Quality of cause of death certification at an academic hospital in Cape Town, South Africa

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Objectives. To investigate the quality of cause of death certification and assess the level of under-reporting of HIV/AIDS as a cause of death at an academic hospital.

Design. Cross-sectional descriptive retrospective review of death notification forms (DNFs) of deaths due to natural causes in an academic hospital in Cape Town during 2004. Errors in cause of death certification and ability to code causes of death according to the 10th revision of the *International Statistical Classification of Diseases and Related Health Problems* (ICD-10) were assessed. The association between serious errors and age, gender, cause of death and hospital ward was analysed. A sample of DNFs (*N*=243) was assessed for level of under-reporting of HIV/AIDS.

Results. A total of 983 death certificates were evaluated. Almost every DNF had a minor error; serious errors were found in 32.2% (95% confidence interval (CI) 29.3 - 35.1%).

Errors increased with patient age, and cause of death was the most important factor associated with serious errors. Compared with neoplasms, which had the lowest error rate, the odds ratios for errors in endocrine and metabolic diseases and genito-urinary diseases were 17.2 (95% CI 8.7 - 34.0) and 17.3 (95% CI 7.8 - 38.2), respectively. Based on the sub-sample, the minimum prevalence of HIV among the deceased patients was 15.7% (95% CI 11.1 - 20.3%) and the under-reporting of deaths due to AIDS was 53.1% (95% CI 35.8 - 70.4%).

Conclusion. Errors were sufficiently serious to affect identification of underlying cause of death in almost a third of the DNFs, confirming the need to improve the quality of medical certification.

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South Africa has a well-established system for vital registration and collection of mortality statistics, but is challenged by under-reporting of death statistics, particularly in rural areas and of young children.[1] The quality of medical certification and misclassification of causes of death are also of concern.[2-5] Errors could result from difficulties in clinical diagnosis, poor certification or statistical coding and data processing.[6]

Efforts have been made to improve cause of death information by standardising the reporting and coding of cause of death through the 10th revision of the *International Statistical Classification of Diseases and Related Health Problems* (ICD-10).[7] This defines the underlying cause of death as the condition or injury that started the sequence of events leading directly to death and provides a standard format for medical certification on the death notification form (DNF). The DNF allows for four lines of information (labelled line a to line d in part I) on the causal sequence leading from the underlying cause to the immediate cause of death. The immediate cause should be listed in line a and the underlying cause on the lowest line. Contributory causes can also be listed in a second part (part II).

The underlying cause, which is extremely relevant for public health, should be a distinct entity on the DNF and aetiologically specific.[8] South Africa adopted the international format of medical certification in the new DNF, the BI-1663,[9] as part of revitalising death registration. Whether the death was natural or unnatural must also be indicated. Correct diagnosis and certification of the cause and manner of death are major determinants of the accuracy and completeness of mortality statistics. Problems in the quality of cause of death certification in South Africa have been identified.[2,3,10]

We aimed to quantify the extent and identify the types of errors in death certification that occurred at an academic hospital in Cape Town in order to improve its cause of death certification, and highlight concerns that these errors might be arising more generally. We assessed the ICD-10 codability of the information provided by doctors, the extent to which errors in certification of the cause of death were made, and the level of under-reporting of HIV/AIDS as a cause of death.

Methods

Study design and population

A retrospective cross-sectional descriptive study of death notifications and a sample of medical records was conducted at a tertiary hospital in Cape Town. Unnatural deaths were excluded because their DNFs are completed by a forensic pathologist, with additional information from an autopsy.

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Ethics approval was obtained from the University of Cape Town and University of the Western Cape ethics committees.

Sample size and sampling

All DNFs from 1 January 2004 to 31 December 2004 were included. A sub-sample of the natural deaths was selected to assess completeness of the reporting of HIV/AIDS on DNFs. Using Epi-Info a sample size of 243 was estimated to provide an error margin of 10% at a 95% confidence level if the proportion of AIDS deaths with HIV indicated on the death notification was 30%. A systematic sample was drawn.

Data collection and processing

Information on age, sex, causes of death on the death notification and the ward where the patient died was collected. Cause of death information was processed using the Super Mortality Medical Indexing, Classification and Retrieval system (SuperMICAR) of the USA National Center for Health Statistics (NCHS) for coding of causes of death to ICD-10. Some records were rejected by SuperMICAR as being inadequate for coding to ICD-10, e.g. unknown abbreviations or use of the word 'pre-existing' in front of conditions. The cause of death specified on each line of the DNF was assessed as *codable*, or *codable with difficulty* (cause of death inadequate for coding and needed some modification to suit the ICD-10 rules, e.g. use of abbreviations, or two causes written on one line, or use of non-ICD nomenclature), or *not codable* (diagnosis vague and no ICD-10 code could be assigned).

