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Co-existing conditions for deaths from infectious and parasitic diseases in Australia

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Summary *Objective:* To examine the frequency distribution of co-existing conditions for deaths where the underlying cause was infectious and parasitic diseases.

Materials and methods: Besides the underlying cause of death, the distributions of co-existing conditions for deaths from infectious and parasitic diseases were examined in total and by various age and sex groups, at individual and chapter levels, using 1998 Australian mortality data.

Results: In addition to the underlying cause of death, the average number of reported co-existing conditions for a single infectious and parasitic death was 1.62. The most common co-existing conditions were respiratory failure, acute renal failure — non-specific causes, ischaemic heart disease, pneumonia and diabetes. When studying the distribution of co-existing conditions at the *ICD-9* chapter level, it was found that the circulatory system diseases were the most important. There was an increasing trend in the number of reported co-existing conditions from 60 years of age upwards. Gender differences existed in the frequency of some reported co-existing conditions. The most common organism types of co-existing conditions were other bacterial infection and other viruses.

Conclusions: The study indicated that the quality of death certificates is less than satisfactory for the 1998 Australian mortality data. The findings may be helpful in clarifying the *ICD* coding rules and the development of disease prevention strategies.

Introduction

Although the leading causes of death in most developed countries including Australia have shifted from infectious and parasitic diseases to chronic and degenerative diseases, communicable diseases are still the most important public health problems in both developing and developed countries.[1] In 1998, for example, 1,355 people died from infectious and parasitic diseases in Australia (not including deaths from AIDS, pneumonia and influenza, which were classified elsewhere in the *ICD-9*) from its population of around 18 million.[1]

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In cases where the recorded cause of death is an infectious and parasitic disease, there are often other co-existing conditions that play an important role. While these are reported at the time of death, they are usually ignored when causes of death are compared across countries or over time. Studying other co-existing conditions contributing to deaths from infectious and parasitic diseases is also important for the development of disease prevention and control strategies — treating and preventing other contributory conditions will probably reduce mortality from infectious and parasitic diseases.

During the course of this study, the quality of the death certificates as a data source was examined. This provided information and suggestions to the Mortality Reference Group of the World Health Organization to use in its deliberations on coding rules in the International Classification of Diseases. An analysis was conducted (using 1998 Australian mortality data) to examine the distribution of other conditions contributing to the deaths, for which infectious and parasitic diseases were the underlying cause.

Materials and methods

Data collection

Australian mortality data for 1998 were provided by the Australian Bureau of Statistics (ABS). They covered all deaths in Australia in 1998 and provided information on age, sex, underlying cause of death, and co-existing conditions that contributed to the death. The death certificate was the source of the primary data. The data were coded using the *ICD-9* classification by the ABS.

Data analysis

SAS software (version 6.12) was used for the data analysis.[2] Besides the underlying cause of death, the distributions of co-existing conditions for deaths from infectious and parasitic diseases were examined in total and in various age and sex groups. Individual co-existing conditions with frequencies of more than 50 were picked up. The frequency distribution of co-existing conditions at the chapter level of the *ICD-9* was examined. The frequency distribution of co-existing conditions for each type of infectious and parasitic disease was also checked. The average frequency of co-existing conditions for each infectious and parasitic disease as the underlying cause of death was calculated.

Results

Co-existing conditions of infectious and parasitic diseases

In 1998, 1,355 people died from infectious and parasitic diseases as the recorded underlying cause. Co-existing conditions that contributed to these deaths number 3,159. The average number of co-existing conditions for each death from infectious and parasitic diseases is 1.62.

