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

Beatrice Nojilana, Pamela Groenewald, Debbie Bradshaw, Gavin Reagan

ABSTRACT

Background

Cause of death certification continues to be a useful tool in obtaining demographic, epidemiological and legal information. However errors in death certification are widespread and range from incomplete certificates to inaccurate causes and manners of death. The accuracy of the immediate and underlying causes of death listed on the death certificate, to a large extent depends on the doctor and his or her understanding of the guidelines for reporting immediate and underlying causes. It is anecdotally suspected that HIV/AIDS as an underlying cause of death is underreported, however this has not been verified and the degree of underreporting, if any is unknown.

Objectives – To evaluate the quality of certification causes of natural death and to assess the level of underreporting of HIV/AIDS as a cause of death at an academic hospital in Cape Town, South Africa.

Study design

This is a cross sectional descriptive study based on a retrospective review of death certificates and medical records at an academic hospital in Cape Town.

Methods A total of 983 death certificates filed from January to December 2004 were examined in this cross-sectional descriptive study. These were evaluated to assess whether the causes of death recorded on death certificates could be coded into ICD-10 as per WHO guidelines and to determine the frequency and types of errors made by medical practitioners. In addition a proportion of death certificates (sample N=245) which consisted of 24.9% of all natural deaths that occurred at the hospital over a period of one year, was assessed for the level of underreporting of HIV/AIDS

Findings

Only 16 out of 983 death certificates (1.6%) were error free. Almost half (45.4%) had at least one major error that could compromise the identification of the underlying cause of death. The results indicate a low proportion of sampled medical records in 2004 had a recorded HIV test. Of those cases that were identified as HIV positive on

the medical record, only 39.5% (CI: 23.9-55.0) were identified as having HIV as an underlying cause of death on the death certificate.

Conclusions. This study has demonstrated that in almost half of the cases major avoidable errors are present on death certificates. There is therefore a clear need to improve the quality of medical certification of causes of death so that reliable statistics can be compiled from them and used to generate vital public health information. It is likely that a short training programme for doctors on the completion of death certificates would improve the quality of the certification of causes of death.

Introduction

Complete and accurate reporting of cause of death is extremely important for establishing meaningful statistics for public health policies and is also required by the deceased's family for emotional and legal purposes (Adjuik *et al.*, 2006; Murray & Lopez, 1996). South Africa has a well established civil registration system which includes the systematic collection of cause of death statistics. It is one of the few countries in Sub-Saharan Africa that routinely submits cause of death statistics to the WHO (Mathers *et al*., 2002). However, review of the data produced by the systems shows that they are of poor quality as a result of under-registration and the high level of ill-defined causes of death. In addition, limitations of cause specific mortality statistics due to missing specific (underlying) cause of death on death certificates have been reported (Grandin *et al*., 2006).

A new death certificate (BI-1663) (Appendix A) was introduced in South Africa in 1998 as part of a strategy to increase the accuracy of cause of death certification through recording the specific cause of death, the causation sequence and any other condition that may have contributed to the death (Grandin *et al*., 2006, Bradshaw *et al*., 2006; Dhai *et al*., 2001). The section on the cause of death was revised to follow the WHO International Classification of Diseases guidelines. The death certificate has space for 5 lines of information in accordance with the International Statistical Classification of Diseases and Related Health Problems (ICD-10). The national statistical office codes this information and identifies the underlying cause according to the ICD-10 guidelines.

The quality of the cause of death statistics is greatly dependent on the physician and his or her understanding of the guidelines for certifying the causes of death. While several studies have evaluated the accuracy of cause of death certification, there have been no recently published studies on the accuracy and completion of cause of death certification in South Africa. In addition, there is indirect evidence of misclassification or underreporting of HIV and AIDS deaths (Groenewald *et al.* 2005a and b). Given the growing numbers of HIV related deaths and the concerns of stigma related to this disease, the extent of incomplete information on the HIV status on the death certificate might be large. It was therefore useful to assess the extent of errors in

the certification of cause of death and the extent of misclassification of AIDS as a cause of death in the South African setting. A local academic hospital was selected for an initial assessment for pragmatic reasons and all deaths certificates of deceased patients in 2004 were reviewed to examine the information provided about the cause of death and assess their completeness and to assess whether they comply with the ICD-10 guidelines.

The specific objectives of the study were:

1. To determine what proportion of causes of natural death listed on death certificates were *adequate for coding* to ICD-10
2. To determine what proportion of death certificates had sufficiently logically consistent information to *identify an underlying* cause
3. To determine the extent of major and minor errors in the cause of death certification
4. To assess whether factors such as age of deceased, gender of deceased, category of health service and category of cause of death are associated with the adequacy of cause of death information *for coding to* ICD 10.
5. To assess whether factors such as age of deceased, gender of deceased, category of health service and category of cause of death are associated with the adequacy of cause of death information for identification *of an underlying cause* of death.
6. To assess the completeness of reporting of HIV/AIDS data on the death certificates

Methodology

Study design

This is a cross sectional descriptive study based on a retrospective review of death certificates and medical records among five major departments namely Medical general, Medical special, Surgical, Maternal and casualty at academic hospital in Cape Town Since the aim is to measure and describe the level/proportion of inaccuracies in cause of death certification as well as to determine which factors are associated with the adequacy of cause of death certification, a quantitative

methodology was used to establish the size of the problem (accuracy of certification) and quantify the types of errors in cause of death certification.

At the time of certifying the cause of death, a copy of the death certificate is retained in the deceased's folder and stored at the medical records department. After receiving permission from the relevant personnel, death certificates and medical records were obtained for review.

Study population

All death certificates for natural deaths at a major academic hospital in Cape Town (n= 983) completed between 1 January to 31 December in the year 2004 were identified. Unnatural deaths were excluded from this study because these death certificates were completed under different conditions. A post mortem is performed on all unnatural deaths and a forensic pathologist (specialist doctor) completes the death certificate. It is expected that under such conditions, errors would be minimal. In the case of natural causes of deaths, it is extremely unusual for a post-mortem to e conducted. In addition any level of doctor is allowed to certify natural causes of death, even newly qualified interns.

