

Measuring pre-existing health conditions in death certification – deaths involving COVID-19: March 2020

A method for deciding which pre-existing condition mentioned on death certificates is the main pre-existing condition.

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1 . Summary

This methodology article outlines a method for deciding:

- which of a number of health conditions mentioned on the death certificate are pre-existing conditions
- which one of those is the “main pre-existing condition”, for use in certain mortality analyses, for example, deaths involving the coronavirus (COVID-19)

A pre-existing condition is defined as any condition that either preceded the disease of interest (for example, COVID-19) in the sequence of events leading to death, or was a contributory factor in the death but was not part of the causal sequence.

The main pre-existing condition is defined as the one pre-existing condition that is, on average, mostly likely to be the underlying cause of death for a person of that age and sex.

This method allows for consistent analysis of which conditions most commonly co-occurred with a disease of interest such as COVID-19 to better understand the risks associated with pre-existing conditions.

2 . Purpose

Using the coronavirus (COVID-19) as an example, this article sets out a method for determining pre-existing health conditions of those who have died of a disease of interest, using only information provided on the death certificate.

The [death certificate \(PDF, 225KB\)](#) used in England and Wales for deaths over 28 days of age is similar to that recommended by the World Health Organization (WHO). The cause of death information is set out in two parts. Part 1 gives the condition or sequence of conditions leading directly to death, while Part 2 gives the details of any associated conditions that contributed to the death but are not part of the causal sequence.

The process of coding cause of death consists of:

- first, converting each of the conditions mentioned on the death certificate into an International Classification of Diseases, 10th Revision (ICD-10) code
- second, deciding which of the conditions is the underlying cause of death for statistical purposes

[Rules for these decisions \(PDF, 1.01MB\)](#) are provided by the WHO.

Mention of COVID-19 (new ICD-10 codes U071 and U072) on the death certificate is being processed following existing rules used for influenza. During March 2020, around 86% of deaths involving COVID-19 in England and Wales (that is, with COVID-19 mentioned anywhere on the death certificate) had COVID-19 as the underlying cause of death according to the WHO rules.

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 1 should be selected, but only if it could have given rise to all the conditions entered above it.

For overall counts such as in the [weekly deaths release](#), the Office for National Statistics (ONS) uses the concept of “deaths involving COVID-19”, which means any mention of U071 or U072 anywhere on the certificate. However, there is great interest in understanding what underlying factors were involved in the risk of death involving COVID-19.

One way we can do this is to use all pre-existing conditions, which is informative but means that each death may be counted multiple times in the analysis. A pre-existing condition can be defined as any mention on the certificate that was either in the causal chain leading to the COVID-19 infection (Part 1 of the certificate), or not in the causal chain but contributed to the death (Part 2).

It is also possible that COVID-19 itself could be mentioned in Part 2 of the certificate rather than Part 1, that is, the certifier considered COVID-19 to be a contributory factor but not part of the causal chain.

For some analyses, we want to assign to each death a single pre-existing condition that is the most “important”, ideally the one that was most likely to lead to death in the absence of the COVID-19 infection. This is obviously difficult to decide, as the certificate gives information on sequence of conditions (but only partially), but not on the severity or duration of each condition mentioned.

3 . Concepts

Pre-existing conditions

A pre-existing condition is defined for our purposes as any mention on the certificate that predated or was independent of COVID-19.

Pre-existing conditions – Part 1 of certificate

Assuming that COVID-19 is mentioned in Part 1, all mentions can be classed as one of the following.

(a) Consequence of the COVID-19, that is, any mention appearing in Part 1 above the COVID-19. A consequence is by definition not a pre-existing condition, so is excluded from this type of analysis.

(b) The COVID-19 itself.

(c) Pre-existing conditions that appear in Part 1 below the COVID-19, and therefore are in the causal chain leading to death.

(d) Pre-existing conditions that appear in Part 2, and therefore are not in the causal chain but are known to have contributed to the death.

