Promoting the periodic assessment of the quality of medical records and cause-of-death data: lessons learned from a medical records study in Sri Lanka

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Acknowledgments

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Summary

Reliable, accurate and timely cause-of-death statistics are essential to inform policy and planning in the health sector. It is generally assumed that when a death occurs in a hospital or health facility, adequate diagnostic information and the provision of care by physicians will mean that the cause of death for people dying in hospitals is reliably certified. Yet, even in hospitals, where all deaths are in principle medically certified and a cause-of-death form routinely prepared for each death, it cannot be taken for granted that the correct underlying cause of death is written on the death certificate. Most doctors certify death infrequently, and even if they have been trained in medical certification during their studies, they may have forgotten how to do it well and how to correctly fill in the form. In addition, doctors are often overworked, hospitals may lack diagnostic facilities and have poor medical record practices. There may also be a general lack of awareness of the importance of correct cause-of-death diagnosis for public policy. These factors contribute in varying degrees to poor diagnostic accuracy of medical certification even for deaths occurring in hospitals.

The Health Information Systems Knowledge Hub at the University of Queensland has undertaken a series of targeted operational research projects to assist countries to improve the quality, and hence utility of their cause-of-death information. The purpose of this study was to:

- determine the accuracy of cause-of-death certification by physicians in selected hospitals in the capital district of Sri Lanka
- describe the quality and adequacy of hospital documentation of medical records
- propose, on the basis of this evidence, best cause-of-death certification and medical record practices for the country
- describe a reproducible methodology and infer some lessons that other countries could benefit from.

Evaluation of the quality and reliability of cause-of-death data from routine reporting systems is rarely undertaken. Yet as demonstrated in this study, without validating their cause-of-death information countries have no assurance that their information base for health policies and planning is reliable and correct.

We studied a selected sample of 602 medical records from hospitals in the Colombo district of Sri Lanka over the period March to April 2010. The research design and study instruments were similar to those used in other international cause-of-death validation studies. Five physicians were trained to do the data extraction from hospital medical records and to do the cause-of-death certification. The coding of death certificates was carried out by the national ICD training centre in Sri Lanka using ICD-10.

The accuracy (as assessed by sensitivity) of certification of all leading causes of death in these hospitals was less than 65 per cent, indicating serious quality issues with hospital cause-of-death certification. True cause-specific mortality fractions for deaths in this sample were typically 30–50 per cent higher (or lower) than what was suggested by the vital registration system, calling into serious question the utility of this information for guiding health debates in the country. It was evident from the results of this study that misclassification of cause of death is frequent in Sri Lanka’s cause-of-death information system, part of which might be due to poor understanding of the concept of the underlying cause of death by certifying physicians. The study also identified serious problems with medical records practices in leading hospitals in Colombo, thus considerably reducing their public health utility and value. This situation is unlikely to be unique to Sri Lanka and other countries may wish to apply a similar approach to critically assess the quality of their cause-of-death data using similar methods to this study.
Introduction

Without regularly validating their cause-of-death information countries have no assurance that the information base for their policies and planning is reliable and correct.

Medical records generally contain adequate evidence about the treatment for the condition(s) the person was suffering from prior to death and can therefore be used to help determine the causes that led to death.

Importance of reliable cause-of-death information

The usefulness and importance of information on causes of death for effective decision-making in public health cannot be overemphasised. However, these statistics are not always available in many low-income and lower-middle-income countries, where the need for robust evidence for decision-making is most critical. Measures to improve vital registration systems in developing countries over the past few decades have also been fragmented and inadequate (AbouZahr, Cleland et al 2007). Evaluation of the quality and reliability of data from routine vital registration systems is rarely undertaken, yet as demonstrated in this study, is critical. Without regularly validating their cause-of-death information countries have no assurance that the information base for their policies and planning is reliable and correct (Khosravi, Rao et al 2008).

Prior to their use for epidemiological research or public health policy, cause-of-death information from hospitals needs to be validated. Where necessary, procedures for death certification and coding of the underlying cause of death must be streamlined to improve the reliability of cause-of-death data. Rao et al identified autopsy as a ‘gold standard’ against which to compare the cause of death reported by vital registration systems (Rao, Yang et al 2007). However, given the limited possibilities of using autopsy as a gold standard for large samples of deaths, medical records can be used as a reasonable alternative for validation. Many previous studies have used medical record reviews as a ‘gold standard’ for evaluating cause-of-death data reported by vital registration systems (Pattaraarchachai, Rao et al 2010; Rao, Yang et al 2007).

Medical records as a source of cause-of-death information

Medical records of patients admitted to hospital generally contain adequate evidence about the treatment for the condition(s) the person was suffering from prior to death and can therefore be used to help determine the causes that led to death and especially the underlying cause. The ‘underlying cause of death’, as defined by the World Health Organization (WHO) refers to the ‘disease or injury which initiated the train of events directly leading to death or the circumstances of the accident or violence which produced the fatal injury’. This definition allows identification of the chain of events leading to a death, and from a public health point of view, also identifies measures that can be taken to intervene and break the chain at any point to prevent death (WHO 1993). The WHO standard cause-of-death certificate form allows listing of multiple conditions that occur in chronological and pathophysiological sequence terminating in death (WHO 1993).

The cause of death of a particular patient would usually be based on the opinion and knowledge of the attending physician regarding the illness and circumstances leading to death. Furthermore, the selection of the final underlying cause of death by trained coders largely depends on the adequacy of the information provided on the medical death certificate. Occasionally, medical officers on call on the wards would certify cause of death for patients who die during the weekends and after hours. These medical officers would not necessarily be the treating physicians for some of the patients and therefore not be very familiar with the medical history of the patient. Hence, the reliability of documentation in the medical records of patients can play a vital role in ensuring the accuracy of the diagnosis that the medical officer writes on the death declaration form, which later will be used to identify the final underlying cause of death.
Cause-of-death information for Sri Lanka

The civil registration system in Sri Lanka is maintained by the Registrar General’s Department, and has been operating continuously since 1867. The registration of births and deaths, which was voluntary at the beginning, was made compulsory under an ordinance passed in 1885 (WHO 2006). Today in Sri Lanka, around 48 per cent of total deaths occur in hospitals, and for these that the cause of death is medically certified. The medical officer certifies the death using a death declaration form (B33) with three lines where the doctor can state the causes of death (Department of Census and Statistics in Sri Lanka). Previously the form itself was not forwarded to coders but only the transcribed cause(s) of death which meant that errors arising from transcription were unavoidable and without having access to the original form, it was often impossible to determine the final underlying cause of death. This is no longer a concern for hospital deaths in Sri Lanka, since the system of scanning death declarations by the treating physician was introduced in 2006 and coders now have access to copies of the original form. As a result, one might expect a higher degree of accuracy in assigning cause of death. In general transcription of information before coding should be avoided since it invariably introduces some errors or inconsistencies into the data. A recent study in Thailand also found that errors due to transcription from local Thai language to English lead to lower quality cause-of-death assignments (Pattaraarchachai and Rao et al 2010).

