

Improving the accuracy of death certification



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Abstract

Background: Population-based mortality statistics are derived from the information recorded on death certificates. This information is used for many important purposes, such as the development of public health programs and the allocation of health care resources. Although most physicians are confronted with the task of completing death certificates, many do not receive adequate training in this skill. Resulting inaccuracies in information undermine the quality of the data derived from death certificates.

Methods: An educational intervention was designed and implemented to improve internal medicine residents' accuracy in death certificate completion. A total of 229 death certificates (146 completed before and 83 completed after the intervention) were audited for major and minor errors, and the rates of errors before and after the intervention were compared.

Results: Major errors were identified on 32.9% of the death certificates completed before the intervention, a rate comparable to previously reported rates for internal medicine services in teaching hospitals. Following the intervention the major error rate decreased to 15.7% ($p = 0.01$). The reduction in the major error rate was accounted for by significant reductions in the rate of listing of mechanism of death without a legitimate underlying cause of death (15.8% v. 4.8%) ($p = 0.01$) and the rate of improper sequencing of death certificate information (15.8% v. 6.0%) ($p = 0.03$).

Interpretation: Errors are common in the completion of death certificates in the inpatient teaching hospital setting. The accuracy of death certification can be improved with the implementation of a simple educational intervention.

Résumé

Contexte : Les statistiques démographiques sur la mortalité sont tirées des renseignements consignés sur les certificats de décès. Ces renseignements servent à de nombreuses fins importantes, notamment à l'élaboration de programmes de santé publique et à l'affectation des ressources consacrées aux soins de santé. Même si la plupart des médecins doivent remplir des certificats de décès, beaucoup d'entre eux ne reçoivent pas de formation suffisante en la matière. L'information inexacte qui en découle mine la qualité des données tirées des certificats de décès.

Méthodes : On a conçu et mis en œuvre une intervention de formation pour améliorer l'exactitude des données consignées par les résidents en médecine interne lorsqu'ils remplissent des certificats de décès. On a examiné au total 229 certificats de décès (146 remplis avant l'intervention et 83 remplis après celle-ci) pour y repérer les erreurs importantes et mineures et l'on a comparé les taux d'erreur avant et après l'intervention.

Résultats : On a repéré des erreurs importantes sur 32,9 % des certificats de décès remplis avant l'intervention, taux qui se compare aux taux signalés auparavant dans le cas des services de médecine interne d'hôpitaux d'enseignement. Après l'intervention, le taux d'erreurs importantes est tombé à 15,7 % ($p = 0,01$). La réduction du taux d'erreurs importantes s'explique par des réductions considérables du taux d'indication du mécanisme de la mort sans cause sous-jacente légitime (15,8 % c. 4,8 %) ($p = 0,01$) et du taux d'erreurs dans la séquence des renseignements consignés sur le certificat de décès (15,8 % c. 6,0 %) ($p = 0,03$).

Education

Éducation

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This article has been peer reviewed.

CMAJ 1998;158:1317-23



Interprétation : Les certificats de décès remplis en service interne dans le contexte d'un hôpital d'enseignement contiennent souvent des erreurs. Il est possible d'améliorer l'exactitude des certificats de décès par une intervention simple de formation.

Death certificate information within epidemiologic databases is used for such purposes as tracking the health of the population and guiding the allocation of resources for research and health programs. Although almost all physicians complete death certificates, many report uncertainty about the proper process for completion. In a 1993 survey of 214 house officers and family physicians, 90% of the respondents regarded the recording of accurate death certificate information as important, and over half felt in need of more education in this skill.¹ Although the topic of death certification is included in many medical school undergraduate curricula, it has little practical significance at this early stage of medical education.¹⁻³ Few hospitals or residency programs offer formal instruction in the process of death certification.⁴

The inaccuracy of death certificate information is well documented and can occur as a result of errors at a number of the steps in the certification process. Inadequate or misinterpreted clinical information can lead to erroneous antemortem diagnoses, which are then recorded by the physician on the death certificate. This problem has been identified and confirmed in studies comparing death certificate information with autopsy results or with the opinions of panels of expert reviewers.⁵⁻⁸ The rate of major discrepancies in autopsy series has been documented to be as high as 30%.⁵

The certifying physician may knowingly include erroneous information on certificates in an effort to conceal diagnoses that might cause distress to family members.^{1,3,9} Maudsley and Williams¹ found that 18.5% of family physicians surveyed would consider modifying a death certificate for this reason. The degree to which this factor affects the quality of death certificate information is unknown.