Sample size

For objectives 1-5, all natural deaths that occurred in GSH in the year 2004 were reviewed. A sub-sample of these was selected to assess the completeness of reporting of HIV/AIDS on death certificates (objective 6).

Table 1. Possible combinations of status from medical records and death certificate

Total	a + c	b + d	n
	HIV positive from the records	**HIV negative from the records**	**Total**
HIV/AIDS positive on death certificates	a	b	a + b
HIV/AIDS negative on death certificates	c	d	c + d

In order to estimate the sample size, it was necessary to estimate the number of deaths that would result from HIV/AIDS. Dorrington, *et al*., (2006), using a modelling technique estimated that 21% of all deaths in the Western Cape were due to AIDS in 2006 (but lower percent in 2004 than in 2006). Based on an estimated 1000 deaths in 2004 and assuming that 30% (this is higher but our study has only natural deaths, rather than all deaths) of these deaths could be due to AIDS (a higher figure than the 21% was assumed as the proportion of deaths due to AIDS is likely to be higher in a tertiary hospital than in the general population), it was conservatively estimated that 300 deaths in 2004 were due to AIDS.

Using Epi-Info, it was calculated that if 50% of these 300 deaths were properly recorded on their death certificate as being due to HIV, a sample size of 168 would be required to allow for an error margin of 5%, at a confidence level of 95% and a sample of 73 would be required to allow for an error margin of 10%. However, as it was not possible to know which cases were HIV positive until the records were examined, it was necessary to draw a larger sample to allow for the cases that were HIV negative. Assuming 30% of the cases are expected to be HIV positive, the sample must be multiplied by a factor of 100/30. Thus for an error margin of 5% the sample needs to be [(168 *100)/30] = 560. Using error margin of 10%, at a confidence level of 95% a sample size of 73 was calculated. This would mean that the sample size needs to be [(73 *100)/30] = 243. Due to time constrains, and the acceptability of a 10% error margin it was decided that a sub-sample of 243 would be drawn to capture sufficient HIV positive cases.

Sampling procedure

A systematic sampling procedure was used. In order to draw a sample of 243, every 4^{th} record was selected (983/243 = 4.0453). Each record was assigned a unique observation number from 1-983 based on the date of death. A new variable was created taking the remainder after the observation number was divided by 4 (with values 0, 1, 2, and 3). A random starting point (2) was selected. All records with this value were selected for the sample, giving a systematically selected sample of 246 records.

Data Collection and processing

Information on the age, sex, causes of death as listed on the death certificate and the department where the patient died was collected. This information was captured directly onto an Excel spreadsheet and checked for spelling errors. The data was converted into a flat file that could be run through the Super Mortality Medical Indexing, Classification and Retrieval system (SuperMICAR) which is computer software developed by the United States National Center for Health Statistics (NCHS) for the automatic coding of causes of death into the ICD-10 classification system.

A proportion of records were rejected by SuperMICAR as being inadequate for coding to ICD-10. Some of the reasons for rejections were spelling, unknown abbreviations, and use of co-morbid or pre-existing words in front of conditions. In addition, some of the causes were not recognised by the MICAR dictionary. On the basis of the reasons given by SuperMICAR, an outcome was coded clerically for each line of information on the death certificate and the data was then cleaned and re-run until no errors were listed. The categories used were:

1= codable to ICD-10

2= abbreviation used

3 = 2 codes in 1 line,

4 = non-ICD nomenclature,

5 = not codable to ICD-10

Once the data was coded to ICD-10, the Automated Classification of Medical Entities (ACME) was used to identify the underlying cause of death. ACME is computer software that employs ICD-10 rules to select the underlying cause of death according to the guidelines in the ICD (Johansson & Westerling, 2002). The selection procedure contains two steps. Firstly, ACME identifies the starting point in the certifier's description of the chain of events leading to death, entered in the death certificate. This entails testing whether an immediate cause listed on line (a) can be due to a condition listed on line (b). Secondly, ACME checks whether this starting point is itself an obvious consequence of some other condition, and searches for underlying causes from all the conditions listed on the death certificate. ACME then selects the underlying cause of death where sufficient coded information was available to

ascertain the cause of death. The records which were rejected by ACME were coded clerically directly into the database for the re-run. The coded data was stored in a database, and was transferred back into excel and then into Stata statistical software for further analysis.

Based on the results from Super MICAR and the manual coding, a retrospective review of the errors in the death certificates was performed using the criteria for major and minor errors set out in Table 3. These criteria have been adapted from ones used by Myers & Farquhar, (1998) and Jordan & Bass, (1993). Errors have been conceptualized as major errors if they would impact on the coding of the cause of death and if the mistake affected the underlying cause of death, while minor errors are unlikely to compromise the coding of the cause of death with little direct epidemiological impact. For each death certificate reviewed, four questions were asked to assess the codability based on WHO guidelines. These questions were assigned a number from 1-5 with the more severe problem being allocated a bigger number.

In addition to codability of the information on the death notification, each certificate was reviewed for errors. The presence of 8 problems was assessed by reviewing the outcome from ACME as well as the changes that had to be made for SuperMICAR. The problems included:

1. Absence of time intervals
2. Underlying cause of death but description not specific enough
3. Improper sequencing recorded
4. Underlying cause of death listed in Part II
5. Competing underlying causes
6. Underlying cause missing
7. Mechanisms recorded (0= none, 1=mechanisms of death with legitimate underlying cause, 2= mechanism of death without underlying cause recorded)
8. Signs, symptoms or organ failure recorded (0= none, 1=signs/organ failure with legitimate underlying cause of death 2= signs/organ failure without underlying cause of death 3=organ failure in Part II)

The information about these 8 problems was then used for analysis of the extent of major and minor errors on the death certificate based on a slight adaptation to the categories defined by Myers and Farquhar (1998).