The distribution of co-existing conditions at the *ICD-9* chapter level, with infectious and parasitic diseases as the underlying cause of death

At the *ICD-9* chapter level, it was found that the most common frequency of co-existing conditions for deaths from infectious and parasitic diseases was in the chapter concerned with circulatory system diseases, with 24.4% of all co-existing conditions. The co-existing conditions in the symptoms, signs and ill-defined conditions chapter were ranked second — 13.8% of such conditions. This indicates that the data quality of death certificates needs to be improved in Australia. The chapters of the respiratory system (11.8%), genitourinary system (10.3%) and the digestive system diseases (9.7%) were the next three co-existing conditions for deaths from infectious and parasitic diseases. The results indicate that the control of circulatory system diseases is important in the reduction of infectious and parasitic deaths (Table 1).

The distribution of co-existing conditions for deaths from infectious and parasitic diseases

There were many co-existing conditions that contributed to deaths from infectious and parasitic diseases. For clarity, only the co-existing conditions with frequencies more than 50 have been listed (Table 2). These represented 43% of the total.

Among the 3,159 co-existing contributing conditions for deaths from infectious and parasitic diseases in the 1998 Australian mortality data, respiratory failure was the most common single co-existing condition, at 4.6%. Next was acute renal failure, unspecified, which represented 4.0% of the total co-existing conditions. Both the respiratory failure and renal failure reported here are general conditions, and more specific

Table 1 Co-existing conditions for deaths from infectious and parasitic diseases at the *ICD-9* chapter level in Australia, 1998.

Chapter (ICD code)	Frequency
Chapter I: Infectious and parasitic diseases 0010—139	160
Chapter II: Neoplasms 140—239	132
Chapter III: Endocrine, nutritional and metabolic diseases and immunity disorders 240—279	190
Chapter IV: Diseases of blood and blood-forming organs 280—289	78
Chapter V: Mental disorders 290—319	87
Chapter VI: Diseases of the nervous system and sense organs 320—389	99
Chapter VII: Diseases of the circulatory system 390—459	771
Chapter VIII: Diseases of the respiratory system 460—519	373
Chapter IX: Diseases of the digestive system 520—579	308
Chapter X: Diseases of the genitourinary system 580—629	326
Chapter XI: Complications of pregnancy, childbirth and the puerperium 630—679	0
Chapter XII: Diseases of the skin and subcutaneous tissue 680—709	21
Chapter XIII: Diseases of the musculoskeletal system and connective tissue 710—739	53
Chapter XIV: Congenital anomalies 740—759	7
Chapter XV: Certain conditions originating in the perinatal period 760—779	13
Chapter XVI: Symptoms, signs and ill-defined conditions 780—799	437
Chapter XVII: Injury and poisoning 800—999	104
Total	3159

detail could easily have been recorded on the death certificate. Ischaemic heart disease, pneumonia and diabetes were also important contributing conditions for deaths from infectious and parasitic diseases. The results showed that the prevention and treatment of the above diseases might reduce mortality from infectious and parasitic diseases as the underlying cause of death.

The distribution of co-existing conditions in different genders

The co-existing conditions for deaths from infectious and parasitic diseases in males and females are listed in Table 2. It shows that across all of the 3,159 co-existing conditions, the ratio of males to females is 1,731:1,428 (This ratio would be 1,748: 1,411 when adjusted by the male:female ratio in

Table 2 Co-existing conditions for deaths from infectious and parasitic diseases in Australia, 1998.

ICD	Co-existing conditions	Male	Female	Total
038.9	Unspecified septicaemia	37	18	55
250.0	Diabetes mellitus without mention of complication	44	38	82
401.9	Essential hypertension	17	34	51
414.9	Ischaemic heart disease, unspecified	58	55	113
427.5	Cardiac arrest	46	56	102
428.0	Congestive heart failure	30	47	77
436.9	Acute but ill-defined cerebrovascular disease	23	29	52
486.9	Pneumonia, organism unspecified	55	41	96
496.9	Chronic airways obstruction, not elsewhere classified	32	31	63
571.5	Cirrhosis of liver without mention of alcohol	34	25	59
572.8	Other sequelae of chronic liver disease	53	26	79
584.9	Acute renal failure, unspecified	66	61	127
585.9	Chronic renal failure	36	21	57
586.9	Renal failure, unspecified	51	31	82
785.5	Shock without mention of trauma	36	37	73
799.1	Respiratory failure	90	55	145
799.8	Nervousness	35	26	61
Total		743	631	1374

Table 3 The frequencies of co-existing conditions for Australian deaths from infectious and parasitic diseases in various age groups, 1998.