The final step in the certifying process, coding by a person trained in this skill (known as a nosologist), is believed to be objective and relatively accurate.¹⁰ However, the accuracy of the coding is limited by the information received from the certifying physician. Previous studies have shown that 16% to 33% of sampled death certificates contain major errors in the Cause of Death statement.¹¹⁻¹³ In 1993 Jordan and Bass¹¹ discovered that 31.9% of a sample of death certificates completed at a Canadian tertiary care teaching hospital contained such errors. The highest rate of inaccurate completion occurred within the Department of Medicine, with 40.3% of certificates classified as unacceptable because of major errors.

At our institution the Department of Medicine's Mortality Review Committee reviews all deaths and death certificate information. As is the case at most teaching centres, the majority of death certificates at our hospital are completed by physicians in their first or second year of postgraduate training (PGY-1 or PGY-2).^{3,10} Our observation of frequent errors in the completion of the Cause of Death section prompted efforts to develop an educational intervention aimed at improving the accuracy of death certification by residents. In this article we describe the content of a seminar on death certification and the results of an audit of death certificate accuracy before and after the seminar.

Background

Process of death certification

After pronouncing death, the certifying physician must decide whether the case requires notification of the coroner. This depends on the certifying physician's determination of the manner of death as "natural" or "unnatural" (Table 1). Deaths designated as unnatural or associated with uncertainty regarding the medical condition accounting for death must be reported to the coroner. Other indications for coroner notification include death within certain populations, such as prison inmates.⁹

If coroner notification is deemed unnecessary, the physician must use the clinical information, including autopsy results, when available, to complete the Cause of Death section of the death certificate (Fig. 1). The underlying cause of death listed on the certificate is then coded to one of the 17 International Classification of Diseases (ICD) categories and then to a disease-specific cause of death.¹⁴ The certifying physician must make every effort to be as specific as possible when determining the underlying cause of death.

The format of the Cause of Death section is based on recommendations of the World Health Organization and consists of 2 parts. Part I has 3 lines — labelled (a), (b) and (c) — and is used to record the underlying cause of death as well as any "immediate" and "antecedent" causes of death (Table 1). Part II is used to record other significant conditions contributing to death.

The concept of the "underlying cause of death" is often a source of confusion for certifying physicians.¹ The underlying cause of death is the disease that triggered the chain of events leading to the patient's death and without



which death would not have occurred. It must appear on the *lowest completed line* of part I and should be as etiologically specific as possible. Mechanisms of death and non-specific conditions (defined in Table 1) are not etiologically specific and therefore are not acceptable as an underlying cause of death.

In many cases it is neither necessary nor appropriate to complete all 3 lines in part I. An immediate or antecedent cause of death may not be identifiable in all cases. An underlying cause of death can stand alone as the only completed line in part I.

Controversy exists regarding the appropriate content for inclusion in part II.⁹ Many jurisdictions encourage inclusion of risk factors and all significant medical conditions in this section. The information recorded here is used primarily to ensure proper coding of the underlying cause of death since, until recently, the underlying cause of death was the only information from the certificate recorded by Statistics Canada (Judy Hartman, Manager, Policy and

Legislation, Office of the Registrar General of Ontario, Thunder Bay, Ont.: personal communication, 1997).

Case scenario illustrating common errors in Cause of Death statements

A 75-year-old male smoker with a 5-year history of emphysema is admitted to hospital for exacerbation of his lung disease caused by *Haemophilus influenzae* pneumonia. His only other medical problem is coronary artery disease of 10 years' duration. His condition deteriorates, but he has decided against further measures, such as intubation and ventilation. One week after admission he is found in his bed with vital signs absent. You are called to pronounce and certify his death.