Table 2: Definition of major and minor errors in Death Certificate

Type of error	Definition
Major	
Underlying cause missing	No acceptable underlying cause of death recorded
Mechanism of death listed without an underlying cause including signs and symptoms and organ failure	Mechanism or non-specific condition listed as the underlying cause of death
Competing potential underlying causes	Two or more causally unrelated, etiologically specific diseases listed in part I And one or both of them could have acted as the underlying cause
Underlying cause of death listed in Part II	The cause of death is placed in Part II and mechanisms of death or complications of the cause of death listed in Part I
Improper sequencing of the causes of death from immediate to underlying cause	Sequence of events does not make sense, underlying cause of death not listed on the lowest competed line of Part I e.g underlying cause listed on line a, and immediate cause listed on line c
Minor	
Ambiguous abbreviations used instead of full names	Abbreviation used to identify diseases e.g MI for myocardial infarcts
Absence of time intervals since the onset of the disease to immediate cause o death	No time interval listed in part I or part II
Mechanism of death followed by a legitimate underlying cause of death	Use of a mechanism, but qualified by an etiologically specific underlying cause
Single underlying cause given but description not specific enough	Include listing cancer without specifying the primary site, or list stroke (CVA) without specifying subtype

Adapted: Myers and Farquhar, 1998

In order to determine the underreporting of HIV/AIDS deaths on death certificates a review of medical records for a sub-sample of deaths was undertaken to determine the HIV status of the patient. This information was collected 'blind' of the information on the death certificate or the underlying cause of death. In this sub-sample, the medical records were examined and checked whether their HIV or AIDS status was recorded

in the folder. The cause of death on the death certificate was then compared to the medical records in terms of whether HIV was correctly specified as an underlying cause.

Validity and reliability

The criteria for assessing errors have been clearly defined and will enable reproducibility. Codability of the underlying cause of death was assessed using WHO ICD-10 rules and guidelines through the Super MICAR and ACME. Both computer programs are used in routine production of United States mortality statistics and are regarded as the de facto international standard for the selection of underlying cause of death (Johansson & Westerling, 2002). Selection bias has been ruled out as all deaths were reviewed. Measurement bias has been minimized by using blinding and clearly defined criteria to assess errors. A large sample of death certificates (25%) has been used so it is not likely that results are due to chance.

Analysis

The data was analysed using the Stata 9.0 analysis software to generate basic tabulations and determine the proportion of death certificates that provided sufficient information to identify rational and plausible underlying causes of death. The proportion of major and minor errors were assessed by age, sex and department. The 95% confidence intervals were calculated for key proportions and a chi-squared test was used to compare the sex distribution of deaths by department. In the sub-sample data, the prevalence of HIV, the sensitivity of the death certificates to identify HIV as an underlying cause and the overall agreement between the medical records and the death certificates were calculated. The probability of HIV being correctly recorded on the death certificate given a positive test in the medical records was measured (sensitivity) as well as the overall proportion of the cases where the death certificate and the medical records agree in terms of HIV. Table 1 shows the possible categories of combinations of HIV status from the medical records and on the death certificate. The main measure of interest is the proportion of HIV positive cases recorded correctly on the death certificate (a/(a +c)). The overall agreement is (a+d)/(a+b+c+d) which is also a useful measure.

Ethical and Legal considerations

The underlying cause of death has greatest medical, legal and epidemiologic importance. Permission to undertake the study was approved by the University Western Cape Ethics Committee. Permission to examine hospital records was granted by the mentioned hospital authorities. Careful measures were taken to treat the death certificates with confidentiality. All identification data is stored in the computer database that is accessible only to the student and the supervisor and is password protected.

Results

Out of the 1523 deaths that occurred at GSH in 2004, it was possible to obtain 1362 records (89.4%). Most of these records were found from medical records (natural deaths) with a few from medico-legal department (unnatural deaths). The remaining 161 (10.6%) records could not be traced.

Out of the 1362 records, 357 were due to unnatural causes and 22 contained no information for the cause of death. These were excluded from the study as they were not completed by health professionals in the hospital. A total of 983 natural deaths were therefore included in the analysis.