Study methods

This study reviewed medical records to determine the accuracy of the cause of death certification and the quality of medical records.

Purpose and objectives

The purpose of the study was twofold; one, to determine the accuracy of cause-of-death certification by physicians, and second, to describe the quality and adequacy of the medical records documentation in selected hospitals in the capital district of Sri Lanka. In this paper, we report the results of the study and draw key learnings for other countries.

Standard diagnostic criteria are the set of features (Symptoms, signs and investigation results) that should be present in order to assign a death to a specific cause. For example, any patient with two fasting plasma glucose levels of 126 mg per dl (7.0 mmol per L) or greater is considered to have diabetes mellitus (Mayfield 1998). Standard diagnostic criteria should be used as the ‘gold standard’ diagnosis in countries where these criteria are available. However, due to the unavailability of such diagnostic criteria in Sri Lanka, this method could not be adopted in this study.

Instead we designed a descriptive cross-sectional study to determine the cause-of-death for a selected sample of deaths through a review of medical records. The study was carried out between March-April 2010. The same sample of medical records used by Gamage et al in their study of the accuracy of cause-of-death coding practices was used for the medical record review in this study, in order to allow a link to this initial study for further analysis (Gamage 2009b).

COD = cause of death; VRS = vital registration system
The purpose of the study by Gamage et al (2009b) was to assess the accuracy of the cause-of-death information captured on the death declaration forms (DDFs) compared to the cause-of-death information available in the inpatient medical records in hospitals in the district of Colombo. The study reviewed a sample of deaths that occurred in the period between 1 January 2006 and 31 December 2008.

The study was conduct at different types of hospital, but all within the Colombo district because of cost and time constraints, proximity was an important criteria. All government hospitals of the Colombo district were stratified according to hospital type. A sample of hospitals was selected representing all categories of hospitals. The number of death certificates (DDFs) to be reviewed was selected by using a stratified systematic sampling technique based on the number of deaths reported from each of the selected hospitals, using probability proportional to stratum size. The sample size was determined by using appropriate statistical formulae for estimating a population proportion with specified absolute precision as follows (Lwanga and Lemeshow 1991):

\[ n = \frac{z^2 \times (1-P)}{d^2} \]

\( P \) (anticipated population proportion) = 0.5
\( d \) (absolute precision required on either side of the proportion) = 0.03
\( z = 1.96 \)

\[ n = \frac{1.96^2 \times 0.5 \times (1-0.5)}{0.03^2} = 1067 \]

Accordingly it was estimated that a minimum sample size of 1067 sets of death certificates and medical records was required for the study. The sample size and the selection of hospitals for the review were therefore decided by the local setting, the objectives and the feasibility of the study, given available resources.

To extract the relevant clinical information from the medical records, a data extraction form was developed.
by adapting the medical data extraction form used in the Philippines for the Grand Challenges 13 (GC13) Population Health Metrics study (Riley 2010). The questionnaire and procedures that were used in the Sri Lankan study consisted of the following components (see Appendix 1).

1 **Basic demographic profile**

   This component included information on the patient’s age at death, sex, residential information, the clinical specialty (ward) he/she was treated in, and date of death. The age and sex of the patient was important in order to check the representativeness of the sample and to calculate age and sex-specific mortality rates.

2 **Clinical summary of the patient, describing events leading to death**

   The clinical summary was important for the study physicians to summarise the events leading to death and to help them decide on the chain of events leading to death. This clinical summary was also used by the principal investigator to validate the cause of death reported by the study physician in the death certificate.

3 **Cause-of-death certificate**

   The international standard cause-of-death certificate was used by the study physicians to construct a cause-of-death certificate for each case.

4 **Assessment of the quality of the documentation contained in the medical records**

   This component included an assessment by the study physicians of the quality of medical record documentation. The study physicians scored each case on a 5-point scale (5=Excellent, 4=Good, 3=Average, 2=Weak, 1= Poor) using seven different quality criteria (see Box 1).

<table>
<thead>
<tr>
<th>Box 1 Criteria used to assess the quality of the medical record documentation</th>
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</thead>
<tbody>
<tr>
<td>1. Handwriting / legibility of the medical records</td>
</tr>
<tr>
<td>2. Adequacy of record measurements</td>
</tr>
<tr>
<td>3. Adequacy of information to arrive at a conclusive diagnosis</td>
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<tr>
<td>4. Recording of the time duration of illness</td>
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<tr>
<td>5. Use of non-standard abbreviations</td>
</tr>
<tr>
<td>6. Condition of the medical record</td>
</tr>
<tr>
<td>7. Overall opinion of the study physician regarding the quality of the documentation</td>
</tr>
</tbody>
</table>

The seven parameters we used to describe the quality of the medical records are similar to those employed in previous studies to assess the quality of medical records in support of cause-of-death certification in China and Thailand (Rao et al 2007). However, instead of using a three point scale (weak, probable and confirmed) to grade the records, we used a five-point Likert scale to improve greater insight into the quality of medical record practices.

The assessment showed that less than 13 per cent of the 648 records analysed were classified by the study physicians as being good or excellent, and only 8 per cent of records were judged to have information that was sufficiently good to allow the certifying doctor to arrive at a conclusive diagnosis regarding the disease(s) or condition(s) that lead to deaths. Therefore, arriving at a cause-of-death diagnosis was sometimes difficult for the study physicians due to the general weakness of, and disorganised way, that information in the medical record was presented.

The rationale for collecting the clinical summary was to provide sufficient evidence for the study physician to identify the cause of death without having to go back to the original medical record. The summary was also used by the chief investigator to check the quality of the cause-of-death diagnosis derived by the study physicians. If the study only concentrated on the quality of cause-of-death diagnosis and not on addressing the quality of the medical records, a simpler version of the questionnaire with fewer details could have been used.
**Data collection and processing**

We recruited and trained five physicians for the study. The study physicians were instructed in how to identify the sequence of events leading to death from medical records and clinical summaries and the concept of the underlying cause of death was explained to them. They were then given ‘hands on’ practice in applying this knowledge. To assist them, they were supplied with reference materials on how to certify according to ICD rules and procedures. All five study physicians worked on a part time basis since the recruitment of full time physicians was not possible in Sri Lanka.

