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**Mortality Coding and the Uses of
Multiple Cause Data**

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1. INTRODUCTION

In January 1999, the Australian Bureau of Statistics (ABS) published multiple cause of death statistics for the first time. This step, strongly driven by client demand for more comprehensive mortality statistics to provide a basis for medical research, was the culmination of a long process which involved the search for a suitable coding vehicle, the comprehensive testing of the chosen software, and finally, the implementation of the Automated Coding System (ACS) developed and provided by the United States National Centre for Health Statistics (NCHS).

2. BACKGROUND TO MORTALITY CODING IN AUSTRALIA

Until 1997, the ABS manually coded causes of death and resource constraints restricted coding to the 'underlying cause of death', which was assigned in line with guidelines laid down by the World Health Organisation (WHO). The underlying cause of death is defined as:

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

The medical certificate of cause of death, recommended by WHO for international use, was designed to facilitate the selection of the underlying cause. When more than one condition is entered on the death certificate, the underlying cause is selected using the coding rules of the relevant version of the International Classification of Diseases (ICD). The underlying cause is selected so that preventive strategies can be instituted to address that particular cause. Since its adoption in 1948, statistics based on the underlying cause concept have served the purpose of summarising international cause-specific mortality statistics into a single index which has been used to assess trends in causes of death.

3. INTRODUCTION OF THE AUTOMATED CODING SYSTEM (ACS) AND MULTIPLE CAUSE CODING

In 1997, after considerable research and testing, the ABS finally commenced the implementation of automated coding using the system (ACS) developed and provided by the United States National Centre for Health Statistics (NCHS). Apart from the potential this system has for substantially improving the cost effectiveness of mortality coding, it offers several major benefits:

- Through its use of pre-coded logic, it removes much of the subjectivity inherent in any manual coding system. However, a percentage of coding, including the coding of many external causes, still requires manual intervention.

- It also provides the potential to facilitate the production of more internationally comparable mortality statistics, as the use of this software continues to spread to other countries.
- It facilitates the coding of all causes of death (multiple cause coding).

Multiple cause coding is best defined as:

'the coding of all morbid conditions, diseases and injuries entered on the death certificate, including those involved in the morbid train of events leading to the death which were classified as either the underlying cause, the intermediate cause, or any intervening causes, and those conditions which contributed to death but were not related to the disease or condition causing death.'

It is understandably the introduction of multiple cause coding, with its potential to reveal the relationships between the various causes, conditions and circumstances leading to death, which has created most interest in the user community.

4. THE RATIONALE FOR INTRODUCING MULTIPLE CAUSE CODING

The current leading causes of death are very different from those which prevailed when the single underlying cause concept was first adopted. Over time, the leading causes of death in most developed countries have shifted from infectious and parasitic diseases to chronic and degenerative diseases, and from infant and child deaths to deaths among the elderly. As the population continues to age, chronic diseases become increasingly more important. Because deaths from chronic conditions commonly occur with a number of concurrent or coexisting conditions, the initiating condition is often difficult to isolate. It has been postulated that some deaths cannot occur without the influence of more than one cause. The ability of the single underlying cause statistics alone to accurately summarise the mortality pattern of a population, therefore, has long been questioned.

When only a single underlying cause is selected for tabulating cause-specific statistics, we lose other valuable information provided on the death certificate such as the immediate cause of death, causes and conditions that intervene between the underlying and immediate causes of death and many other contributory causes that were involved, but did not directly cause the death. The information lost is often important to the understanding of the process of death. This loss of information is a particular problem for deaths attributed to external causes (injury, poisoning and violence) which are classified to the circumstances of death (E Codes), rather than according to the nature of injury.

5. A SUMMARY OF 1998 MULTIPLE CAUSE STATISTICS

In 1998, a total of 363,895 causes were coded for the 127,202 deaths registered during the year, giving a mean 2.9 causes per death.

The mean number of causes of death varied with age of the deceased. The variation was related to changes in the leading cause of death with age and the likelihood that these causes would have more than one contributory condition reported on the Certificate of Cause of Death.

The overall mean number of causes per death for males (2.9) and females (2.8) was similar. However, the mean number of causes per death varied considerably by age group for both males and females.

