as:

- the disease or injury which initiated the train of morbid events leading directly to death
- the circumstances of the accident or violence which produced the fatal injury

More information about the selection of underlying cause of death from among the conditions mentioned on a death certificate can be found in the background notes.

[Table 1 \(59 Kb Excel sheet\)](#) shows a cross-tabulation of deaths from the dual coding study grouped by the ICD-10 chapter of the underlying cause of death, presenting results from both ICD-10 versions (ICD-10 v2010, NCHS and ICD-10 v2013, IRIS). The table shows that more than 95% of deaths in this sample remained in the same chapter. However, there were movements in and out of some chapters reflecting the changes in the selection of the underlying cause of death from the combination of conditions recorded on the death certificate. The impact of these movements on specific chapters is examined in the individual chapter sections below.

Comparability ratios (with confidence intervals) have been calculated using standard methods. These are the ratio of the number of deaths coded to a particular underlying cause in ICD-10 v2010 (NCHS), to the number coded to the same cause in ICD-10 v2013 (IRIS). These ratios reflect the net effect of the change. If the ratio is 1, the number of deaths coded to that cause is the same in both versions. If the comparability ratio is 0.5, half as many deaths have been coded to that cause using ICD-10 v2013 (NCHS), compared with ICD-10 v2010 (IRIS). Confidence intervals indicate the reliability of the comparability ratio. Where a comparability ratio is given, but its confidence interval includes 1, this means that the difference between the number of deaths allocated to that underlying cause using ICD-10 v2010 (NCHS) and ICD-10 v2013 (IRIS) was not statistically significant.

The dataset of sampled records, including codes for every condition mentioned on the death certificate and the underlying cause of death coded using both ICD-10 v2010 (NCHS) and ICD-10 v2013 (IRIS) is available in [table 2 \(18.86 Mb Excel sheet\)](#).

## **I Certain infectious and parasitic diseases (ICD-10 codes A00–B99)**

Overall the number of deaths assigned to the infections chapter increased by 4.9% (a statistically significant change). The biggest increase is in deaths from sepsis / septicaemia (ICD-10 code A41) and bacterial infections of unspecified site (A49). These deaths were previously coded to a variety of chapters, most commonly respiratory diseases (such as chest infections or chronic obstructive pulmonary disease).

There were only a small number of within chapter coding changes, where the underlying cause of death was assigned to the infectious disease chapter in both ICD-10 v2010 (NCHS) and ICD-10 v2013 (IRIS), but the specific code differed.

## **II Neoplasms (ICD-10 codes C00–D48)**

The number of deaths assigned to neoplasms has increased very slightly by 0.3%. Whilst in absolute terms, this is not a big increase, because a large number of people die from neoplasms, this increase is statistically significant.

There are also a number of specific changes to ICD-10 coding practices which affect the coding of deaths within the neoplasms chapter. Specifically, the code for malignant neoplasms (cancers) of independent (primary) multiple sites (C97) is no longer in use. Instead, ICD-10 v2013 (IRIS) codes each cancer mentioned and then assigns the underlying cause to the first mentioned cancer. Therefore deaths that were previously assigned an underlying cause of C97 are now distributed throughout the malignant neoplasm codes.

In ICD-10 v2010 (NCHS), any cancer that was described as metastatic would be amended from a secondary cancer code to the appropriate primary code, if it was the only cancer mentioned on the death certificate. In ICD10 v2013 (IRIS), these codes will only be amended to the primary cancer code if the cancer site is not recognised as a common site for metastases. Cancers that are recognised as ones that commonly metastasise will remain as secondary codes and be assumed to be due to an unknown carcinoma. As a result, in ICD-10 v2013 (IRIS), the number of deaths with an underlying cause code of unknown carcinoma (C80) has increased.