For each selected death certificate, the corresponding medical records were traced by the medical record room staff. The name of the deceased person was not collected to ensure the anonymity of the record. Relevant information in the medical records was extracted by the study physicians using the data collection instrument described above. The extracted clinical history, examination findings, investigation results, treatments prescribed, and referral notes were used to compose a clinical summary and construct the death certificate. We used the same physician who had extracted the relevant information to construct the cause-of-death certificate as he/she had first hand information about the medical record. In some cases, where the diagnosis was uncertain, it was discussed and jointly resolved by the study physician and the chief investigator. Expert judgment was sought where appropriate by consulting relevant clinical experts. It was not possible to trace back to the treating/certifying physicians for their opinion about controversial cases, due to the time gap between the death and time of the study.

The completed data extraction forms were then sent to the National Institute of Health Sciences in Sri Lanka for coding by a certified coder. No additional training was provided to the coder but the objectives of the study were discussed with him before the mortality coding was performed. As only one coder was assigned to do the coding there were no biases introduced due to variation in coding. Because of the coder’s training and experience in the field of ICD coding it was assumed that the coding was best practice.

**Statistical analyses**

The final underlying cause of death was assigned to each death by the study coder according to the rules of the 10th revision of the *International Classification of Diseases* (ICD-10). These codes were then entered into an Access database and aggregated using the ICD-10 Mortality Tabulation List 1 consisting of 103 cause categories (WHO 1993). We used these aggregated data for all subsequent analyses in this study. The advantages of using the ICD-10 Tabulation List 1 for medical record review studies such as this one are that it provides adequate cause-specific precision required for population level study, and allows comparison of findings with previous medical record studies (Rao, Yang et al 2007). Excel worksheets and the SPSS statistical data package were used for data analyses.

The main aim of medical record review studies is to help hospital administrators, doctors and policy makers understand the importance of good quality medical record practices and of reliable cause-of-death certificates. Therefore it is important that the information be analysed using simple statistical techniques and that results be presented in a simple format to facilitate dialogue with this critical target audience.
Principal findings and lessons learned from the study

The major lessons learned from the study can be categorised into two broad areas: (i) lessons for Sri Lanka and (ii) lessons for other countries who may wish to undertake such as assessment.

I Lessons from Sri Lanka

Medical record practices

Storage and retrieval of medical records

Medical records are an integral part of effective patient care. They are used not only for primary clinical purposes, but also for secondary purposes including reporting the activity of hospital services, monitoring performance of hospitals, and for research. They remain the most important focus of any patient complaint or litigation. It is expected that medical record rooms will store records in a manner that allows easy retrieval of the medical records for patient management, legal purposes or for research such as reported in this paper. Yet, the traceability of the medical records in the study for the 1067 sample cases was less than 70 percent.

The usual practice in Sri Lanka is to store medical records in chronological order of registration number, and to group them in bundles. As a result medical records that were taken out for consultation purposes were often not returned to their original place; therefore the traceability of the medical records was greatly reduced. The medical record officers or the medical record room staff were unable to locate the missing records.

The number of staff working in the medical record rooms was insufficient and they had not been trained in standard medical record management practices. The knowledge of the medical record room staff regarding proper medical record storage and its importance was therefore not satisfactory, and none of the medical record rooms visited had adequate facilities required for a functioning medical record department. This undoubtedly contributed to the low traceability of records. Two lower-level hospitals (district and rural) had to be excluded from the study owing to lack of medical record staff making it impossible to trace any medical records in these hospitals.

Medical record documentation practices in Sri Lanka

Medical records are expected to contain adequate information to adequately describe the clinical history of the patient and the progress of events during hospitalisation and to have adequate information about the clinical investigations and treatment the patient received while in the hospital. Insufficiency of information was a critical issue in reviewing the medical records and extracting information to arrive at a cause-of-death diagnosis. Eleven percent of the records (n=76) that were able to be traced had to be excluded from the study due to insufficient information to enable the physician to arrive at a conclusive diagnosis.

When a patient is admitted to a hospital he or she is registered in the hospital inpatient register and a medical record is issued. All the details relating to patient management are entered in this medical record and upon patient discharge or death the attending physician documents the discharge diagnosis or cause of death on the first page. The medical record is then sent to the medical record room of the hospital for archiving.

The diagnosis of patient conditions and treatment provided to patients in Sri Lanka are usually of good quality. However, the medical curriculum and clinical practice culture do not place much emphasis on proper medical documentation. The study results showed that the opinion of the consultants/specialists, regarding the condition of the patient and the diagnosis is not always recorded in the medical record other than the fact that the patient has been seen by a specialist/consultant and any suggested alterations to patient management. Furthermore, recording of the duration of illness in the medical records was not always satisfactory, despite the importance of this information in constructing a cause-of-death certificate using the ICD.

The understanding of the important uses and need for proper medical records seemed to be rather poor other than for legal requirements and even among clinicians many do not seem to recognise the link between their cause-of-death diagnosis and national public health statistics. It was also evident from the causes of death that were written in the medical record that many doctors lack understanding about the concept of underlying cause of death. In numerous cases the doctors have reported the immediate cause of death or any condition that may have contributed to death as the underlying cause of death without considering the chain
of events that has contributed to the death. Hospital and health information management is still relatively new to the country and neither the medical curriculum nor other training in health sciences contains a module on the importance of health information and its management.

Medical record practices: key lessons

It is essential that all medical administrators be aware of the importance of proper hospital medical record management so that sufficient resources are allocated to ensure that medical records are available for each patient whenever needed.

The number of staff working in medical records departments was insufficient and in most places, staff had not received any specific training in proper medical record practices. Availability of adequate numbers of trained staff is essential for proper medical record practices so that these records can be used for intended public health purposes.

None of the hospitals studied had the required standard facilities for proper medical record storage.

Many medical record rooms did not follow standard procedures for storing medical records and the knowledge among staff about these procedures was generally unsatisfactory.

Medical record documentation practices

The diagnosis of the condition(s) the patient was treated for is not always reflected in the cause-of-death certificate.