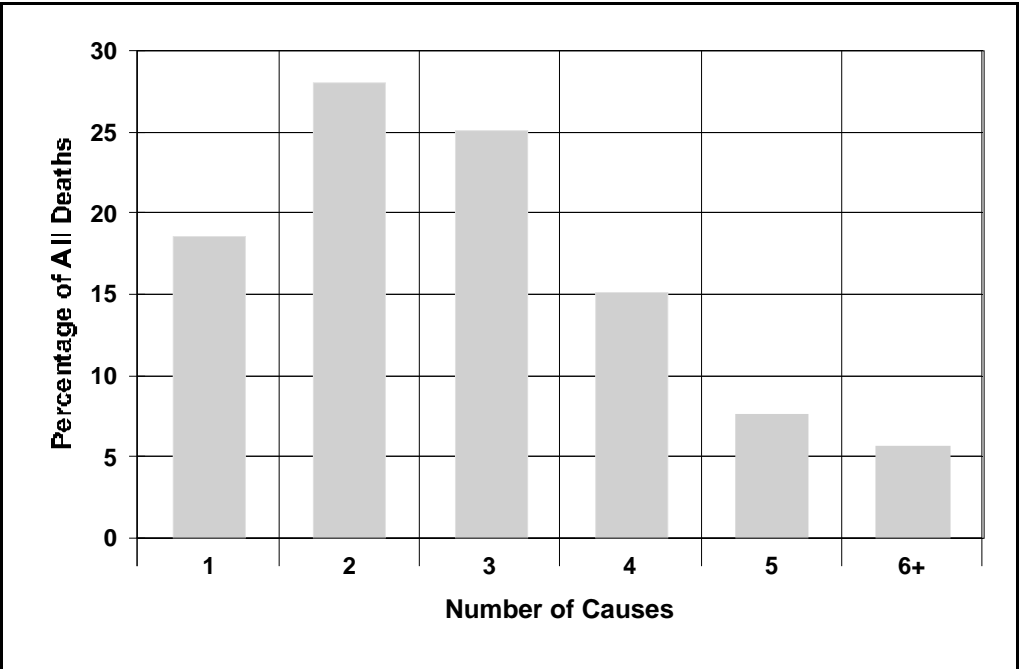
The mean number of causes of death varied considerably for different underlying causes of death. Chapter XVI, Signs, symptoms and ill defined conditions (780 - 799) exhibited a mean of just 1.1 while a mean of 4.0 was recorded for Chapter XIII, Diseases of the Musculoskeletal system and connective tissue (710 - 719). Specific causes with a high mean number of causes per death included diabetes (3.7), rheumatic heart disease (3.6), and chronic liver disease and cirrhosis (3.4).

Underlying Causes and Contributory causes

For ease of analysis, it is helpful to dissect multiple cause data into underlying causes of death and contributory causes of death. Contributory causes can be considered to be all those causes which appear on the death certificate, but have not been selected as underlying causes.

Of the 127,202 deaths registered in 1998, about 19% recorded a single cause of death. Either one or two contributory causes were reported for just over 53% of deaths registered during the year, while only a little more than 5% of cases reported five or more contributory causes

Table 1 Deaths, Number of Causes Reported, Australia, 1998



The number of times a condition is recorded on death certificates as either an underlying cause of death or a contributory cause gives an indication of its overall relative importance as a multiple cause of death. The following table gives the ten leading multiple causes of death in 1998 and their corresponding relativity in terms of underlying causes for this year.

Table 2 Leading Multiple Causes of Death

Causes of Death	Multiple Causes No**	Multiple Causes Prop of Total %	Multiple Causes Rank	Underlying Causes Prop of Total %	Underlying Causes Rank
Malignant neoplasms	50 720	39.9	1	27.6	1
Ischaemic heart disease	48 767	38.3	2	21.9	2
Cerebrovascular disease	21 450	16.9	3	9.4	3
Pneumonia & Influenza	15 576	12.2	4	3.6	6
Chronic obstructive pulmonary disease	14 316	11.3	5	4.8	4
Hypertensive diseases	12 147	9.5	6	0.9	17
Nephritis, nephrotic syndrome and nephrosis	11 062	8.7	7	1.3	11
Accidents and adverse affects	10 736	8.4	8	3.8	5
Diabetes mellitus	9 580	7.5	9	2.2	7
Diseases of arteries, arterioles and capillaries	9 290	7.3	10	2.2	8
All Causes	127 202				

*** Deaths can include more than one cause, and hence the number of causes will not add to the total number of deaths.*

The top three underlying causes, malignant neoplasms, ischaemic heart disease and cerebrovascular disease are also the major contributory causes in the majority of deaths registered in 1998. On the other hand, it is interesting to note that, while Hypertensive disease and Nephritis, nephrotic syndrome and nephrosis together account for little more than 2% of total deaths classified by underlying cause, they were contributing factors in over 18% of deaths registered in 1998.

Associations viewed by focusing on contributory causes

In 1998, only about 19% of deaths were recorded without a contributory cause. Understanding the association between the underlying cause of death and the various contributory causes is an important element in understanding the totality of the death process. For example:

- Hypertensive diseases were a contributory cause in nearly 10% of total deaths registered in 1998. In particular, they were a contributing factor in more than one in five deaths from

Diabetes mellitus and Cerebrovascular disease and one in six deaths classified to Ischaemic heart disease.

- Nephritis, nephrotic syndrome and nephrosis were a contributory cause in nearly one in five deaths resulting from Diabetes mellitus and Heart failure in 1998.
- Diabetes mellitus was a contributory cause in over 7% of all deaths registered during 1998. The major causes with which Diabetes mellitus was associated included Ischaemic heart disease (9% of total deaths) and Cerebrovascular disease (7%).