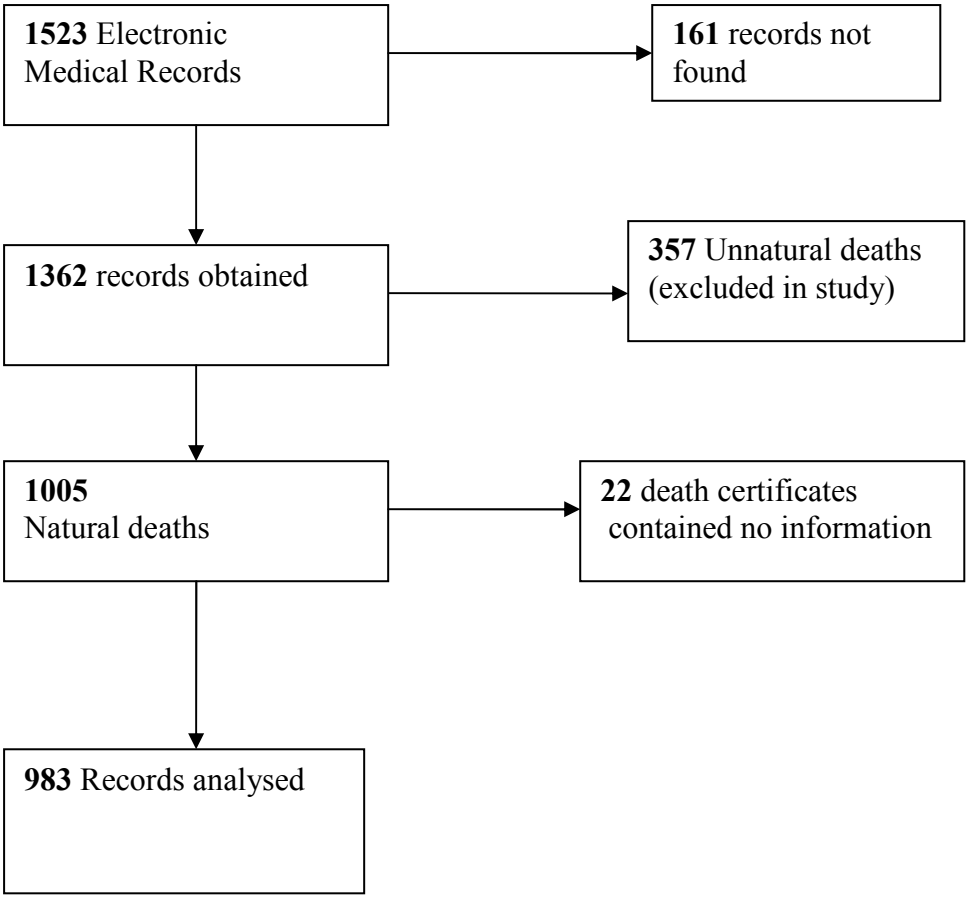

Table 3. shows the sex distribution of the deceased for 2004. Just over half (51%) of the deceased were female and the male:female ratio of deaths was 1:1.04.

Table 3. Sex distribution of deaths, 2004

Sex	Frequency	%
Female	499	50.8
Male	484	49.2
Total	983	100.0

The overall median age at death was 57.9 years and a third (34.3%) of the deceased were 65 years and above. For both sexes the lowest age at death was 2 hours (data not shown). The highest age at death for female was 94 years old and for males was 91years old. There were a few < 25 years and these are neonates which accounted for 2.03% of the total deaths. The most frequent age group is 55-64 years old 218 (22.2%) followed by 65-74 years old 198 (20.1%). From Table 4, it can be seen that

there were few child deaths, reflecting the fact that Cape Town has a specialist children's hospital and that the academic hospital assessed has few children as patients.

Table 4. Sex and age distribution of deaths, 2004

Age group	Female	%	Male	%	Total	%
Neonates	33	6.6	28	5.8	61	6.2
1 month-4 years	5	1.0	7	1.5	12	1.2
<25	13	2.6	7	1.5	20	2.0
25-34	40	8.0	30	6.2	70	7.1
35-44	44	8.8	60	12.4	104	10.6
45-54	82	16.4	80	16.5	162	16.5
55-64	109	21.8	109	22.5	218	22.2
65-74	91	18.2	107	22.1	198	20.1
75+	82	16.4	56	11.6	138	14.0
Total	499	100.0	484	100.0	983	100.0

It can be seen from Table 5 that the deaths are presented by ward with the highest numbers from the casualty ward (27.5%) and the medical specialty ward (25.7%). The lowest numbers were from the neonates ward, accounting for 6.5%.

Table 5. Sex distribution of deaths by departments, 2004

Wards	Female	%	Male	%	Total	%
Neonates	34	6.8	30	6.2	64	6.5
Medical general	99	19.8	107	22.1	206	21.0
Medical special	146	29.3	107	22.1	253	25.7
Surgical	80	16.0	110	22.7	190	19.3
Casualty	140	28.1	130	26.9	270	27.5
Total	**499**	**100.0**	**484**	**100.0**	**983**	**100.0**

About a third (34%) of the certificates had only a single cause written on line (a) of the death certificate, while 11.9% had all four lines completed of Part I. In addition 13% had causes in Part II. Table 6 presents the levels of codability on death certificates as recorded per line (immediate, intermediate and underlying cause). The immediate cause of death was listed on line (a) of the certificate with up to three levels of underlying cause listed on lines (b) to (d). If there were any contributing cause of death, this was listed on Part II of the certificate. Approximately 83.3% (CI: 81.7-84.8) of the causes recorded on lines (a) to (d) and Part II could be coded to

ICD-10.91% (CI: 89%-92%) of the causes recorded on line (a) could be coded by ICD, and about 11% (CI: 5.3%-16.9%) of the causes recorded on line (d) could not be coded. Non ICD nomenclature was used more in line (d) and Part II. When combining all lines 83% (CI: 81.7%-84.8%) of the causes were codable to ICD-10, 5% used abbreviations and 4% of all the causes could not be coded to ICD-10.

Table 6. Codability levels (95% confidence intervals) of causes of death on death certificate by line, 2004

Outcome	Line a N=983	Line b N=646	Line c N=329	Line d N=117	Part 2 N=127	All lines N=2202
Codable	90.5% CI:88.7-92.4	82.2% CI:79.2-85.2	79.3% CI:74.9-83.7	71.8% CI:63.5-80.0	53.5% CI:44.8-62.3	83.3% CI:81.7-84.8
Abbreviation used	2.8% CI:1.8-3.8	7.6% CI:5.5-9.6	7.0% CI:4.2-9.8	6.0% CI:1.6-10.3	9.4% CI:4.3-1.6	5.4% CI:4.5-6.3
Two causes on one line	1.8% CI:1.0-2.7	2.8% CI:1.5-.4.1	3.3% CI:1.4-5.3	3.4% CI:0.8-6.8	27.6% CI:19.7-35.4	3.9% CI:3.1-4.7
Non-ICD nomenclature	1.3% CI:0.8-2.0	3.1% CI:1.8-.4.4	5.8% CI:3.2-8.3	7.7% CI:2.8-12.6	7.1% CI:2.6-11.6	3.2% CI:2.4-3.9
Not codable	3.5% CI:2.3-4.6	4.3% CI:2.8-5.9	4.6% CI:2.3-6.8	11.1% CI:5.3-16.9	2.4% CI:0.3-5.0	4.2% CI:3.4-5.1

Table 7 shows the levels of codability on death certificates by department. The surgical department has the highest level of non-codable causes 7.3% (CI: 5.0%-9.5%), followed by the general medical wards 5.2% (CI: 3.4%-7.0%) compared to trauma/casualty which had only 1.5% (CI: 0.5%-2.5%).