Understanding of the concept of underlying cause of death seems to be poor.

Recording of the timing of events in the medical records was not satisfactory. Proper specification of time periods spent in various morbid states is very important in constructing a cause-of-death certificate using WHO standard procedures.

Medical certification of cause of death

Quality of cause-of-death certification

A study carried out in a district of Sri Lanka in 1996 to assess the quality and coverage of death certification found that 15.5 per cent of doctors had misclassified the cause of death ie the diagnosis by the treating doctor was incorrect according to the diagnosis derived by the study physicians (Fonseka 1996). The same study also found that the use of ill-defined terms (eg cardiovascular arrest) to identify the immediate cause of death was common (76.4 per cent). The use of non-standard abbreviations which could eventually lead to coder misunderstandings was also high (26.4 per cent). A study by Wijesekara (2002) of two government hospitals in a district of Sri Lanka highlighted the poor quality of documentation in terms of availability of minimum required information, legibility and adequacy of the medical record.

Agreement on cause of death

The extent of agreement between the cause of death reported by the vital registration system, and that obtained from the ‘gold standard’ is a good measure of how well the routine vital registration system captures the true cause of death. This is of critical importance for public health policy given the extensive use made of routine cause-of-death statistics for health planning. Using the 103 cause list described earlier, agreement between the two was comparatively low (249 cases, or 41.4 per cent) implying that in Sri Lanka, hospitals are only correctly diagnosing the cause of death in 4 out of 10 hospital deaths. Many health planning decisions and policies are based upon the cause-of-death pattern reported by the vital registration system and resources are being directed accordingly to reduce the burden of the country’s leading causes of death. Our study suggests that policy and resource allocation in Sri Lanka cannot confidently depend on the vital registration data.

Ill-defined cause of death

Ill-defined causes of death are of no public health use to and may seriously distort understanding of the real disease distribution in a population. In Sri Lanka, the routine vital registration system reports a significant proportion of deaths as due to ill-defined categories (R codes in ICD-10). The Registrar General’s Department publishes the cause-of-death data for all deaths without making the distinction between deaths that occurred in hospitals (the subject of this study) and those that occurred outside hospitals. The percentage of deaths reported as being due to ill-defined causes of deaths for deaths occurring in hospitals is less than 2 per cent, while for all deaths in the country the ill-defined proportion is around 20 per cent for the most recent years available. This is consistent with the findings of this study which
showed that the sample of medical records studied only had 1.2 per cent of all deaths assigned to ill-defined causes. However, as our study has shown, this does NOT mean that the remaining 98.8 per cent of deaths in hospitals are being correctly diagnosed. Only about 4 in 10 of them are. The implications of this finding for the intended use of vital statistics in Sri Lanka are very substantial and would not have been evident had a study of this type not been carried out.

**Ill-defined causes of death**

Deaths assigned to ill-defined causes are comparatively low for hospital deaths where physicians certify deaths. It is important to separately tabulate and analyse causes of deaths reported by physicians in hospitals from a lay reporting of home deaths by non-physicians. Mixing the two sets of data dilutes the utility and reliability of national causes of death data.

**Measures of validity and patterns of misclassification of causes of death**

Measures of validity are important for estimating the reliability of the cause-of-death data reported by the vital registration system. In this study we have used sensitivity and positive predictive value as measures of validity, as has been done elsewhere (Rao et al 2007).

Sensitivity in the context of this study measures the proportion of actual cases (causes of death) which are correctly identified by the routine vital registration system. Positive predictive value (PPV), or post-test probability of disease, is more indicative of the validity of registration diagnoses as it shows the proportion of deaths that are registered from a specific cause that are actually due to that cause as assessed from the medical records. PPV measures the probability that an assigned cause of death actually reflects the correct underlying condition. However, its value depends on the prevalence of the disease, which may vary across diseases. For both sensitivity and PPV, higher values mean better diagnoses while low values mean poor quality of diagnosis.

Table 1 summarises the results of the study. We will describe the column entries for diabetes mellitus as an example. In this sample of 602 deaths, 94 were assigned by the vital registration system to diabetes mellitus, but on further review of the medical records of all 602 cases, only 34 were actually confirmed as being diabetes mellitus deaths. Sixty of the 94 were incorrectly diagnosed and were assigned to other causes by the medical record review. Conversely the review found that 28 deaths, assigned by the vital registration system to other causes, were in fact deaths caused by diabetes mellitus. Hence, the ‘true’ number of diabetes mellitus deaths in the sample of 602 cases was NOT 94 as recorded by the VR system, but 62 (34 + 28) confirmed by medical record review. The ‘sensitivity’ of the VR system in capturing diabetes mellitus deaths is thus 34 (correctly diagnosed)/62 (actual cases) = 54.8 per cent. The fraction of deaths suggested by the VR system as being due to diabetes mellitus in the sample was 94/602 (CSMF from VR) or 0.16, whereas the true fraction was actually 62/602 (0.10) (CSMF from GS) confirmed from medical records (gold standard).

Our study found that the sensitivity of the VR system in correctly diagnosing all leading causes of death to be below 64 per cent, and in some cases much lower, indicating serious quality issues in cause-of-death certification in these hospitals (see Table 2). The vital registration system shows an average sensitivity of 50–75 per cent in reporting deaths due to ‘other’ heart diseases, diseases of the liver, all other neoplasms and cancers of the gastro-intestinal tract. Sensitivity ranged from 17 per cent for external causes of mortality, to 65 per cent for all other neoplasms, whereas the PPV ranged from a extremely poor 4.2 for external causes of mortality to 68.8 for ‘All other malignant neoplasms’.

PPV is a useful operational measure of the reliability of a registration system, as it reflects both test validity in terms of sensitivity, as well as the proportion of all the deaths in the sample which were due to the cause of interest (Rao, Yang et al 2007). Findings from our study for PPV are mostly similar to findings for sensitivity, with none of the diseases having good positive predictive value. The highest PPV was found for ‘All other malignant neoplasms’ (68.8 per cent) with three other diseases reporting a PPV over 60 per cent. Both sensitivity and specificity show wide confidence intervals due to the small sample size in each case.