External Causes of Death and multiple cause coding

In 1998, there were 7,946 deaths due to External causes (accidents, poisonings and violence). Multiple cause coding has the potential to greatly enhance the understanding of the death, but in a different way than in the case of diseases. Multiple cause data for external causes of death includes external causes codes, nature of injury codes and natural causes codes.

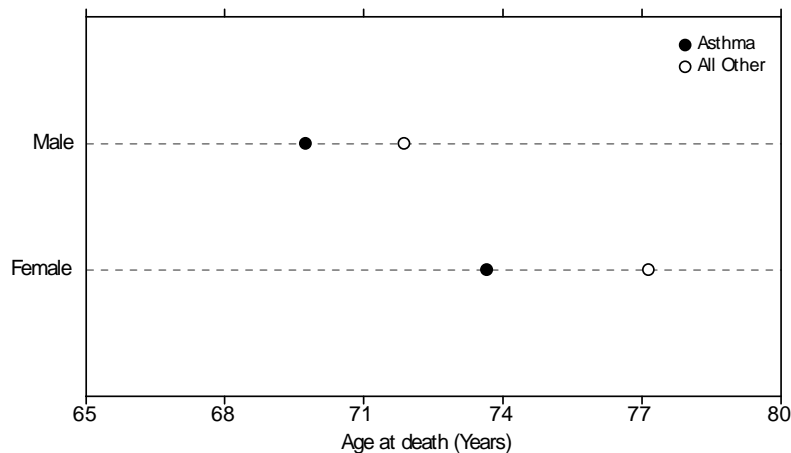
Traditionally, the external cause, (indicated by an E-code), describing the event (eg a traffic accident, a hanging, a poisoning) is designated as the underlying cause of death. Nature of injury codes summarise the results of the event (eg in the case of a road traffic accident, the resultant injuries) so their relationship to the underlying cause is intrinsically different to the associations described above for other causes of death. However, by providing insight into the physical harm resulting from the event, they can be used to investigate the potential for survival. In some cases, very strong associations can be formed, particularly in cases where natural causes are present. For example, pre existing conditions such as Cancer and severe depression may link closely to cases of Suicide, or chronic diseases such as Diabetes mellitus may hinder the recovery process from an injury causing an infection which results in Septicaemia and death.

There were 21,763 multiple causes recorded for deaths from External causes registered in 1998, giving an average of 2.7 causes per death.

Multiple cause coding allows researchers to focus on other levels of variables. As stated above, over four in every five deaths registered in Australia provide more than one condition on the death certificate. Concentrating on the contributory causes, rather than just underlying causes, may increase the available knowledge on these conditions and offer alternatives in terms of treatment and/or prevention.

The effect of asthma on life expectancy can be demonstrated in the example below.

Table 4 Effects of Asthma on Life Expectancy, 1998
(Excluding External Causes)

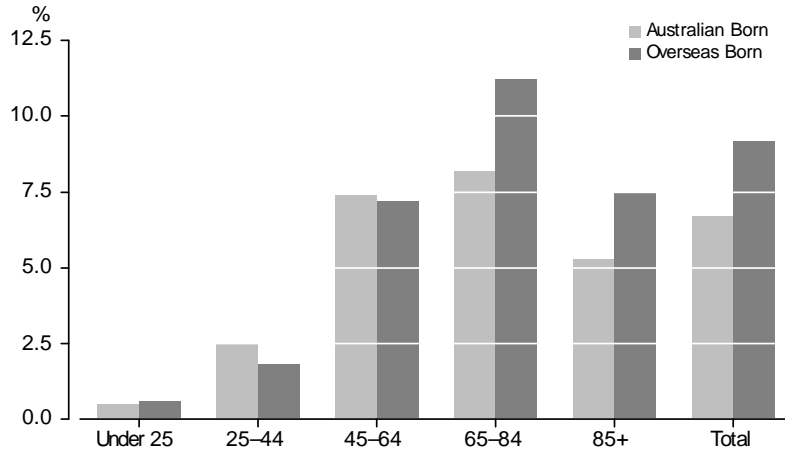


Benefits for population research

While the benefits of multiple cause coding have a primary health focus, information obtained from this source can also assist other population or demographic research. The ABS annual death file contains a variety of demographic variables and when these are cross classified with multiple cause codes, interesting results are produced.

The composition of a particular population will impact on its health status and consequently on such areas as life expectancy, years of potential life lost etc. The table below compares the numbers of deaths registered in 1998 where diabetes was mentioned on the death certificate. These deaths are differentiated into broad age groups and compare persons born in Australia with those born overseas. Overseas born persons have more mentions of diabetes as a proportion of total deaths than do Australian born persons. This type of information can be used to refine some of the demographic characteristics of a particular population.

Table 5 Deaths by Diabetes Mellitus as a Percentage of All Deaths, Australian and Overseas Born, 1998



7. SUMMARY

The introduction of multiple cause coding has been a major step in enhancing the usefulness of causes of death statistics as a basis for providing researchers with a better understanding of the circumstances associated with mortal events. While the main focus of the data relates to the health area, it also provides a rich source of demographic information that can be further refined to show interesting similarities and differences in groupings within the population.