Table 7. Codability levels (95% confidence intervals) of causes of death by department, 2004

Outcome	Maternity N=130	Medical g N=576	Medical s N=464	Surgical N=498	Casualty N=534
Codable	93.9% CI: 89.7-98.0	71.2% CI: 67.5-74.9	88.8% CI:85.9-91.7	83.3% CI:80.1-86.6	89.0% CI:86.3-91.6
Abbreviation used	0.8% CI: 0-2.3	10.8% CI: 8.2-13.3	3.2% CI:1.6-4.8	2.8% CI:1.4-4.5	5.1% CI:3.2-6.9
Two causes on one line	0.0% -	7.1% CI: 5.0-9.2	2.6% CI:1.1-4.0	4.6% CI:2.8-6.5	1.9% CI:0.7-3.0
Non-ICD nomenclature	1.5% CI: 0.0-3.7	5.7% CI: 3.8-7.6	2.4% CI:1.0-3.8	2.0% CI:0.8-3.2	2.6% CI:1.3-4.0
Not codable	3.9% CI: 0.5-7.2	5.2% CI:3.4-7.0	3.0% CI:1.5-4.6	7.3% CI:5.0-9.5	1.5% CI:0.5-2.5

Only 16 out of 983 death certificates (1.6%) were error free. There were 98.4% (CI: 97.6-99.2) with at least one minor error and 45.4% (CI: 42.3-48.5) had at least one major error (Table 8). Among the major errors, the most frequent inaccuracy was improper sequencing, found in 21.4% (CI: 18.8-23.9) of the death certificates. Missing acceptable underlying cause of death was found in 17.3% (CI: 14.9-19.7) and competing causes of death were found in 14.9% (CI: 12.6-17.1). In terms of minor errors, absence of time interval between the onset of disease and death was the most common error and was found in 98.4% (CI: 97.6-99.2) of death certificates. Mechanisms of death followed by legitimate cause of death were found in 20.6% (CI: 18.0-23.1) of deaths. When comparing males and females, error rates were very similar. Females had a slightly higher proportion of cases with missing underlying cause of death (19.0% vs 15.5%) while males had a slightly higher proportion with abbreviations (12.4% vs 9.0%).

Table 8. Frequency, percentage and 95% confidence intervals of major and minor errors found in death certificates, 2004

	N	%	95% CI
Major errors			
No underlying cause of death	170	17.3	14.9-19.7
Competing causes	146	14.9	12.6-17.1
Mechanisms without underlying cause	99	10.1	8.2-12.0
Improper sequencing	210	21.4	18.8-23.9
Underlying cause listed in Part II	26	2.6	1.6-3.6
At least one major error	**446**	**45.4**	**42.3-48.5**
Minor errors			
Absence of time interval	916	93.0	91.4-94.6
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	**967**	**99.2**	**97.6-101.2**

Tables 9 and 10 present the frequency of errors according to age group and department. Major errors were higher in <24 years age group (60.0%) followed by the 75+ age group (55.8%). In contrast, minor errors were higher in the neonate group (98.4%). The general medical department was the highest for major errors (66.5% medical general and 34.4% in medical special wards) while maternity was the lowest (34.4%). Medical general department had the highest proportion of improper

sequencing and for competing causes of death. The surgical department had the highest proportion with missing underlying cause of death as an error (Table 10).

Table 9. Frequency and percentage of errors found in death certificates by age group, 2004

Major errors	Neonates	1 month-4 years	5-14	15-24	25-34	35-44	45-54	55-64	65-74	75+	Total
	N=61	**N= 12**	**N= 5**	**N=15**	**N=70**	**N=104**	**N=162**	**N=218**	**N=198**	**N=138**	**N=983**
No underlying cause of death*	11.5	25.0	20.0	13.3	18.6	13.5	17.9	14.7	17.2	25.4	**17.3**
Competing causes*	8.2	0.0	0.0	33.3	11.4	19.2	14.2	10.6	18.2	18.8	**14.9**
Mechanisms without underlying cause*	3.3	0.0	0.0	6.7	14.3	8.7	9.9	10.1	8.6	15.9	**10.1**
Improper sequencing	18.0	25.0	20.0	26.7	21.4	17.3	17.3	22.5	26.3	21.0	**21.4**
Underlying cause listed in Part II	0.0	0.0	0.0	6.7	2.9	5.8	1.2	3.7	1.5	2.9	**2.6**
At least one major error	**32.8**	**50.0**	**40.0**	**66.7**	**44.3**	**44.2**	**40.7**	**42.2**	**48.5**	**55.8**	**45.4**
Minor errors											
Absence of time interval	91.8	100.0	80.0	100.0	100.0	98.1	100.0	98.6	98.5	98.6	**98.4**
Underlying cause listed but description not specific enough	32.8	0.0	20.0	0.0	4.3	7.7	8.6	6.4	4.0	7.2	**7.9**
Mechanisms with underlying cause	3.3	8.3	0.0	26.7	25.7	32.7	21.0	24.3	16.7	16.7	**20.5**
Abbreviation used	1.6	0.0	0.0	33.3	14.3	19.2	9.9	9.6	9.1	10.1	**10.7**
At least one minor error	**95.1**	**100.0**	**100.0**	**100.0**	**100.0**	**99.0**	**100.0**	**100.0**	**98.5**	**99.3**	**99.2**

Table 10. Frequency and percentage of errors found in death certificates by departments, 2004