More importantly, these findings, if applicable to all hospital deaths in Sri Lanka, suggest important changes to the pattern of causes of death with many leading causes being 20–40 per cent more (or less) important than suggested by the vital registration system. The final column of Table 1 shows the percentage change in the CSMR for a given cause of death that is implied by the medical records review. Such large changes (>20 per cent in most cases) suggest the need for great caution when...
using vital registration data from Sri Lanka to understand the true prevailing pattern of causes of death. In particular, diabetes mellitus is much less important (10 per cent versus 16 per cent) as a cause of death than suggested by the VR, while ischaemic heart disease (21 per cent versus 15 per cent in the VR) and stroke (9 per cent versus 5 per cent in the VR) are much more important as causes of death in Colombo than the vital registration suggests.

An interesting finding from Table 1 is the very low CSMF for external causes of death (accidents and violence). Only 6 deaths out of 602 (1 per cent) were confirmed as injury deaths, compared to 24 (4 per cent) in the vital registration system. Even that proportion is very low (10–15 per cent is common as the fraction of deaths due to injuries in most populations (Lopez et al 2007).

Table 2 shows to which causes the misdiagnosed cases of injury deaths should actually have been assigned, with significant misclassification of infectious disease deaths, diabetes, ischaemic heart diseases and diseases of the liver as injury deaths in the VR system. Such ‘overdiagnosis’ of injury deaths in routine vital registration is uncommon and should be investigated carefully to understand the reasons.

More generally, Table 2 provides detailed insight into the patterns of misclassification of causes of death by the VR system. So, for example, only 34 of the 62 true cases of diabetes mellitus were identified as such by the system. The remaining 28 cases were classified to numerous other causes (eg one to ‘Certain infectious and parasitic diseases’, one to ‘Trachea, bronchus and lung cancer’, two to ‘Hypertensive diseases’ and so on) (see the column labelled ‘Diabetes mellitus’ in Table 2). Conversely, diabetes mellitus is being used to diagnose deaths that are actually due to ischaemic heart disease (22 deaths), stroke (9 deaths) and several other causes (see the row labelled ‘Diabetes mellitus’ in Table 2). These patterns of misclassification of leading causes of death carry important lessons for corrective action to improve cause-of-death certification practices.

Judging from the actual pattern of misdiagnosis of the sample deaths reported by the vital registration in Table 2, there are clearly major misclassification errors in identifying deaths due to vascular diseases and diabetes mellitus, which are among the leading causes of death. Thirty per cent of the deaths due to ischaemic heart disease, (the leading cause of death), were misclassified to diabetes mellitus and to other heart diseases, whereas 25 per cent of deaths due to diabetes mellitus (third leading cause of death) were misclassified to various diseases of the circulatory system. Diseases of the liver, (second highest cause of death), is misclassified to a surprisingly wide range of causes.

The findings from this study show that misclassification of causes death is a serious quality issue in the cause-of-death interventions to improve quality of certification and quality of coding proposed by Gamage (2009a) are critical statistics from hospitals in Sri Lanka. The to implement urgently if the vital statistics are to be a credible source of information to guide policy in the country.

**Misclassification of causes of death**

Misclassification (ie misdiagnosis) of cause of death is a serious quality issue in the cause-of-death statistics in Sri Lanka.

Doctors urgently need training in identifying the correct underlying cause of death and an understanding of the importance of correctly certifying causes of death for public health purposes.

Interventions to improve the quality of certification and quality of coding are essential in order to reduce the serious misclassification of causes of death often found in this study.

**Training of medical doctors in cause-of-death certification**

Our experience in training the study physicians showed that it is not a difficult task to train medical officers in the proper medical certification of causes of death and correctly identifying the underlying cause of death. When doctors understand the importance of good certification they are likely to spend more effort to certify cause of death correctly. Doctors in Sri Lanka have the necessary skills for making a diagnosis and treating a patient, and correctly ascertaining the cause of death should not pose a problem if they had received some basic training. The doctors used in our study were given this training and quickly learned to correctly certify and fill in the WHO death certificate form (see Box 2). All doctors need to understand the importance of proper cause-of-death certification and should be trained in correct certification practices.

Making available a brief and simple certification guide and reference materials on certification practices would be a good strategy to improve cause-of-death
### Table 1: Operational characteristics (sensitivity, PPV, implied changes in CSMF) of vital registration system in Colombo, Sri Lanka

<table>
<thead>
<tr>
<th>Condition</th>
<th>No. of deaths</th>
<th>Reassigned</th>
<th>True GD no. of deaths</th>
<th>Sensitivity (95% CI) a/ (a+c)</th>
<th>PPV (95% CI) a/(a+b)</th>
<th>CSMF_{VR} = x/ total cases (602)</th>
<th>CSMF_{GS} = y/ total cases (602)</th>
<th>Change in CSMF (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diabetes mellitus (E10–E14)</td>
<td>94</td>
<td>34</td>
<td>60</td>
<td>28</td>
<td>62</td>
<td>54.8 (43.0-66.0)</td>
<td>36.2 (28.4-43.5)</td>
<td>0.16</td>
</tr>
<tr>
<td>Ischaemic heart disease (I20-I25)</td>
<td>89</td>
<td>54</td>
<td>35</td>
<td>73</td>
<td>127</td>
<td>42.5 (35.8-48.7)</td>
<td>60.7 (51.1-69.5)</td>
<td>0.15</td>
</tr>
<tr>
<td>Other heart diseases (I26–I51)</td>
<td>70</td>
<td>21</td>
<td>49</td>
<td>14</td>
<td>35</td>
<td>60.0 (43.4-74.8)</td>
<td>30.3 (21.7-37.4)</td>
<td>0.12</td>
</tr>
<tr>
<td>Diseases of the liver (K70-K76)</td>
<td>60</td>
<td>39</td>
<td>21</td>
<td>25</td>
<td>64</td>
<td>60.9 (50.5-69.9)</td>
<td>65.0 (53.9-74.5)</td>
<td>0.10</td>
</tr>
<tr>
<td>Hypertensive diseases (I10-I14)</td>
<td>44</td>
<td>12</td>
<td>32</td>
<td>15</td>
<td>27</td>
<td>44.4 (27-62.6)</td>
<td>27.3 (16.6-38.4)</td>
<td>0.07</td>
</tr>
<tr>
<td>All other malignant neoplasms (C17, C23-C24, C26-C31, C37-C41, C44-C49, C51-C52, C57-C60, C62-C66, C68-C69, C73-C81, C88, C96-C97)</td>
<td>32</td>
<td>22</td>
<td>10</td>
<td>12</td>
<td>34</td>
<td>64.7 (49.9-76.2)</td>
<td>68.8 (53-81)</td>
<td>0.05</td>
</tr>
<tr>
<td>Cerebro-vascular diseases (I60-169)</td>
<td>28</td>
<td>17</td>
<td>11</td>
<td>37</td>
<td>54</td>
<td>31.5 (21.8-39.9)</td>
<td>60.7 (42.1-77)</td>
<td>0.05</td>
</tr>
<tr>
<td>Chronic lower respiratory diseases (J40-J47)</td>
<td>28</td>
<td>13</td>
<td>15</td>
<td>25</td>
<td>38</td>
<td>34.2 (21.6-46.9)</td>
<td>46.4 (29.3-63.6)</td>
<td>0.05</td>
</tr>
<tr>
<td>External causes of mortality (V01-Y89)</td>
<td>24</td>
<td>1</td>
<td>23</td>
<td>5</td>
<td>6</td>
<td>16.7 (9-62.4)</td>
<td>4.2 (0.2-15.6)</td>
<td>0.04</td>
</tr>
<tr>
<td>Pneumonia (J12-J18)</td>
<td>23</td>
<td>9</td>
<td>14</td>
<td>10</td>
<td>19</td>
<td>47.4 (26.7-67.7)</td>
<td>39.1 (22.0-55.9)</td>
<td>0.04</td>
</tr>
</tbody>
</table>