### **III Diseases of the blood and blood-forming organs and certain disorders involving the immune mechanism (ICD-10 codes D50–D89)**

The number of deaths assigned to this chapter decreased by 1.1%, which was not a statistically significant change. However, the sample of dual coded data only contained a small number of deaths with an underlying cause assigned to this chapter, so these findings should be treated with caution.

### **IV Endocrine, nutritional and metabolic diseases (ICD-10 codes E00–E90)**

There has been a statistically significant increase of 5.7% in the number of deaths assigned to 'endocrine, nutritional and metabolic diseases' in ICD-10 v2013 (IRIS). This increase is mainly caused by deaths moving from diseases of the genitourinary system (N00–N99) and circulatory system (I00–I99) in ICD-10 v2010 (NCHS) to endocrine, nutritional and metabolic diseases (E00–E90) in ICD-10 v2013 (IRIS). More specifically, deaths where the underlying cause was previously coded as renal failure (N17–N19) or hypertensive renal disease (I12) in ICD-10 v2010 (NCHS) are now coded as diabetes (E10–E14) if the latter was mentioned on the death certificate. This is due to a change to ICD coding rules affecting the selection of the underlying cause of death, where renal failure is now considered as an obvious consequence of diabetes, so if both are mentioned on the death certificate, diabetes will now be selected as the underlying cause of death. This change has resulted in a 6.8% rise in the number of deaths with an underlying cause of diabetes using ICD-10 v2013 (IRIS).

There were very few within-chapter changes for endocrine, nutritional and metabolic diseases.

### **V Mental and behavioural disorders (ICD-10 codes F00–F99)**

The number of deaths allocated to 'mental and behavioural disorders' has increased by 7.0% (a statistically significant change). This increase is largely due to deaths which were previously assigned an underlying cause of respiratory disease, now being assigned to the mental and behavioural disorders chapter (mainly the F01 and F03 dementia codes).

The main reason for this increase is the change to the coding of chest infections, which is described in the section on 'Diseases of the respiratory system'. Specifically, deaths which mention both a chest infection (ICD-v2010 code J98 and v2013 code J22) and dementia (F01 or F03) are now allocated an underlying cause of dementia, whereas in ICD-10 v2010 (NCHS), the chest infection would have been assigned as the underlying cause.

The second reason for this increase in dementia deaths is due to a coding change that affects deaths where both aspiration pneumonia (ICD-10 code J69) and dementia (F01 or F03) are mentioned on the death certificate. Previously in ICD-10 v2010 (NCHS), the underlying cause was assigned to J69, but in ICD-10 v2013 (IRIS), dementia is assigned as the underlying cause. This is because aspiration pneumonia (J69) is considered an 'obvious consequence' of conditions that affect swallowing, and in ICD-10 v2013 (IRIS), dementia was added to the list of conditions that affect swallowing.

The percentage of deaths with ICD-10 codes F01 or F03 mentioned on the death certificate was the same, whether ICD-10 v2010 (NCHS) or ICD-10 v2013 (IRIS) was used to code the deaths. This highlights the fact that it is only the allocation of underlying cause for dementia that has changed in ICD-10 v2013 (IRIS). Overall, this change has caused a 7.1% increase in the number of deaths where dementia was allocated as the underlying cause.

This change follows on from the large increase in deaths from dementia reported in 2011 death registrations data, when the ICD-10 v2010 (NCHS) was first introduced in England and Wales. More information on this previous change can be found on the [ONS website](#).

For more information on the WHO rules used to decide which condition mentioned on a death certificate should be recorded as the underlying cause of death, see background notes 1 – 4.

There were very few within-chapter changes for mental and behavioural disorders.

## **VI Diseases of the nervous system (ICD-10 codes G00–G99)**

There have been a number of coding changes that have affected whether a death is assigned an underlying cause in the diseases of the nervous system chapter. However, these changes have tended to cancel each other out. Therefore the net effect is a very small increase (0.4%) in the number of deaths assigned to this chapter which is not statistically significant.