For analysis that uses all pre-existing conditions, mentions in classes (c) and (d) are both applicable.

Pre-existing conditions – Part 2 of certificate

If COVID-19 is mentioned in Part 2, mentions can be classed as one of the following.

(e) Consequence of the underlying cause, that is, any mention appearing in Part 1 above the single underlying cause of death that has been identified according to World Health Organization (WHO) coding rules. A consequence is excluded from this type of analysis.

(f) The single underlying cause of death that has been identified according to WHO coding rules, usually the lowest line in Part 1. This is the condition that would be used for analysis by “underlying cause” in routine mortality statistics. From the point of view of analysis of COVID-19 this is a pre-existing condition.

(g) The COVID-19 itself.

(h) Pre-existing conditions that appear in Part 2, whether before or after the COVID-19, and therefore are not in the causal chain but are known to have contributed to the death.

For analysis that uses all pre-existing conditions, mentions in classes (f) and (h) are both applicable.

Main pre-existing condition

The main pre-existing condition is defined as the pre-existing condition that is most likely to cause death in the absence of the COVID-19. While, for many purposes involving modelling and estimation of deaths, competing risks can be handled at an aggregate level and may draw on alternative sources of data, for some mortality analyses we have to impute a main pre-existing condition at the individual level, based on the certificate only.

One option would be to infer this using WHO rules, that is, choose the mention that would become the “underlying cause” if the certificate were processed without the COVID-19 or any of its consequences. However, this approach has two main drawbacks:

- the technical and logistical difficulties of undertaking a “duplicate” coding process to re-apply the WHO rules
- the unknown relationship between the mentions at the time of death involving COVID-19 and the likely underlying cause at a hypothetical later time of death without COVID-19, bearing in mind both unknown severity of each condition mentioned, and that conditions that contributed to death involving COVID-19 might not have contributed to death with an alternative cause

The preferred option is to derive the main pre-existing condition analytically, based on the sequence of mentions on the certificate and informed by available data on the probability of death from different underlying causes at different ages.

4 . Derivation of main pre-existing condition

The steps for derivation of the main pre-existing condition are described in this section and illustrated in the flowcharts in Section 6.

1. If there are no pre-existing conditions, that is, the coronavirus (COVID-19) is the only mention on the certificate, or COVID-19 is the lowest mention in Part 1 and there are no mentions in Part 2, the main pre-existing condition is “none”.
2. If COVID-19 is in Part 1 and there is only one pre-existing condition, either below the COVID-19 in Part 1, or in Part 2, that is the main pre-existing condition.
3. If COVID-19 is in Part 2 it is excluded from the analysis, since it cannot be a pre-existing condition relative to itself.
4. Since the conditions in Part 1 are in a causal order, it can be assumed that only the lowest mention in Part 1 (the originating condition of the causal chain) needs to be considered. Therefore, any pre-existing conditions in Part 1 other than the lowest in the sequence are excluded from the analysis.
5. The conditions (if any) in Part 2 are not in causal order, and do not form a sequence with the lowest mention in Part 1, therefore all mentions in Part 2 need to be considered separately.
6. The main pre-existing condition is then the pre-existing condition out of the set of (the lowest in Part 1 and all in Part 2) that is the highest priority, namely the most common out of the relevant causes of death for the relevant five-year age-sex group.
7. The choice of which is the highest priority (most common) cause of death is determined by a rank order based on the five-year average percentage frequency of causes, by five-year age and sex group, where causes are grouped into the Office for National Statistics (ONS) “leading causes of death” International Classification of Diseases (ICD-10) groupings. Minor modifications are made to the “leading causes” groupings to reduce the number of cases falling into the “other” group.
8. If more than one of the mentions ranked falls into the same “leading causes of death” ICD-10 grouping, the choice of main pre-existing condition is determined by the sequence priority order:

(1) the lowest line of Part 1

(2) mentions in Part 2 in the order they appear on the certificate

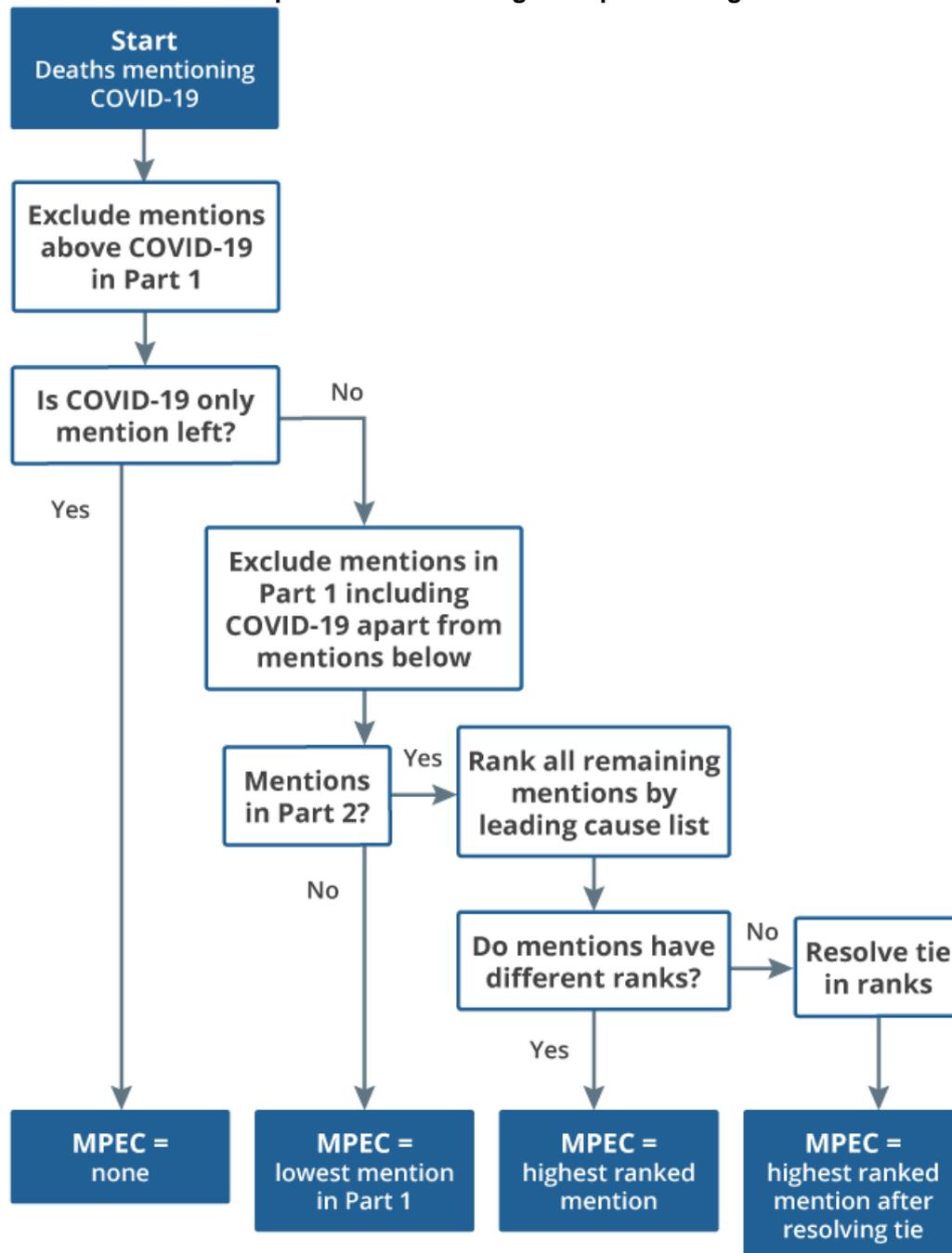
5 . Limitations of the method

The World Health Organization (WHO) rules for identifying the underlying cause are simple in concept but can be very complex in application. The assumption that all mentions above the underlying cause in Part 1 following it in time in a causal sequence, and all mentions in Part 1 below the underlying cause precede it in time, is generally true but does not apply in all cases. The resulting error is difficult to quantify but is considered acceptable for the present purpose.