ICD Code[a]	Age (years)											
	0–9	10–19	20–29	30–39	40–49	50–59	60–69	70–79	80–89	90–99	100+	Total
250.0	0	0	1	2	5	12	17	22	20	3	0	82
414.9	0	0	0	0	2	2	12	20	61	16	0	113
427.5	2	0	1	4	2	2	9	22	47	13	0	102
428.0	0	0	0	0	1	2	3	21	38	12	0	77
486.9	1	2	2	2	4	7	9	22	38	9	0	96
572.8	0	0	2	11	19	6	12	24	4	1	0	79
584.9	0	0	0	2	3	5	12	39	47	19	0	127
586.9	0	1	1	6	8	3	5	22	29	7	0	82
785.5	2	2	1	2	3	4	11	18	26	4	0	73
799.1	2	2	6	9	8	11	21	34	38	14	0	145
Total	7	7	14	38	55	54	111	244	348	98	0	976

[a] Diabetes mellitus without mention of complication (250.0); ischaemic heart disease, unspecified (414.9); cardiac arrest (427.5); congestive heart failure (428.0); pneumonia, organism unspecified (486.9); other sequelae of chronic liver disease (572.8); acute renal failure, unspecified (584.9); renal failure, unspecified (586.9); shock without mention of trauma (785.5); respiratory failure (799.1).

the population.) There is no significant difference in the gender distribution at the aggregate level.

The distribution of co-existing conditions in different age groups

The frequencies of co-existing conditions for deaths from infectious and parasitic diseases among different ages were selected from the 1998 Australia mortality data. The top ten frequencies of co-existing conditions are shown in Table 3.

There were some differences between age groups. There was an increasing trend in reported co-existing conditions in those aged between 60–69 years. The frequency of co-existing conditions in those older than 70 years was 2,093, which was 66.3% of all the 3,159 contributing conditions. This outcome is even more pronounced when the fact that the 70+ age group represents only a small proportion of the overall population is taken into account. In fact, in the 70+ age group there are seven times as many co-existing conditions as would be expected if such conditions were evenly distributed across the population.

The frequency distribution of co-existing conditions for different types of infectious and parasitic diseases

The co-existing conditions were also examined for each individual type of infectious and parasitic disease in the *ICD-9*. Among the total of 3,159 co-existing conditions, most (56.0%) were bacterial infections. The next most important were other infections due to viruses and chlamydiae, accounting for 16.3% of all contributing conditions.

Discussion

Death commonly occurs with a number of concurrent or co-existing conditions. Some deaths, it has been postulated, cannot occur without the influence of more than one cause. The ability of statistical reports that present a single underlying cause to summarise accurately the mortality pattern of a population has been questioned.[3] It is therefore very important to study the distribution of co-existing conditions that also contribute to death.

This project studied the co-existing conditions for deaths from infectious and parasitic diseases using 1998 Australian mortality data. The results showed that the average number of co-existing conditions for each death from infectious and parasitic diseases is 1.62. It was more than that for pneumonia (1.57) and equal to that for suicide (1.62).[4,5] The results indicated that when a death recorded infectious or parasitic disease as the cause, this was generally not the only cause.

At the chapter level of the *ICD-9*, it was found that as a co-existing condition, circulatory system diseases made the greatest contribution to deaths from infectious diseases in 1998 (24.4%). This could be because 66.3% of all co-existing conditions occurred in those aged 70 years and older. Many people in these age groups suffer from circulatory system diseases and with poor health status, an infection may lead to death. Hence, the circulatory system diseases are probably as important as

the infection, and the prevention and treatment of circulatory system diseases may reduce mortality from infectious and parasitic diseases.