	Neonates	**Medical general**	**Medical special**	**Surgical**	**Casualty**	**Total**
	N=64	**N=206**	**N=253**	**N=190**	**N=270**	**983**
Major errors						
No underlying cause of death	12.5	19.4	13.8	21.1	17.4	17.294
Competing causes	7.8	23.8	12.3	13.2	13.3	14.9
Mechanisms without underlying cause	3.1	15.0	5.9	15.3	8.1	10.1
Improper sequencing	18.8	32.0	15.8	20.5	19.6	21.4
Underlying cause listed in Part II	0.0	7.8	0.8	2.1	1.5	2.6
At least one major error	**34.4**	**66.5**	**34.4**	**46.3**	**41.5**	**45.4**
Minor errors						
Absence of time interval	92.2	99.0	98.8	97.9	99.3	98.4
Underlying cause listed but description not specific enough	31.3	4.4	3.2	7.4	10.0	7.9
Mechanisms with underlying cause	3.1	36.9	12.3	27.4	15.2	20.5
Abbreviation used	1.6	24.3	5.1	7.4	10.0	10.7
At least one minor error	**95.3**	**100.0**	**99.2**	**98.9**	**99.6**	**99.2**

The underlying causes of death are presented in Table 11 by ICD-10 chapter, while Table 12 presents the top 20 single causes of death. The top three underlying causes of death by ICD chapters are malignant neoplasms (N=287 or 29.2%), diseases of circulatory system (N=243 or 24.7%) and certain infectious and parasitic disease (N=110 or 11.2%). The leading malignant neoplasms are cancer of the lungs (N=56 or 5.7%), cancer of the oesophagus (N = 36 or 3.7%), cancer of the breast (N=28 or 2.9%) and cervical cancer (N=17 or 1.7%). The leading diseases of the circulatory system are stroke (N=100 or 10.2%), myocardial infarction (N=36 or 3.7%), and Ischaemic heart disease (N =18 or 1.8%). The leading causes from the infectious and parasitic diseases are: tuberculosis of lung unspecified bacteriological (N=31 or 3.2%) and other septicaemia (N=18 or 1.8%). Diseases in neonates also account for bigger numbers (N = 58 or 5.9%).

Table 11. Underlying causes by ICD_10 chapters, 2004

	N	**%**
Infectious and parasitic diseases	110	11.2
Neoplasms	287	29.2
Disease of blood and blood forming organs	3	0.3
Endocrine, nutritional and metabolic disease	67	6.8
Mental and behavioural disorders	4	0.4
Diseases of the nervous system	25	2.5
Diseases of the circulatory system	243	24.7
Diseases of the respiratory system	76	7.7
Diseases of the digestive system	49	5.0
Diseases of the skin and subcutaneous tissue	1	0.1
Diseases of the musculoskeletal system	11	1.1
Diseases of the genitourinary system	42	4.3
Perinatal conditions	45	4.6
Congenital malformations and chromosomal abnormalities	13	1.3
Symptoms, signs and abnormal clinical findings	4	0.4
External causes	3	0.3
Total	**983**	**100.0**

A sub-sample of 243 medical records were reviewed for information about the HIV status of the deceased. This was done blind to the death certificate information. Of these cases, only 52, accounting for 22% of the records, had a clear record of an HIV test. There were 38 cases that were HIV positive indicating that the prevalence of HIV among the sub-sample was 15.6% (CI: 4.1%-27.2%). Given the high proportion of cases not tested for HIV, this must be considered a minimum prevalence. The low proportion of recorded tests was surprising and requires further investigation.

Of those cases that were identified as positive on the medical record, only 39.5% (CI: 23.9%-55.0%) were identified with HIV as the underlying cause on the death certificate. However, in some of these cases, HIV infection may have been incidental to the cause of death. Examining the 23 cases that were HIV positive on the medical records but not specified as HIV on death certificate most (87.0%, CI: 73.3-100.7) were conditions that would be considered to be related to AIDS e.g pneumonia, pulmonary TB, septicaemia, Kaposi's sarcoma, meningitis and lymphoma. There were 3 cases where there was no clear suggestion of AIDS on the death certificate (stoke, hypertension and ischaemic hepatitis associated with drug abuse

Discussion

Accuracy of cause of death statistics is influenced by the codability of the information provided on the death certificate. Although only 4% of the cause of death information reviewed in this study could not be coded at all, it was only possible to consider 83.3% of the causes codable as a further 3.2% used non-ICD nomenclature such as immuno-compromise, retroviral etc, two causes were specified on a single line case in 3.9% of the cases and 5.4% of causes were abbreviations. The guidelines to use standard terminology and avoid abbreviations have been put in place to reduce the scope of errors being made in the translation of the information into statistics.

This study has revealed that a high proportion of errors were made in the certification of the cause of death in an academic hospital in Cape Town. Using criteria adapted from a study by Myers and Farquhar (1998), nearly half of the cases (45%) had a major error that could affect the identification of the underlying cause of death. The

most common problem was an improper sequencing of the causes – which makes it difficult to be sure of the actual underlying cause. This was followed by there being no underlying cause specified on the one hand or competing causes on the other.

Minor errors were made on most certificates. The high incidence of minor errors in this study is largely accounted for by the absence of time intervals in 93% of cases. The time intervals can be very useful to the certifier to double-check that conditions leading to death have been listed in the right order (bottom-top-order). It greatly assists to clarify the order of events and makes the job easier for coders. In Myers et al, 1998 the omission of time interval occurred in 71.6% of certificates. Judging from the high percentage of error it is likely that the vast majority of deaths are unaware of the value of this information or the time sequence is naturally difficult to determine.

Similar to this study, Lu *et al.*, 2001 found that that error rates increase with advancing age of the deceased. Since elderly people often have multiple pathologies, there is a greater likelihood of sequencing errors and recording multiple causes of death. The complexity of certain clinical cases can make it hard to identify a single underlying cause of comparable in this study (10%) with studies in Taiwan (7%) (Lu *et al*., 2001) and Ontario (10%) (Jordan & Bass, 1993).

This study shows that the error rate rises with the number of lines in the cause of death sequence completed is not surprising given that this increases the opportunity for error. It is more difficult to explain the higher rates of cases not being codable in the surgical department (7.3%) compared to the other departments. This warrants further investigation of the data.