As in the case of dementia, deaths that mentioned either aspiration pneumonia (J69) or a chest infection (J98), as well as a disease of the nervous system (most commonly G30 Alzheimer's disease, G20 Parkinson's disease, or G31 other degenerative diseases of nervous system, not elsewhere classified) were allocated an underlying cause of J69 or J98 in ICD-10 v2010 (NCHS). However, in ICD-10 v2013 (IRIS), the underlying cause is allocated to the disease of the nervous system. The reasons for this are discussed in the mental and behavioural disorders section above.

The reverse trend was seen for deaths that mentioned both pneumonia and a disease of the nervous system, in these cases pneumonia is selected as the underlying cause, because of changes with respect to which diseases are now considered to be a consequence of another condition.

## **VII Diseases of the eye and adnexa (ICD-10 codes H00–H59)**

The number of deaths classified to these chapters in the annual mortality statistics is extremely small and ONS expect to see no significant change in the reported statistics.

## **VIII Diseases of the ear and mastoid process (ICD-10 codes H60–H95)**

The number of deaths classified to these chapters in the annual mortality statistics is extremely small and ONS expect to see no significant change in the reported statistics.

## **IX Diseases of the circulatory system (ICD-10 codes I00–I99)**

Diseases of the circulatory system showed a 0.7% decrease between ICD-10 v2010 (NCHS) and ICD-10 v2013 (IRIS). Although in absolute terms this is a relatively small drop, due to the large number of people who die from circulatory diseases, it is a statistically significant decrease. This small decrease is caused by an update to the selection rules that are applied when the circulatory disease are mention as a significant condition contributing to the death but not part of the direct due to sequence leading to death. In these cases the circulatory disease will only be selected as the underlying cause if described as severe, grave or advanced.

## **X Diseases of the respiratory system (ICD-10 codes J00–J99)**

In ICD-10 v2013 (IRIS) a change has been made to the coding of deaths mentioning a chest infection. Previously chest infections were coded to ICD-10 code J98 (other respiratory disorders), but an amendment to the ICD-10 alphabetical index in v2013 (IRIS) means that chest infections are now coded to J22 (unspecified acute lower

respiratory infections). Existing ICD-10 rules for assigning the underlying cause of death mean that J22 can be part of an acceptable causal sequence with many different conditions. For example if J22 and F03 (dementia) were both mentioned on the death certificate, because J22 can be caused by F03, dementia (F03) would be assigned as the underlying cause (assuming no other conditions were mentioned). In contrast, if both J98 and F03 were mentioned on the death certificate, J98 would be assigned as the underlying cause, because J98 is not a recognised consequence of dementia. In fact, J98 is only recognised as a consequence of a small number of conditions, so is less likely to be selected as the underlying cause than J22.

It is relatively common for chest infections to be mentioned on a death certificate, so this change will have an impact on mortality statistics, based on underlying cause of death. The dual coded data shows a statistically significant decrease of around 2.5% of deaths with an underlying cause assigned to this chapter, between ICD-10 v2010 (NCHS) and ICD-10 v2013 (IRIS). This decrease is largely due to deaths which were previously assigned to the respiratory diseases chapter now being assigned to mental and behavioural disorders (mostly dementia), diseases of the nervous system (mostly Alzheimer's disease) and to neoplasms.

## **XI Diseases of the digestive system (ICD-10 codes K00–K93)**

There was a statistically significant decrease of 2.2% of deaths with an underlying cause assigned to this chapter, between ICD-10 v2010 (NCHS) and ICD-10 v2013 (IRIS). The main reason for this change is the way post-operative conditions are coded when mentioned on the death certificate. Some deaths that were previously assigned to a digestive disease underlying cause are now assigned to either a respiratory or circulatory disease cause of death.

## **XII Diseases of the skin and subcutaneous tissue (ICD-10 codes L00–L99)**

There was a 2.8% increase in the number of deaths allocated to this chapter using ICD-10 v2013 (IRIS). However, there are relatively few deaths from diseases of the skin and subcutaneous tissue, so this increase was not statistically significant.