CSMF = cause specific mortality fraction (out of 602 cases in the sample); GS = gold standard; VR = vital registration
Change in CSMF = \( \frac{\text{CSMF}_{\text{GS}} - \text{CSMF}_{\text{VR}} \times 100}{\text{CSMF}_{\text{VR}}} \)
certification practices in the country. The study physicians benefitted greatly from the guide and the reference materials that were made available to them and also drew confidence in knowing that help was available if needed (Appendix 2).

A review of different teaching experiences in cause-of-death certification concluded that pragmatic education on best practice can lead to improvements in the reliability of how doctors certify and fill in the medical form and hence in the identification of the true underlying cause of death (Aung et al 2009).

### Training of medical doctors on certification

Training of doctors gives them the necessary skills for making a diagnosis and treating a patient, but does not generally provide an understanding of how to certify cause of death well or why it matters.

Developing a short and simple certification guide and reference materials on certification would be a useful step in improving the cause-of-death certification practices in the country.

Specific training of medical officers in correct cause-of-death certification and identification of the underlying cause of death is critical for improving the quality of death certification.

---

**Box 2 International form of medical certificate of cause of death**

**INTERNATIONAL FORM OF MEDICAL CERTIFICATE OF CAUSE OF DEATH**

<table>
<thead>
<tr>
<th>Cause of death</th>
<th>Approximate interval between onset and death</th>
</tr>
</thead>
<tbody>
<tr>
<td>I Disease or condition directly leading to death*</td>
<td>(a) ........................................</td>
</tr>
<tr>
<td>Antecedent causes</td>
<td>due to (or as a consequence of)</td>
</tr>
<tr>
<td>Morbid conditions, if any, giving rise to the above cause, stating the underlying condition last</td>
<td></td>
</tr>
<tr>
<td>(b) ........................................</td>
<td>........................................</td>
</tr>
<tr>
<td>(c) ........................................</td>
<td>........................................</td>
</tr>
<tr>
<td>(d) ........................................</td>
<td>........................................</td>
</tr>
<tr>
<td>II Other significant conditions contributing to the death, but not related to the disease or condition causing it</td>
<td></td>
</tr>
</tbody>
</table>

*This does not mean the mode of dying, e.g. heart failure, respiratory failure.
It means the disease, injury, or complication that caused death.*
<table>
<thead>
<tr>
<th>Cause of death as assigned by the VR system</th>
<th>Certain infectious and parasitic diseases</th>
<th>Cancers of the GI tract</th>
<th>Liver cancer</th>
<th>Trachea, bronchus, and lung cancer</th>
<th>All other neoplasms</th>
<th>Blood and immune disorders</th>
<th>Diabetes mellitus</th>
<th>Other diseases of the nervous system</th>
<th>Hypertensive diseases</th>
<th>Ischaemic heart diseases</th>
<th>Cerebrovascular diseases</th>
<th>Other heart diseases</th>
<th>Chronic lower respiratory diseases</th>
<th>Other diseases of the lower respiratory system</th>
<th>Diseases of the liver</th>
<th>External causes of morbidity and mortality</th>
<th>All other codes</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Certain infectious and parasitic diseases</td>
<td>9  0  1  1  1  1  1  1  2  0  1  0  1  2  3</td>
<td>23</td>
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<tr>
<td>Cancers of the GI tract</td>
<td>0  4  0  1  0  0  0  0  0  0  0  0  0  0  0</td>
<td>6</td>
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<tr>
<td>Liver cancer</td>
<td>0  0  4  0  0  0  0  0  0  0  0  0  0  0  0  0  2  0  1  0  1  2  3</td>
<td>7</td>
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<tr>
<td>Trachea, bronchus and lung cancer</td>
<td>1  0  0  2  0  0  1  0  0  0  1  0  0  0  0  0  0  0  0  0  0  0  0  0  5</td>
<td>32</td>
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<tr>
<td>All other neoplasms</td>
<td>0  0  0  1  22 1  0  0  2  2  0  0  4  0  0  0  0  0  0  0  0  0  0  0  0  7</td>
<td>44</td>
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<tr>
<td>Blood and immune disorders</td>
<td>1  0  0  0  0  2  1  0  0  2  0  1  0  0  0  0  0  0  0  0  0  0  0  0  0  9</td>
<td>89</td>
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<tr>
<td>Diabetes mellitus</td>
<td>3  0  0  0  3  0  34 1  4  22 9  1  3  2  0  3  1  8  94</td>
<td>11</td>
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<tr>
<td>Other diseases of the nervous system</td>
<td>2  0  0  0  0  0  0  3  0  2  0  0  1  0  1  2  0  0  0  0  1  1  1  3  5  23</td>
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<tr>
<td>Hypertensive diseases</td>
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<td>30</td>
<td></td>
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<tr>
<td>Ischaemic heart diseases</td>
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<td>90</td>
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<tr>
<td>Cerebrovascular diseases</td>
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<td>70</td>
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<tr>
<td>Other heart diseases</td>
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<tr>
<td>Pneumonia</td>
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<tr>
<td>Chronic lower respiratory diseases</td>
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<td>15</td>
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<tr>
<td>Other diseases of the respiratory system</td>
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<tr>
<td>Diseases of the liver</td>
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<td>24</td>
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<tr>
<td>External causes of morbidity and mortality</td>
<td>3  0  0  1  2  0  3  0  2  3  0  1  0  1  0  2  1  5  24</td>
<td>36</td>
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<tr>
<td>All other codes</td>
<td>1  2  0  0  1  0  2  2  1  4  3  1  1  1  0  4  0  13 36</td>
<td>59</td>
<td></td>
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<tr>
<td>TOTAL</td>
<td>32  7  8  7  34 6  62 11 27 127 54 35 19 38 6 64 6  59 602</td>
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</tbody>
</table>
II Implications for application of medical records in other review in other countries