Table 2 shows 4 different Cause of Death statements, 3 of which (A, B and C) are inaccurate. In completion A "respiratory failure" is listed as the underlying cause of death. Respiratory failure is a mechanism of death, not an underlying cause of death. A certificate completed with such an error lacks an etiologically specific disease for coding according to the ICD classification. In completion B the temporal sequence of events does not make sense. Reading from the lowest line upward, the antecedent cause is listed as pneumonia, which resulted in emphysema. Had the time intervals been filled in, this error would have been readily identified by the coders, since in this case the emphysema preceded the pneumonia by 5 years. In completion C emphysema and coronary artery disease are listed in part I. These are "competing" causes of death because they are causally unrelated. Coronary artery disease is listed on the lowest completed line and, therefore, would be coded as the underlying cause of death. This would result in classification to an entirely different ICD category (diseases of the circulatory system) than is appropriate (diseases of the respiratory system) for this case. Finally, in completion D the Cause of Death statement is accurate. Reading up from the lowest completed line, the sequence of events can be interpreted easily: emphysema developed 5 years ago, then pneumonia developed 1 week before death. The patient had a 10-year history of coronary artery disease, which was not causally related to his death. Emphysema will be coded properly as the underlying cause of death. Smoking could be identified in part II as a risk factor for the underlying cause of death.

Table 1: Terminology of death certification

Term	Definition
Certifying physician	Physician completing Cause of Death statement on death certificate (may be the attending physician, his or her delegate, or the coroner)
Cause of Death statement	Completion of part I and part II of the death certificate
Underlying cause of death	The condition that triggered the chain of events leading to death; temporally, the most remote condition; etiologically specific
Immediate cause of death	The final complication resulting from the underlying cause of death, occurring closest to the time of death and directly causing death
Antecedent ("intervening" or "intermediate") cause of death	A disease or condition that occurred as a result of the underlying cause of death but was not the final complication or immediate cause of death
Mechanism of death	A physiologic derangement or biochemical disturbance by which a cause of death exerts its lethal effect (e.g., cardiac arrest, respiratory arrest); ⁹ must not be used as an underlying cause of death
Nonspecific condition	An anatomic or functional derangement that has more than one possible cause (e.g., sepsis, hemorrhage, heart failure, renal failure); ⁹ must not be used as an underlying cause of death
Manner of death	A classification of death based on the type of conditions that caused death and the circumstances under which they occurred (e.g., natural [due solely to disease], homicidal, suicidal, accidental or undetermined) ⁹

Methods

Over a 6-month period residents assigned to an internal medicine rotation at our hospital were invited to attend a 75-minute seminar on proper completion of death certificates. Three seminars were held, one every 2 months. Each seminar was facilitated by one of us (2 by



K.A.M. and 1 by D.R.F.), and 2 of the 3 seminars were attended by the regional coroner.

Through a literature review and by examining inaccurately completed certificates in our own department, we identified common pitfalls in completing a death certificate accurately. We designed our intervention to begin with a brief didactic session outlining the process of death certification and the terminology used in writing Cause of Death statements. The remainder of the session was interactive, involving 10 case scenarios that we developed and then revised after review with the regional coroner. [Most of the case scenarios, each accompanied by an incorrectly and a correctly completed death certificate, can be found online [www.cma.ca/cmaj/vol-158/issue-10/1317.htm].) The residents attempted to complete a Cause of Death statement based on the scenarios and were asked to identify errors in mock death certificates. In addition to the seminar, a memorandum was attached to each death certificate package reminding residents to avoid use of mechanisms of death in Cause of Death statements.

Death certificates from January through December 1995 (preintervention) and from January through June 1996 (postintervention) were collected for audit. Certificates completed by attending physicians or coroners were excluded from the analysis. All dates and patient information were removed from the certificates to blind the auditor to the status (pre- or postintervention) of the physician completing the certificate.

Two previous methods of auditing death certificates for errors were adapted for use in our audit.^{11,12} The death

certificates were audited for 6 types of error (Table 3). A list of unacceptable mechanisms of death was created to ensure consistency in review of the certificates. A senior medical student was trained to audit the certificates for accuracy. Where uncertainty existed as to classification of errors, one of us (K.A.M.) reviewed the certificate with the medical student.