The use of “leading causes of death”, and generally a method for ranking the pre-existing conditions on a probability basis, means that a more common cause of death may be selected as the main pre-existing condition in preference to one that is relatively uncommon in the population, but potentially more severe (more likely to cause death) in the individual case. Again, the risk of error from this issue is considered acceptable overall.

6 . Flowcharts

Flowchart to describe process for selecting main pre-existing condition from death certificate



Source: Office for National Statistics

7 . Worked examples

To aid understanding of the proposed method, Table 1 details some hypothetical death certificates and what the main pre-existing condition would be recorded as in these cases given the process described.

Table 1: Examples of main pre-existing conditions in deaths involving COVID-19

Death Certificate Information	Example 1	Example 2	Example 3	Example 4	Example 5
Age	74	80	50	66	49
Sex	Male	Female	Male	Female	Male
Part 1 Line a	Pneumonia	Pneumonia	Multi-organ failure	Respiratory failure	COVID-19
Part 1 Line b	COVID-19	COVID-19	COVID-19	Pneumonia	Pneumonia
Part 1 Line c	--	--	Pneumonia	COVID-19	
Part 2	--	Diabetes	--	Diabetes, Ischemic Heart Disease, COPD	Diabetes, Ischemic Heart Disease, COPD
Main pre-existing condition	None	Diabetes	Pneumonia	COPD	Ischemic Heart Disease

Source: Office for National Statistics

Notes

1. Hypothetical death certificate data to illustrate the method for selecting main pre-existing condition. [Back to table](#)

8 . Analysis of current data

In March 2020, there were 3,912 deaths that occurred in England and Wales involving the coronavirus (COVID-19) and 3,372 of these (86%) had an underlying cause of death of COVID-19.

Analysis of the main pre-existing condition showed that ischaemic heart disease was the most common main pre-existing condition among deaths involving COVID-19, with 541 out of 3,912 deaths (14% of all deaths involving COVID-19 in March 2020). Figure 1 shows the most common pre-existing conditions by sex and whether the deceased was aged up to 69 years, or 70 years and over.