Sample size

- The size and the selection of the sample of cases (medical records) for the study should be based on the study objectives, feasibility, local contexts and the resources available for the study. A representative sample should be chosen if resources permit.
- Even a review of a small sample of medical records is important as an audit of medical record practices at institutional level.
- If any individual hospital wants to examine the quality of its cause-of-death certification, the hospital can select a sample of death certificates from that hospital only. Even a small scale study at individual facility level is helpful in informing hospital authorities about the quality of the cause-of-death statistics that are being produced at their facility.

Study instrument

- The level of detail that needs to be collected should be decided upon according to the study objectives, feasibility and the resources available for the study.
- Make sure to consult the data extraction forms used in previous research before finalising the data collection format for your study (see Appendix 1 for the form used in this study).

Data collection and processing

- Use of the standard international cause-of-death certificate is essential for correctly identifying the underlying cause of death.
- Using a properly trained group of study physicians is critical for the success of the study. It is very important that study physicians and coders are well trained to ensure that the gold standard diagnosis is indeed ‘gold standard’. Training of the study physicians has to be planned carefully to ensure that study physicians can derive the best diagnosis possible using the evidence available in the medical record. This is especially important in cases where the principal investigator is not medically trained. Study physicians should be provided with good reference materials which are now freely available on the web (Appendix 2).
- It is recommended to use physicians to extract the data from the medical records after training them in medical certification of cause of death.
- However, in situations where it is not possible to use physicians to extract data, due to unavailability or expense, carefully trained nurses or other research assistants can be used to extract the information. The ‘gold standard’ cause-of-death certificate, however, must be constructed by a physician using the information from the medical records review.
- Constant monitoring and support of staff involved in the clinical data extraction and completion of the cause-of-death certificate is very important.
- If the original cause of death is attached to the medical record of the deceased person, it should be detached before the review to avoid bias. The study physicians MUST independently derive their own cause-of-death certificate based on the training they receive.
- Coding of study ‘gold standard’ death certificates should be done by experts trained in ICD coding rules and procedures, NOT by the study physicians.

Statistical analysis

- Use ICD-10 Mortality Tabulation List 1 consisting of 103 cause categories for analysis. This gives adequate precision and allows comparison of findings with similar studies.
- The results should be analysed using simple statistics and presented in easy to understand formats (see Table 1).
Conclusions

This study on the application of independent medical record review of a sample of 602 hospital deaths in Colombo provided critical insight into medical record practices in Sri Lanka and the extent and pattern of misclassification in the published cause-of-death statistics. Although the authorities are aware that the causes of deaths reported by the vital registration systems have serious quality issues, little research has been done to quantify and better understand the problem. The findings of this study provide critical evidence for relevant health and civil registration authorities in Sri Lanka as to the key interventions required to improve the quality, credibility, and hence public health utility of the data.

Periodically conducting medical record reviews to assess the quality of cause-of-death reporting is recommended as a simple measure to validate and better understand cause-of-death statistics. Studies at the institutional level would help to guide hospital administrators on the measures that need to be taken at the local level to improve the quality of the information produced by the hospital.

Medical record practices, including availability of storage and archive facilities and staff trained in standard medical record practices, were inadequate in all the hospitals studied. Given that this study was done in Colombo, where facilities generally tend to be better than in other parts of the country, it can be assumed that poor medical record practice is a widespread problem in hospitals throughout the country.

Understanding of the concept of the underlying cause of death is crucial to the certification and preparation of the death declaration form. The evidence from this study indicates that many doctors in Sri Lanka do not fully appreciate the importance of this concept. Moreover, the current death certificate form used in Sri Lanka does not facilitate the correct ascertainment of the underlying cause of death. Adoption of the WHO International Form of Medical Certificate of Cause of Death is urgently recommended as an important measure to increase the quality of the cause-of-death statistics.

Unfortunately, the medical curriculum in Sri Lanka does have a module on cause-of-death certification, but the subject is taught mainly from the viewpoint of legal and forensic medicine. In order to improve the quality of cause-of-death statistics in the country, doctors should also be specifically trained in death certification from the public health perspective based on the proper identification of the underlying cause of death which led to the sequence of morbid events which caused the person to die.

Apart from the training provided during medical school, doctors in Sri Lanka do not usually have many opportunities for professional development unless they engage in a post graduate training program. Continuing professional development is not compulsory in Sri Lanka and although many professional associations and clinical societies conduct professional development workshops, presentations, guest lectures etc, attendance at these events is generally low. The results of our study indicate that doctors should be provided with opportunities to update their knowledge and practices of medical certification of cause of death. Given that many doctors cannot be reached through professional development activities, display charts and quick reference materials supplied in the wards should also be considered.

It is strongly recommended that simple quick reference guides are made available for all certifying physicians to assist them in deriving better cause-of-death diagnoses. Effective interventions to improve the quality of certification will lead to a reduction of the misclassification of the cause of death and thereby improve the quality and utility of cause-of-death reporting in the country.

It was very important to ensure that the study physicians and coders were properly trained to ensure that the study diagnosis was indeed ‘gold standard’. Poorly trained and incompetent study physicians and coders would be less likely to produce reliable results. During the data collection period, it is crucial to monitor the certification work of the study physicians and to provide them with guidance and assistance when necessary. In controversial cases it is important to refer the cases for expert advice before arriving at a conclusion. Diagnosing correctly the cause(s) of death can be difficult for some deaths and discussion with experts is essential in such cases.

Many of the findings from this study are universal and would apply to any country with similar problems in death certification. The key lessons learned from this study have been added to the paper. It is hoped that this research will inspire and provide guidance to many other countries on how to conduct a hospital cause-of-death validation study as a quality assurance method.
for evaluating the quality of their death certification system. Countries spend substantial amounts of money on the annual collection of cause-of-death statistics for their populations. It is critical that they are fully aware of the biases in these data so that public health policy and planning can proceed on the basis of reliable data. They should also use the results of medical record audits such as that done for this study to improve practices.