The investigation of the accuracy of reporting HIV as an underlying cause of death in a sub-sample of cases revealed that a very low proportion of the deceased had been tested for HIV. The study was conducted in a very early phase of the introduction of anti-retroviral treatment. It would be hoped that by now the policy for treating AIDS has been implemented and that there would be more consistent testing and recording of HIV status for patients being treated in the hospital. Based on the limited number of cases that were recorded as being HIV positive, it was found that only 53% of the AIDS related causes of death were certified with HIV as the underlying cause of

death. This point towards extensive under-reporting of AIDS as a cause of death, confirming the findings by Groenewald *et al.* (2005a and b). Collecting accurate mortality statistics on AIDS poses several challenges. Firstly, there is a need for more extensive testing for HIV to enable the clinician to arrive at a thorough diagnosis. Secondly, there is a need to explore ways in which sensitive information can be collected. For example, the inclusion of a separate field for HIV status should be considered.

One limitation of our study is that the determination of the various types of errors was left to the judgement of the student (BN). Methodologically the study could have been improved by a second researcher independently cross-checking her findings, however the use of pre-specified categories of error will have helped to reduce bias. Furthermore, we did not make any attempt to validate the accuracy of the underlying cause of death by comparing the date in the certificate with that in the folder. This will be the focus of a follow up study. There are unmeasured confounders that may affect the results of this study. These include, for example, the level and/or experience of the doctor as one would assume that the more experience the medical practitioner has, the fewer errors would be made. Such confounders could not be measured in this study. This paper presents the initial analysis of the data collected in the study. Further analysis using multiple logistic regression will be undertaken to analyse the association between various factors and types of errors.

The information entered on the cause of death section of the death certificate is used in developing epidemiologic information important for public health planning and research. Since death certificates are virtually the only source of data on cause of death statistics, it is essential for this information to be gathered as accurately as possible. This study highlights that even in an academic hospital there is scope to improve the quality of medical certification. Together with another study in South Africa (Burger *et al*., in press) and other international studies (Pritt, *et al.*, 2005, Myers et al, 1998), there are clear indications that many doctors may not have received adequate training in completing death certificates.

Conclusion and recommedations

South Africa has made good progress in improving the cause of death statistics. The completeness of registration has improved. However, this study has demonstrated that avoidable mistakes occur in the majority of death certificates issued at an academic hospital and that in almost half of the cases, the errors are serious enough to affect the accuracy of cause of death coding. This study, suggests that the accuracy of death certification is a significant problem at the academic hospital in which the study was conducted.

More time and attention should be devoted to educating medical students and trainee specialists in the completion of death certificates. Targeted educational interventions should be developed and tested in South Africa as a matter of urgency. Health care facilities should also consider introducing strategies, including incentives, to encourage doctors and administrative staff to comply with the rules of DNF completion. The statistical office should introduce a system of recall to the certifying doctor in cases where errors are made.

References

Adjuik M, Smith T, Clark S, Todd J, Garrib A, Kinfu Y, Kahn K, Mola M, Ashraf A, Masanja H, Adazu U, Sacarlal J, Alam N, Marra A, Gbangou, Mwangeni E and Binka F (2006). Cause-Specific Mortality Rates in Sub-Saharan Africa and Bangladesh. Bull world Health Organ 84,181-188.

Bradshaw D, Groenwald P, Bourne DE, Mahomed H, Nojilana B, Daniels J and Nixon J (2006). Making Cause of Death Statistics Useful for Public health at Local Level in the City of Cape Town. Bull World Health Organ 84, 211-217.

Burger EH, Van de Merwe L and Volmink J. Frequency of errors in the completion of the Death Notification Form: A Population-based study in Cape Town, South Africa. In Press.

Dorrington R, Johnson L, Bradshaw D, Daniel T (2006). *The Demographic Impact of HIV/AIDS in South Africa. National and Provincial indicators for 2006*. Cape Town:Centre for Actuarial Research, University of Cape Town. Technical Report.

Grandin W, Westwood T,Lagerdien K and King MS (2006). Deaths at Red Cross Children's Hospital, Cape **Town** 1999-2003_ a study of death notification forms. *S Afr Med J* 96, 964-968

Groenewald P, Nannan N, Bourne D, Laubscher R and Bradshaw D (2005a). Identifying deaths from AIDS in South Africa. *AIDS* **19**, 193-201.

Groenewald P, Bradshaw D, Dorrington R, Bourne D, Laubscher R and Nannan N (2005b). Identifying deaths from AIDS in South Africa: an update *AIDS* **19**, 744-745.

Johansson LA and Westerling R (2002). Comparing Hospital Discharge Records with Death Certificate: Can the difference be explained? *J Epidemiol Community Health* **56**, 301-308.

Lu TH, Shau WY, Shih TP, Lee MC, Chou MC and CK (2001). Factors Associated With Errors in Death Certificate Completion. J Clin Epidemiol 54, 232-238.

Mathers CD, Ma Fat D, Inoue M, Rao C and Lopez AD (2005). Counting the Dead and What they Died From: An Assessment of the Global Status of Cause of Death: *Bull World Health Organ* **83**,171-177.

McAllum C, St George I, White G. Death certification and doctors' dilemmas: a qualitative study of GPs' perspectives. Br J Gen Pract 2005;55(518):677-83.

Murray, CJL. Lopez, AD. (1996). Estimating cause of death: New methods and Global and Regional Applications for 1990. The Global Burden of Disease: A Comprehensive assessment of mortality and disability from disease, injuries and risk factors in 1990 and projected to 2020. CJL Murray & AD Lopez (eds). Cambridge: Harvard University Press: 117-124.

Myers KA and Farquhar DRE (1998). Improving the Accuracy of Death Dertification. *CMAJ* **158**, 1317-1323.