## **XIII Diseases of the musculoskeletal system and connective tissue (ICD-10 codes M00–M99)**

There was a 13.1% decrease in the number of deaths assigned to this chapter using ICD-10 v2013 (IRIS), which was statistically significant.

As with diseases of the digestive system, the main reason for this change is the way post-operative conditions are coded, so now some deaths that were previously assigned an underlying cause of death code within the diseases of the musculoskeletal system and connective tissue chapter are now assigned to codes in the respiratory diseases, circulatory diseases or external causes chapters.

## **XIV Diseases of the genitourinary system (ICD-10 codes N00–N99)**

There has been a statistically significant 7.9% decrease in the number of deaths coded to diseases of the genitourinary system, using ICD-10 v2013 (IRIS). The majority of the decrease is explained by deaths that were previously assigned an underlying cause of death code in the diseases of the genitourinary system chapter, now being assigned a circulatory disease or endocrine, nutritional and metabolic diseases as the underlying cause of death. The biggest change is for deaths that were previously assigned to N03 (chronic nephritic syndrome), which are now assigned to either I12 (hypertensive renal disease), I13 (hypertensive heart and renal disease).

A further change relates to deaths where the underlying cause was previously assigned to renal failure (N17–N19) or hypertensive renal disease code (I12) in ICD-10 v2010 (NCHS), which are now assigned to a diabetes (E10–E14) code.

## **XV Pregnancy, childbirth and the puerperium (ICD-10 codes O00–O99)**

The number of deaths classified to this chapter in the annual mortality statistics is small and ONS expect to see no significant change. There were 7 deaths assigned to this chapter in the sample and the coding remained the same between ICD-10 v2010 (NCHS) and ICD-10 v2013 (IRIS).

## **XVI Certain conditions originating in the perinatal period (ICD-10 codes P00–P96)**

Chapter XVI has not been examined in this report, as there were less than 20 deaths assigned to this chapter in the sample. These deaths occurred in the post neonatal period (over 28 days), a substantial proportion of deaths assigned to this chapter via the routine cause of death coding processes occur in the neonatal period (under 28 days).

In 1986 in line with WHO recommendations, a neonatal death certificate was introduced in England and Wales which allowed diseases or conditions in the fetus or infant, maternal diseases or conditions affecting the fetus or infant and other relevant causes to all be recorded. Since equal weighting is given to conditions in the fetus / infant and in the mother, it is not possible to identify a single underlying cause of death for neonatal deaths.

An important change has been made by ONS to how conditions mentioned on the neonatal death certificate are coded, where the death was caused by a maternal condition. Previously, these neonatal deaths would have been assigned a maternal disease code (for example, a condition relating to pregnancy, childbirth and the puerperium, ICD-10 codes O00–O99). However, in ICD-10 v2013 (IRIS) the maternal condition that contributed to the neonatal death is assigned a code in the range P00–P04 (fetus and newborn affected by maternal factors and by complications of pregnancy, labour and delivery). So if the baby died as a result of maternal pre-eclampsia, the neonatal death would previously have been assigned the O14 code, but will now be assigned the P00.0 code. This is in line with European ICD coding practices. A more detailed explanation of these changes and analysis of their impact on neonatal deaths and stillbirths, including a full code mapping document, will be published later in 2014.

## **XVII Congenital malformations, deformations and chromosomal abnormalities (ICD-10 codes Q00–Q99)**

The number of deaths coded to this chapter increased significantly by 11.7% using ICD-10 v2013 (IRIS). The main reason for this increase is deaths which were previously coded as mental and behavioural disorders, which are now coded as congenital malformations, deformations and chromosomal abnormalities. Specifically deaths that mention Down syndrome (Q90.9) and dementia (F03) are now assigned an underlying cause of Down syndrome. Whilst this increase is statistically significant, substantial proportions of deaths from this cause occur in the neonatal period, and these deaths have not been analysed in this report.