Statistical analysis

We analysed the data using the Stata statistical package (Stata 5.0; Computing Resource Center, Santa Monica, Calif.). Death certificates were classified categorically by their error status for both major and minor errors. We used the χ^2 statistic to compare rates of errors before and after the educational intervention. The kappa statistic was used to assess interrater reliability.¹⁵

Results

Attendance at the seminars was excellent, with over 90% of PGY-1 and PGY-2 residents present. Of the 238 death certificates completed at our hospital during the audit period, 9 were excluded because they were completed by the coroner (in 8 cases) or an attending physician (in 1 case). Of the remaining 229 certificates 146 were completed before and 83 after the educational intervention.

A random sample of 20% of the certificates were audited by one of us (K.A.M.), and the results were compared with those of the original audit to assess inter-rater

MEDICAL CERTIFICATE OF DEATH			
CAUSE OF DEATH	Part I	I	Approx. interval between onset & death
	Immediate cause of death	(a) <i>due to, or as a consequence of</i>	
	Antecedent causes, if any, giving rise to the immediate cause (a) above, stating the <i>underlying cause last</i>	(b) <i>due to, or as a consequence of</i>	
		(c)	
Part II	II		
Other significant conditions contributing to the death but not causally related to the immediate cause (a) above	{		

Fig. 1: Cause of Death section of a medical certificate of death. Source: Office of the Registrar General, Province of Ontario.



reliability. The rate of agreement for major errors was 93.5% (κ value = 0.84) and for minor errors 100%.

During 1995 (before the intervention) 32.9% of the certificates contained at least one major error (Table 4). Mechanisms of death listed without a legitimate cause of death (15.8% of certificates) and improper temporal sequencing (15.8%) accounted for most of the major errors. The proportion of certificates with at least one major error decreased to 15.7% ($p = 0.01$) after the intervention.

Minor errors were frequent both before and after the intervention (Table 4). The most frequent type of minor error was the omission of time intervals (71.6% of certificates). There was no significant change in the overall rate of minor errors after the intervention.

Interpretation

The proportion of death certificates with at least one

major error before our educational intervention, 32.9%, is comparable to that found in previous studies.^{11,12} The intervention was successful in reducing the major error rate by half. This may be a conservative estimate of the improvement after the intervention for 2 reasons. First, a number of certificates were filled out by residents who had been absent during the seminar, and these were not excluded from the analysis. Second, because the seminars took place during the first week, but not always on the first day, of each rotation, several certificates would have been completed by residents before the seminar.

We failed to show a reduction in the minor error rate, which was high both before and after the intervention. Although the primary goal of the intervention was to reduce the occurrence of major errors, we also advised residents to complete time intervals and to avoid abbreviations. Recording the time intervals can be quite helpful to the nosologist faced with an improperly completed certificate,

Table 2: Four examples of death certificate completion for one case scenario,* illustrating common errors in Cause of Death statements

Completion example		Approximate interval between onset and death	Type of error†	
			Major	Minor
Completion A				
<i>Part I</i>				
(a)	Respiratory arrest	–	Mechanism listed without underlying cause of death	Absence of time intervals
(b)	–	–		
(c)	–	–		
<i>Part II</i> Coronary artery disease				
Completion B				
<i>Part I</i>				
(a)	Emphysema	–	Improper sequencing	Absence of time intervals
(b)	Pneumonia	–		
(c)	–	–		
<i>Part II</i> Coronary artery disease				
Completion C				
<i>Part I</i>				
(a)	Emphysema	5 yr	Competing causes of death	Abbreviations used
(b)	CAD	10 yr		
(c)	–	–		
<i>Part II</i> –				
Completion D				
<i>Part I</i>				
(a)	<i>Haemophilus influenzae</i> pneumonia	1 wk	None	None
(b)	Emphysema	5 yr		
(c)	–	–		
<i>Part II</i> Coronary artery disease				

*See text for description of case scenario.

†The components of part I are defined as follows: (a) = the immediate cause of death; (b) and (c) = antecedent causes, if any, giving rise to the immediate cause stated in (a), with the underlying cause stated last. In part II, physicians are required to state other significant conditions contributing to the death but not causally related to the immediate cause stated in (a).