REPUBLIC OF SOUTH AFRICA
DEPARTMENT OF HOME AFFAIRS

BI - 1663

NOTIFICATION / REGISTER OF DEATH / STILL BIRTH

in terms of the Births and Deaths Registration Act, 1992 (Act No. 51 of 1992)

Space for Bar Code

* *Must be completed in black ink (please tick ✓ where applicable)*
* *Please refer to instructions*

SERIAL No: A 0 1857265

FILE No: DATE:

A PARTICULARS OF DECEASED INDIVIDUAL / STILLBORN CHILD

Identity number of deceased

Date of death Y Y Y Y M M D D

Date of birth Y Y Y Y M M D D

Age at last birthday ___ years

Surname

Maiden Name (If female)

Forenames

Sex

If death occurred within 24 hours after birth No. of hours alive

MARITAL STATUS OF DECEASED Single ☐ Civil Marriage ☐ Living as married ☐ Widowed ☐ Religious Law Marriage ☐ Divorced ☐ Customary Marriage ☐

Left thumb print of deceased

PLACE OF BIRTH (municipal district or country if abroad) _____

PLACE OF DEATH (City / Town / Village) _____

PLACE OF REGISTRATION OF DEATH _____

CITIZENSHIP OF DECEASED _____

B PARTICULARS OF INFORMANT

Left thumb print of informant

Identity number

Initials and Surname

Relationship to deceased Parent ☐ Spouse ☐ Child ☐ Other kin ☐ Other (specify) ☐

Postal address

Postal Code

Dialling Code

Was the next of kin of the deceased a smoker* during the past five years? Yes ☐ No ☐ Refuse to answer ☐

Telephone No.

Date _____ Signature _____

CANCELLED

C PARTICULARS OF FUNERAL UNDERTAKER

Office Stamp of Funeral Undertaker

Initials and Surname

Designation No.

Place of burial / cremation _____

Date _____ Signature _____

D CERTIFICATE BY ATTENDING MEDICAL PRACTITIONER / PROFESSIONAL NURSE

Postal Address

I, the undersigned, hereby certify that the deceased named in Section A, to the best of my knowledge and belief, died solely and exclusively due to NATURAL CAUSES specified in Section G ☐

I, the undersigned, am not in the position to certify that the deceased died exclusively due to natural causes ☐

Postal Code

INITIALS AND SURNAME _____ SIGNATURE _____

SAMDC / SANC Reg. No.

Date signed Y Y Y Y M M D D

CERTIFICATE BY DISTRICT SURGEON / FORENSIC PATHOLOGIST

I, the undersigned, hereby certify that a medicolegal post-mortem examination has been conducted on the body of the person whose particulars are given in Section A and that the body is no longer required for the purpose of the Inquest Act, 1959 (Act No. 58 of 1959) and that the cause of death is:

Unnatural ☐ Under investigation ☐

Natural (Cause of Death as indicated in Section G) ☐

Postal Address

Postal Code

Initials and Surname

Place of post-mortem _____ Date

Mortuary Reference _____

Signature _____ Date signed

SAMDC Reg. No.

E FOR OFFICIAL USE ONLY

Registration of death approved and burial order issued

Initials and Surname of Registrar

Office Stamp ▷

Address

Force No. / Designation No.

Persal No.

Date _____ Signature _____

* Someone who smokes tobacco on most days

PARAGON 2256391 (0)

NOTIFICATION / REGISTER OF DEATH / STILL BIRTH

BI - 1663
Page 2

INFORMATION FOR MEDICAL AND HEALTH USE ONLY
(After completion *seal* to ensure confidentiality)

Space for Bar Code

SERIAL No: A01857265

FILE No: DATE:

F DEMOGRAPHIC DETAILS

Initials and Surname of deceased

Identity Number

Place of death 1. Hospital: (Inpatient ☐ ER/ Outpatient ☐ DOA ☐) 2. Nursing Home ☐ 3. Home ☐ 4. Other (Specify) ☐

FACILITY NAME (If not institution, give street and number)

Usual residential address of deceased # Suburb

Town / Village

Name of Plot, Farm, etc. Census Enumerator Area

Street name and number Magist. Dist.

Postal Code

Province

Country

Deceased's Education (Specify ✓ only highest class completed/achieved)

None	Gr1	Gr2	Gr3	Gr4	Gr5	Gr6	Gr7	Gr8 Form 1	Gr9 Form 2	Gr10 Form 3 NTC1	Gr11 Form 4 NTC2	Gr12 Form 5 NTC3	Univ Tech	CODE

USUAL OCCUPATION OF DECEASED (give type of work done during most of working life. Do not use retired)

TYPE OF BUSINESS/INDUSTRY (e.g. Mining, Farming) refer to instructions

CANCELLED

Was the deceased a smoker* five years ago? (✓) : Yes ☐ Do not know ☐ Not applicable (minor) ☐

G MEDICAL CERTIFICATE OF CAUSE OF DEATH

FOR OFFICE USE ONLY
ICD-10

PART 1. Enter the disease, injuries or complications that caused the death. Do not enter the mode of dying, such as cardiac or respiratory arrest, shock, or heart failure. List only one cause on each line.

Approximate interval between onset and Death (Days/Months/Years)

IMMEDIATE CAUSE (Final disease or condition resulting in death) a. Due to (or as a consequence of)

Sequentially list conditions, if any, leading to immediate cause. Enter UNDERLYING CAUSE last (Disease or injury that initiated events resulting in death) b. Due to (or as a consequence of)

c. Due to (or as a consequence of)

d. Due to (or as a consequence of)

PART 2. Other significant conditions contributing to death but not resulting in the underlying cause given in Part 1.

If a **female**, was she pregnant 42 days prior to death? (✓) : Yes ☐ No ☐

If **stillborn**, please write mass in grams

Do you consider the deceased to be: African ☐ White ☐ Indian ☐ Coloured ☐ Other ☐ (Specify)

Method of ascertainment of cause of death:

1. Autopsy ☐ 2. Opinion of attending medical practitioner ☐ 3. Opinion of attending medical practitioner on duty ☐

4. Opinion of registered professional nurse ☐ 5. Interview of family member ☐

6. Other ☐ (Specify)

Where someone lived on most days

* Someone who smokes tobacco on most days