## **XVIII Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified (ICD-10 codes R00–R99)**

There has been a small (0.9%), but statistically significant increase in the number of deaths assigned to this chapter using ICD-10 v2013 (IRIS).

## **XX External causes of mortality (ICD-10 codes U50.9, V01–Y89)**

There has been a statistically significant increase of 3.1% in the number of deaths from external causes using ICD-10 v2013 (IRIS). The largest increase has come from deaths previously assigned to a code in the disease of the musculoskeletal system and connective tissue chapter (ICD-10 codes M00–M99) in ICD-10 v2010 (NCHS), which are now being assigned to external cause codes in ICD-10 v2013 (IRIS). The majority of this increase is due to deaths previously coded to M25 (Other joint disorders, not elsewhere classified), which are now assigned to the Y83.1 code (Surgical operation with implant of artificial internal device).

There are also a relatively large number of deaths that were previously assigned to a circulatory disease code in ICD-10 v2010 (NCHS), which are now assigned to an external cause code in ICD-10 v2013 (IRIS). Some of these changes are from deaths that mention a circulatory disease (for example ischaemic heart disease), which has been operated on (for example, heart bypass surgery). In ICD-10 v2010 (NCHS), the circulatory disease was selected as the underlying cause, but in ICD-10 v2013 (IRIS), the operation is selected as the underlying cause (Y83 or Y84 – complication of surgical or medical procedure).

## 7. Downloadable reference tables

Data from the dual coding study are available to download from the ONS website.

[Table 1 \(59 Kb Excel sheet\)](#) presents the sampled records by ICD-10 chapter of the underlying cause of death, showing results from both ICD-10 versions (ICD-10 v2010, NCHS and ICD-10 v2013, IRIS).

[Table 2 \(18.86 Mb Excel sheet\)](#) presents the dataset of dual coded data, including the selected underlying cause of death every mentioned condition on the death certificate coded using both ICD-10 v2010 (NCHS) and ICD-10 v2013 (IRIS), by age and sex.

## 8. Background notes

1. The death certificate used in England and Wales accords with that recommended by WHO. It is set out in two parts. Part I gives the condition or sequence of conditions leading directly to death, while Part II gives the details of any associated conditions which contributed to the death, but are not part of the causal sequence. An example of the death certificate used in England and Wales is available in Annex A of the [mortality metadata \(2.7 Mb Pdf\)](#) on the ONS website.
2. The General Principle for selection of the underlying cause of death states that when more than one condition is entered on the death certificate, the condition entered on the lowest used line of Part I should be selected, but only if it could have given rise to all the conditions entered above it. If this is not the case then the following selection rules are applied:
  - Rule 1. If there is a reported sequence terminating in the condition entered first on the death certificate, select the originating cause of this sequence.
  - Rule 2. If there is no reported sequence terminating in the condition first entered on the death certificate, select the first-mentioned condition
  - Rule 3. If the condition selected by the General Principle, Rule1 or Rule 2 is obviously a direct consequence of another reported condition (whether in Part I or Part II of the death certificate), select this primary condition
3. Modification tables allow the identification of valid causal sequences of conditions and give modification rules to improve the usefulness and precision of mortality data. For example, the tables will identify a direct causal sequence between two conditions, however, there are particular conditions, combinations or circumstances when modification rules are then applied to select the correct underlying cause of death. So with some death certificates, two or more causes may be given that, when linked together, point to another cause (not explicitly mentioned on the certificate) as the underlying cause.
4. Information on the rules and guidelines adopted by WHO for the selection of underlying cause of death are available in [Volume 2](#) of the ICD-10 manual which can be downloaded from the WHO website

5. Special extracts and tabulations of deaths data for England and Wales are available to order (subject to legal frameworks, disclosure control, resources and agreements of costs, where appropriate). Such enquiries should be made to:

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