Errors in cause of death certification were identified once the data had been processed using the NCHS Automated Classification of Medical Entities (ACME), the '*de facto*' international standard for the selection of the underlying cause of death.[6] Cases rejected by ACME were reviewed and the nature of the error on the DNF was assessed as major or minor, using adapted criteria.[11-13] Errors were classified as major if they could have an impact on the identification of the underlying cause of death (underlying cause missing, competing potential underlying causes or improper sequencing) and minor if less likely to do so (use of abbreviations, absences of time interval, use of mechanism but with an underlying cause, underlying cause not specific enough). 'Serious major errors' included no acceptable underlying cause of death, competing causes and mechanisms without underlying cause, as such errors could prevent the correct identification of the leading causes of death.

Sub-sample review of HIV status in medical folder

Medical records of a sub-sample of deaths were reviewed to check whether HIV status or AIDS was recorded. We calculated the proportion of cases that were potentially due to AIDS and had HIV positive recorded on their medical records, and those that had AIDS reported on the DNF. Deaths potentially due to AIDS were infectious and parasitic communicable diseases

(A00-B99, G00-G03); maternal and perinatal conditions (P05-P94); nutritional deficiencies (E40-E46, D50-D56); selected respiratory conditions, i.e. pneumoconiosis, pharyngitis, chronic rhinitis, chronic nasopharyngitis, adult respiratory distress syndrome, pleural conditions, peritonsillar abscess, chronic sinusitis disease of tonsils and adenoids (J10-J18, J20-J22, J86); other non-infectious gastro-enteritis and colitis (K52, K52); and selected cancers, i.e. vulval cancer, cervical cancer, Kaposi's sarcoma and non-Hodgkin's lymphoma (C46-C46, C51-C54, C81-C90, C97).

Statistical analysis

Descriptive statistics and 95% confidence intervals (CIs) were calculated for key proportions. A chi-square test was used to compare the sex distribution of deaths by ward and whether certain factors influenced the frequency of minor and major errors. Logistic regression analysed the association between various factors and serious major errors. Variables included were sex, age, ward, and the underlying causes.

Results

Response rate

In 2004, 1 523 deaths occurred. Of these records, 12 were duplicates and 161 were missing, leaving 88.6%. Of the remaining records 356 were due to unnatural causes and excluded; 994 deaths were from natural causes, but 11 (1.1%) contained no information about cause of death, leaving 983 natural deaths for analysis.

Basic characteristics

Of the deceased 51% were female. The median age at death was 57.9 years; 34.3% were aged ≥65, and 2.0% were neonates. The few deaths in those younger than 25 years reflect the fact that children are generally not treated at this hospital. Most deaths were in the age groups 55 - 64 years (22.2%) and 65 - 74 years (20.1%). On about 34% of the DNFs only a single cause of death was reported. On 12% of the DNFs a cause was listed on all four lines provided in part I, and in 13% a cause was listed in the section for contributory causes (part II). The underlying cause of death profile is presented in Table I by ICD-10 chapter.

Codability of information to ICD-10

Most causes (83.3%) (95% CI 81.7 - 84.8%) could easily be coded to ICD-10, 4% (95% CI 3.4 - 5.1%) could not be coded, and 12.5% could be coded with difficulty. The codability of causes decreased down the causal sequence from 91% (95% CI 89 - 92%) on line a to 72% (95% CI 63.5 - 80.0%) on line d. In the contributory cause section (part II), only 54% (95% CI 44.8 - 62.3%) could be coded. Non-ICD nomenclature such as 'immunocompromised', 'retroviral disease' and 'multiple organ failure' occurred more frequently in line d and part II than in the other lines. The surgical department had the highest level

649

of non-codable causes at 7.3% (95% CI 5.0 - 9.5%). Ill-defined causes such as 'natural causes' and 'old age' were used in only 4 (0.4%) of the notifications.

Errors in certification of cause of death

Table II presents the frequency of major and minor errors. Only 8 (0.8%) records were completely error-free. At least 98.4% had one minor error and 45.4% at least one major error. Improper sequencing was the most frequent major error.

Factors associated with serious major errors

Serious major errors were found to be significantly associated with ward, cause of death and age of the deceased in the univariate analyses, but only with cause of death and age in the multivariate analysis (Table III). They increased with increasing patient age, and were 4.5 times higher in the ≥65 age group compared with the <5-year age group. Compared with neoplasms, the chance of errors was about 17 times higher for

endocrine, nutrition and metabolic disorders, and for genito-urinary conditions. The pseudo-R2 was relatively low at 0.12, suggesting that there are factors which were not captured in this study.