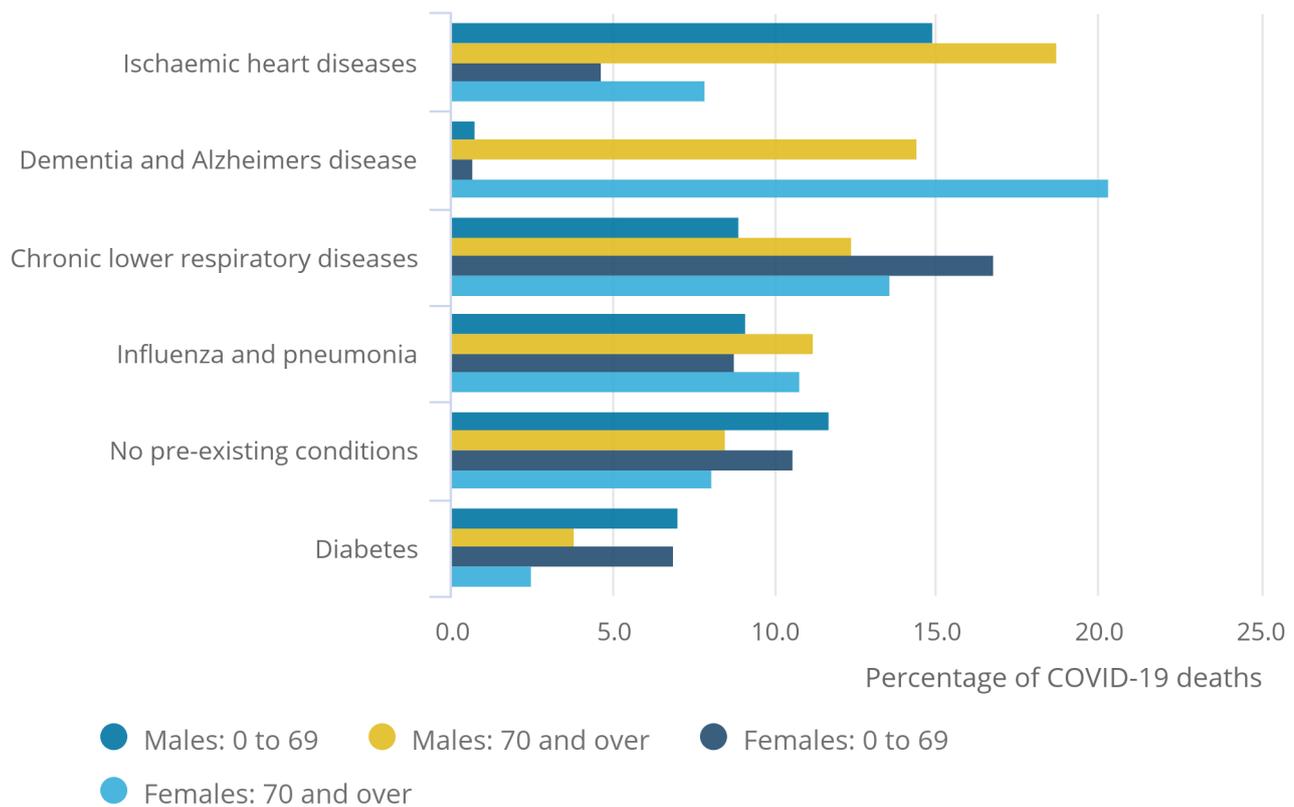
More about coronavirus

- Find the latest on [coronavirus \(COVID-19\) in the UK](#).
- All ONS analysis, summarised in our [coronavirus roundup](#).
- View [all coronavirus data](#).

Breakdowns of the most common main pre-existing conditions by sex and age-group can be found in the datasets accompanying the analysis article [Analysis of deaths involving COVID-19: deaths occurring in March 2020, England and Wales](#).

Figure 1: Proportion of deaths involving COVID-19 by age, sex and main pre-existing condition in England and Wales, March 2020

Figure 1: Proportion of deaths involving COVID-19 by age, sex and main pre-existing condition in England and Wales, March 2020



Source: Office for National Statistics

Notes:

1. Based on deaths occurring rather than deaths registered in March 2020.
2. Deaths involving COVID-19 where International Classification of Diseases (ICD-10) codes U07.1 and U07.2 were mentioned anywhere on the death certificate rather than only deaths with an underlying cause of death of COVID-19.
3. Deaths in England and Wales combined.
4. Groupings of main pre-existing conditions based on the [leading causes of death list](#).

9 . Related links

[Analysis of deaths involving COVID-19: deaths occurring in March 2020, England and Wales](#)

Article | Published 16 April 2020

Analysis of deaths involving the coronavirus (COVID-19) including rates of mortality, age and sex breakdowns, pre-existing health conditions and location.

[Deaths registered weekly in England and Wales, provisional](#)

Dataset | Published weekly

Provisional counts of the number of deaths registered in England and Wales, including deaths involving the coronavirus (COVID-19), by age, sex and region, in the latest weeks for which data are available.

[Leading causes of death in England and Wales \(revised 2016\)](#)

Published 12 October 2017

The leading underlying causes of death are based on a list developed by the World Health Organization (WHO). This categorises causes using the International Classification of Diseases version 10 (ICD-10), specially designed for determining the leading causes of death.

[User guide to mortality statistics](#)

Published 6 August 2019

Supporting information for mortality statistics, which present figures on deaths registered in England and Wales in a specific week, month, quarter or year.