Finally, it is important to note that such periodic investigations of death certification accuracy and medical records practices are not costly. The total cost of the investigation in Sri Lanka was less than US$5000, which is extremely cost-effective given the critical policy value of the findings.
References


Appendix 1  Study data collection instrument

SECTION 1: BASIC INFORMATION

1.1. Name of the Hospital ________________________________

1.2. Department/Ward

☐ 1 Medical  ☐ 2 Surgical  ☐ 3 Pediatric
☐ 4 OB/Gyne  ☐ 5 NICU  ☐ 6 other (Specify)

1.3. Sex

☐ 1 Male  ☐ 2 Female

1.4. Date of Admission

/____/____/_____/
moptic  dd  yyyy

1.5. Date of Death

/____/____/_____/
moptic  dd  yyyy

1.6. Date of Birth or age

/____/____/_____/
moptic  dd  yyyy

Age: ______

1.7. Residence of Deceased

____________________________________________________

____________________________________________________

SECTION 2: HISTORY, EXAMINATION, INVESTIGATION AND PROGRESS

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

(Attach additional sheet when necessary)
## INTERNATIONAL FORM OF MEDICAL CERTIFICATE OF CAUSE OF DEATH

<table>
<thead>
<tr>
<th>Cause of death</th>
<th>Approximate interval between onset and death</th>
<th>ICD Code</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>I. Disease or condition directly leading to death</strong>&lt;sup&gt;*&lt;/sup&gt;</td>
<td>(a) ........................................... Due to (or as a consequence of)</td>
<td>..........</td>
</tr>
<tr>
<td><strong>Antecedent causes</strong></td>
<td>(b) ........................................... Due to (or consequence of)</td>
<td>..........</td>
</tr>
<tr>
<td>Morbid conditions, if any, giving rise to the above cause, stating the underlying condition last</td>
<td>(c) ........................................... Due to (or consequence of)</td>
<td>..........</td>
</tr>
<tr>
<td></td>
<td>(d) ...........................................</td>
<td>..........</td>
</tr>
<tr>
<td><strong>II. Other significant conditions contributing to the death, but not related to the disease or condition causing it</strong></td>
<td>...........................................</td>
<td>..........</td>
</tr>
</tbody>
</table>

* This does not mean the mode of dying, e.g. heart failure, respiratory failure. It means the disease, injury, or complication that caused death.
SECTION 4: MAIN PROBLEMS YOU FOUND WITH THE MEDICAL RECORDS

Please put ‘X’ mark within the more appropriate box as you think

5 – Excellent
1 – Weak

4 to 2 in between these two sides

<p>| | | | | | |</p>
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<td>Legibility of handwriting</td>
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<td>4</td>
<td>3</td>
<td>2</td>
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<tr>
<td>2</td>
<td>Sufficiency Measurements</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
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<tr>
<td>3</td>
<td>Missing information</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
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<td>4</td>
<td>Time period of illness recorded</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>5</td>
<td>Avoiding use of non-standard Abbreviations</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
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<tr>
<td>6</td>
<td>Condition of the MR</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
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<tr>
<td>7</td>
<td>Opinion of the consultants/Doctors on diagnosis</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>8</td>
<td>Other (specify)</td>
<td>5</td>
<td>4</td>
<td>3</td>
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<tr>
<td>9</td>
<td>Other (specify)</td>
<td>5</td>
<td>4</td>
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<td>10</td>
<td>Other (specify)</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
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</tbody>
</table>

5. Study Physician’s Comments

__________________________________________________________________________
__________________________________________________________________________
__________________________________________________________________________
__________________________________________________________________________
__________________________________________________________________________
__________________________________________________________________________
__________________________________________________________________________

(Attach additional sheet when necessary)

Study Physician’s Name & Signature

Date /___/___/____/
Appendix 2  Resources of medical certification of cause of death

List of materials for teaching and learning Medical certification of causes of death.


Death Certification Training Pack; http://www.azmaj.org/word/training.doc


5. Guidance for doctors completing Medical Certificates of Cause of Death in England and Wales http://www.gro.gov.uk/Images/B0521 per cent20ONS per cent20DCAG per cent20Certifiers per cent20guidance per cent20as per cent20at per cent20August per cent202008_tcm69-69976.pdf
The Knowledge Hubs for Health Initiative

The Health Information Systems Knowledge Hub is one of four hubs established by AusAID in 2008 as part of the Australian Government’s commitment to meeting the Millennium Development Goals and improving health in the Asia and Pacific regions. All four hubs share the common goal of expanding the expertise and knowledge base to help inform and guide health policy.

The Knowledge Hubs are funded by AusAID’s Strategic Partnership for Health Initiative.

Health Information Systems Knowledge Hub

The University of Queensland

Aims to facilitate the development and integration of health information systems into the broader health system strengthening agenda, and increase local capacity to ensure that cost-effective, timely, reliable and relevant information is available. The Health Information Systems Knowledge Hub also aims to better inform health information systems policies across Asia and the Pacific.

www.uq.edu.au/hishub

Human Resources for Health Knowledge Hub

The University of New South Wales

Aims to contribute to the quality and effectiveness of Australia’s engagement in the health sector in the Asia–Pacific region by developing innovative policy options for strengthening human resources for health systems. The hub supports regional, national and international partners to develop effective evidence-informed national policy-making in the field of human resources for health.

www.hrhhub.unsw.edu.au

Health Finance and Health Policy Knowledge Hub

The Nossal Institute for Global Health (University of Melbourne)

Aims to support regional, national and international partners to develop effective evidence-informed national policy-making, particularly in the field of health finance and health systems. Key thematic areas for this hub include comparative analysis of health finance interventions and health system outcomes; the role of non-state providers of health care; and health policy development in the Pacific.

www.ni.unimelb.edu.au

Compass: Women’s and Children’s Health Knowledge Hub

Compass is a partnership between the Centre for International Child Health, The University of Melbourne, Menzies School of Health Research and Burnet Institute’s Centre for International Health.

Aims to enhance the quality and effectiveness of women’s and children’s health interventions and focuses on supporting the Millennium Development Goals 4 and 5—improved maternal and child health, and universal access to reproductive health. Key thematic areas for this hub include regional strategies for child survival; strengthening health systems for maternal and newborn health; adolescent reproductive health; and nutrition.

www.wchknowledgehub.com.au