Under-reporting of HIV deaths

One record from the sub-sample selected for review could not be found, and the remaining 242 were assessed blind to the death certificate information. Only 21.5% (95% CI 16.3 - 26.7%) had a clear indication of an HIV test in the medical records. Of these cases 38 were HIV positive, giving an HIV prevalence of 15.6% (95% CI 11.1 - 20.3%) in the sub-sample. Given the high proportion of cases without recorded information, this must be considered a minimum prevalence.

Out of the sub-sample of 243 records, 71 deaths were potentially related to HIV or AIDS, and 33 (46.5%) of these individuals had no indication of a HIV test in their medical record. Furthermore, of the 32 cases that were recorded as HIV

Table I. Underlying causes of death by ICD-10 chapter, 2004

ICD-10 chapter	N	%
Neoplasms	287	29.2
Diseases of the circulatory system	243	24.7
Certain infectious and parasitic diseases	110	11.2
Diseases of the respiratory system	76	7.7
Endocrine, nutritional and metabolic diseases	67	6.8
Diseases of the digestive system	49	5.0
Certain conditions originating in the perinatal period	45	4.6
Diseases of the genito-urinary system	42	4.3
Diseases of the nervous system	25	2.5
Congenital malformations, deformations and chromosomal abnormalities	13	1.3
Diseases of the musculoskeletal system and connective tissue	11	1.1
Mental and behavioural disorders	4	0.4
Symptoms, signs and abnormal clinical and laboratory findings	4	0.4
Diseases of the blood and blood-forming organs and immune mechanism disorder	3	0.3
External causes of morbidity and mortality	3	0.3
Diseases of the skin and subcutaneous tissue	1	0.1
Total	983	100.0

Table II. Frequency of major and minor errors found in death notifications, 2004

Type of error	N	%	95% CI
Major error – serious			
No acceptable underlying cause of death	170	17.3	14.9 - 19.7
Competing causes	146	14.9	12.6 - 17.1
At least one serious major error	**317**	**32.2**	**29.3 - 35.1**
Major error – other			
Improper sequencing	236	24.0	21.3 - 26.7
At least one major error	**446**	**45.4**	**42.3 - 48.5**
Minor error			
Absence of time interval	967	98.4	97.6 - 99.2
Underlying cause listed but description not specific enough	78	7.9	6.2 - 9.6
Mechanisms with underlying cause	202	20.6	18.0 - 23.1
Abbreviation used	105	10.7	8.7 - 12.6
At least one minor error excluding absence of time interval	**338**	**34.4**	**31.4 - 37.4**
At least one minor error	**967**	**98.4**	**97.6 - 99.2**

Table III. Association of serious major errors with age, sex, hospital ward and cause of death based on univariate analysis and logistic regression

Characteristic	N	Univariate analysis			Logistic regression		
		%	95% CI	*p*-value	OR	95% CI	*p*-value
Sex				0.334			0.801
Male	484	33.7	29.5 - 38.0		1.0	-	
Female	499	30.8	26.7 - 34.9		1.0	0.8 - 1.4	
Age (yrs)				0.003			0.039
<5	73	20.5	11.1 - 30.0		1.0	-	
5 - 44	194	32.5	25.8 - 39.1		2.8	0.5 - 15.0	
45 - 54	162	32.1	24.8 - 39.4		3.6	0.7 - 19.4	
55 - 64	218	25.7	19.8 - 31.5		2.6	0.5 - 14.0	
≥65	336	39.0	33.7 - 44.2		4.5	0.8 - 23.9	
Ward				<0.001			0.562
Neonates	64	20.3	11.3 - 32.2		2.3	0.3 - 17.0	
Medical general	206	43.7	36.8 - 50.8		1.8	1.2 - 2.8	
Medical specialised	253	25.7	20.4 - 31.5		1.9	1.2 - 3.1	
Surgical	190	34.7	28.0 - 42.0		1.4	0.9 - 2.2	
Casualty	270	30.7	25.3 - 36.6		1.0	-	
Causes by ICD-10 chapters				<0.001			<0.001
Neoplasms	287	13.9	10.1 - 18.5		1.00	-	
Circulatory	243	31.7	25.9 - 37.9		3.4	2.1 - 5.5	
Infectious and parasitic diseases	110	34.5	25.7 - 44.2		4.3	2.3 - 8.0	
Respiratory	76	38.2	27.2 - 50.0		4.7	2.5 - 9.0	
Endocrine, nutritional and metabolic	67	68.7	56.2 - 79.4		17.2	8.7 - 34.0	
Digestive	49	44.9	30.7 - 60.0		6.3	3.1 - 12.9	
Perinatal conditions	45	17.8	0.8 - 32.1		3.4	0.8 - 15.0	
Genito-urinary	42	71.4	55.4 - 84.3		17.3	7.8 - 38.2	
Other	64	42.2	30.0 - 55.2		5.8	2.9 - 11.5	
Total	983	32.2	29.3 - 35.3				