The diseases of the respiratory (11.8%), genitourinary (10.3%) and digestive systems (9.7%) were the next three contributing conditions for deaths from infectious and parasitic diseases. This might also be related to the age distribution of co-existing conditions, with older people tending to suffer from these diseases. Meanwhile, control of these diseases is also very important in the reduction of infectious and parasitic diseases as the underlying cause of death.

The quality of mortality data is very important to public health, health service research, and policy-making.[6] Good mortality data require precise and consistent coding of death certificates. However, inaccuracy in death certification, the main source of poor mortality data, is a major concern.[7–9] This study found that there was incompleteness and inaccuracy of information on death certificates, with 13.8% of all co-existing conditions belonging to the *ICD-9* chapter of symptoms, signs and ill-defined. This was ranked the second most important at the chapter level of the *ICD-9*. There was also inaccurate information on the death certificates for individual diseases of other chapters, such as respiratory failure, heart failure and renal failure. This suggested that more attention should be paid to the quality of death certificates. Regular training of health information managers in each health facility, retrospective surveys on death certificates from the Registrar of Births, Deaths and Marriages of each state/territory and the Australian Bureau of Statistics might be helpful in the improvement of death certificate quality.

Overall there was no significant difference in the number of co-existing conditions between males and females. However, some co-existing conditions were more prevalent in females than in males. For example, there were more reports of co-existing conditions for congestive heart failure, cardiac arrest, and essential hypertension in females than in males. This indicates that the conditions that contributed to deaths from infectious and parasitic diseases might be different between genders. Apart from the underlying prevalence for different diseases in different genders there is no clear explanation for this outcome. This is an area for further research.

Special care should also be given to the aged population, given the larger number of co-existing conditions in this age group. This is probably because older people had a poorer health status and they might already have been suffering from many types of disease. Whilst an infection might lead to their death, their co-existing diseases should be considered contributory conditions.

After examining the distribution of co-existing conditions for each type of infectious and parasitic disease, this study found that 56.0% of such conditions were other types of bacterial infection, and 16.3% were due to other viruses and chlamydiae infections. The results suggested that the treatment and prevention of other bacterial infections (other than intestinal bacteria infection, tuberculosis, and zoonotic bacterial infections) and other viruses (other than poliomyelitis) might be able to reduce the mortality of infectious and parasitic diseases as the underlying cause of deaths.

The breakdown of the co-existing conditions by underlying microbial cause could not be completed because of unavailability of data. Obviously more detailed data are needed to conduct further analysis.

Conflict of interest: No conflicting interest declared.

References

1. Australian Institute of Health and Welfare: Australia's Health 2000. Canberra: Australia; 2000.
2. SAS Institute Inc. SAS/STAT Software: changes and enhancements through 6.12. Cary NC, USA; 1997.
3. Greig M. An Australian experience in implementing automated coding. Documents for meeting of heads of WHO collaborative centres for the classification of diseases. Cardiff, Wales, UK; 17—22, 1999.
4. Bi P, Walker S. The distributions of co-mortality in pneumonia in Australian mortality data, 1998. National Centre for Classification in Health: Brisbane; 2000.
5. Bi P, Walker S. Co-existing conditions for suicide in 1998 Australian mortality data. National Centre for Classification in Health: Brisbane; 2000.
6. Alexander J, Jayne D. Multi-cause coding: A major step in improving mortality statistics in Australia. ABS: Brisbane; 1999.
7. Johansson LA, Westerling Ragnar. Comparing Swedish hospital discharge records with death certificates — implications for mortality statistics. *Int J Epidemiol* 2000;**29**:495—502.
8. James DS, Bull AD. Death certification: is correct formulation of cause of death related to seniority or experience? *J R Coll Physicians Lond* 1995;**29**:424—8.
9. Kelson MC, Farebrother M. The effect of inaccuracies in death certification and coding practices in the European Economic Community on international cancer mortality statistics. *Int J Epidemiol* 1987;**16**:411—4.