OR = odds ratio; CI = confidence interval.

positive in their medical record, only 15 (47%) had HIV/AIDS indicated on the death certificate. From the sample, it was found that 6 of the 38 patients recorded as being HIV positive died due to causes that were not directly related to HIV/AIDS. The causes included renal failure (*N*=2), stroke (*N*=2), hypertensive heart disease and ischaemic hepatitis associated with drug abuse and accounted for 15.8% (95% CI 4.2 - 27.4%) of the recorded HIV-positive patients.

Discussion

The WHO ICD-10 manuals are the international standard for mortality statistics. Information provided on DNFs at this hospital was well suited for coding to ICD definitions, and <1% had ill-defined signs and symptoms as the underlying cause. However, avoidable mistakes occurred in most death notifications. In 32% the errors were sufficiently serious to potentially affect the accuracy of cause of death coding. Errors occurred more frequently among causes of death certified to genito-urinary or endocrine and metabolic conditions. The error rate did not differ by gender but increased with patient age. This could possibly be associated with an increased tendency for co-morbidity in older people. The difference in

error rates across wards appears to be explained by the patient profile rather than differences between wards.

The major error rate in this study of 45% is comparable to that of Burger *et al.*[3] (43%). However, it is high compared with reports from an academic hospital in Canada (33%)[12] and from a national population-based study in Taiwan (19%).[14] The absence of indication of the time interval from onset of disease to death contributed to the 98% of minor errors in the DNFs, slightly higher than 82%[3] in a population-based study in Cape Town, and much higher than 36% in a study in a teaching hospital in Canada.[11]

Our study reveals extensive under-reporting of HIV as the underlying cause of death. People with HIV are prone to other illnesses and infections, and HIV should be recorded as the underlying cause of death if it 'initiated the chain of morbid events leading directly to death'. The under-reporting of HIV on the DNF appears to have arisen from incomplete clinical information at the time of certification (nearly half potential AIDS cases had no record of an HIV test), and reluctance to certify HIV (in nearly half the HIV-positive cases, the DNF did not reflect this).

651

Reluctance to certify the presence of HIV may be due to concerns about confidentiality of the information on the DNF. The apparent lack of HIV testing was surprising. However, these data predated the antiretroviral roll-out in South Africa and coincided with the commencement of provision of ARVs at academic hospitals, so HIV testing may not have been required for appropriate clinical management. The magnitude of the AIDS epidemic and the need for reliable information require concerted efforts to improve the quality of medical certification and to enhance the system to ensure confidentiality of cause of death information.

The accuracy and completeness of cause of death statistics depend on the details provided by medical practitioners and their ability to correctly identify and certify the cause and manner of death.[15] Medical students and doctors should have improved training in the completion of death notification. In Canada a brief educational intervention significantly reduced rates of major errors in the completion of death notifications.[12] An intervention reported in this issue of *SAMJ* also found a significant reduction in the error rate after a short course accompanied by a pamphlet with guidelines.[16]

Since death certificates are practically the only source of data on cause of death, this information must be as accurate as possible. International practice indicates that a system of review and feedback to the certifying doctors is needed. This should occur at several levels: the statistical office should have a system to check certificates that have major errors, and health care facilities should introduce strategies to encourage doctors and administrative staff to comply with the rules of 'international form of medical notification of cause of death' completion. These should be supported by the provincial and national Departments of Health.

This study has several limitations. One researcher determined the type of error, and this would have been improved methodologically by a second researcher independently cross-checking the findings. As it was conducted in a single facility the results apply to this study population only. Patients who died in this hospital may not be representative of South Africa as a whole, and the certifiers may not represent all doctors in South Africa. Nonetheless, it is anticipated that the findings have broader relevance.

Despite South Africa's improved cause of death statistics based on vital registration, in this study almost a third of errors were serious enough to affect selection of the underlying cause of death, confirming that the quality of medical certification must improve. In such cases the underlying cause of death remains unknown or uncertain, and this has serious public health and policy implications.

Despite errors and misclassification on DNFs, death notification data remain an essential source of information on the health status of the population. It is important to understand the limitations of the data and to make use of the burden of disease approach of checking the consistency of the data against other sources or models to derive meaningful estimates.

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652