‡Definitions of major and minor errors are listed in Table 3.



since this information allows for interpretation of the sequence of events and assignment of the appropriate cause of death.¹²

To our knowledge, only one previous group implemented an educational intervention and measured the subsequent change in death certification errors. Weeramanthri and colleagues¹⁶ sent written educational material as part of a questionnaire to house officers at a teaching hospital in Australia and compared rates of errors on death certificates 1 month before and 1 month after the intervention. Although the error rate dropped (from 22.4% to 15.1%), the change was not statistically significant. Since attempts to change physician behaviour by means of written guidelines alone are often unsuccessful,¹⁷ we tried to enhance the likelihood of achieving a significant change by using an interactive learning method and by involving an opinion leader (regional coroner) in the process.

Table 3: Definition of major and minor errors in death certificates

Type of error	Definition
Major	
Mechanism of death listed without an underlying cause	Mechanism or nonspecific condition listed as the underlying cause of death
Improper sequencing	Sequence of events does not make sense; underlying cause of death not listed on the lowest completed line of part I
Competing causes	Two or more causally unrelated, etiologically specific diseases listed in part I
Minor	
Abbreviations	Abbreviations used to identify diseases
Absence of time intervals	No time intervals 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 cause of death

We used only one of several possible methods to improve the accuracy of death certification. We considered other methods, including immediate audit of death certificate information by attending staff. However, previous studies suggest that seniority alone does not guarantee physicians' proficiency in this skill.^{1,17} Faculty development would be required before implementation of such a process.¹¹

Simplifying the death certificate has also been suggested as a method for improving accuracy.¹⁸ Although a certificate revision meeting is scheduled for this year, changes to the form are expected to be minor, and so physicians must learn to use the current form despite its complexities.¹⁸ Other proposals for improvement include mandatory completion of a workshop on death certification by residents, the inclusion of questions about death certification on specialty examinations and the establishment of hospital-based expert panels to amend inaccurately completed certificates.^{3,11,19}

The durability of change in the certification practices of the physicians in our study was not assessed. Such an assessment would have been difficult for 2 reasons. First, there is a rapid turnover of residents on our services. Second, as residents become more senior they fill out fewer death certificates. Both factors would limit the number of certificates completed by residents who had participated in the seminar.

Could the Hawthorne effect account for the improvement in the major error rate? In an effort to avoid this bias, we did not detail our plans to audit the certificates before and after the educational intervention. However, senior residents sit as members of the Mortality Review Committee, where this project had been discussed, and, therefore, we cannot exclude the Hawthorne effect as a partial explanation for the improvement.

One limitation of our study was that only inaccuracies

Table 4: Frequency of major and minor errors identified on audit of death certificates completed by internal medicine residents before and after an educational intervention

Type of error	No. (and %) of certificates			p value*
	Total sample n = 229	Before intervention n = 146	After intervention n = 83	
Major				
Mechanism only	27 (11.8)	23 (15.8)	4 (4.8)	0.01
Improper sequencing	28 (12.2)	23 (15.8)	5 (6.0)	0.03
Competing causes	18 (7.9)	11 (7.5)	7 (8.4)	0.81
At least one major error	61 (26.6)	48 (32.9)	13 (15.7)	0.01
Minor				
No time intervals	164 (71.6)	101 (69.2)	63 (75.9)	0.28
Use of abbreviations	44 (19.2)	29 (19.9)	15 (18.1)	0.11
Mechanism + legitimate cause	97 (42.4)	67 (45.9)	30 (36.1)	0.15
At least one minor error	198 (86.5)	123 (84.2)	75 (90.4)	0.19

* χ^2 test comparing proportions before and after the intervention.



due to errors of completion were assessed. The effect of inaccurate death certificate information due to deliberate falsification by physicians or incorrect clinical diagnoses was not included in the analysis. Therefore, our findings represent an overestimate of the accuracy of death certificate information.

Conclusion

Death certification is an important skill that all physicians must master to improve the accuracy of Canadian population-based mortality statistics. Although inaccuracies can occur at several steps in the certification process, our study shows that a simple educational intervention can improve the accuracy of physicians' completion of certificates. Death certification is often included in undergraduate medical curricula, but we suggest that educational interventions be offered early in the first year of postgraduate training, when they have the most clinical relevance. Our seminar used common scenarios from internal medicine, but the format could be adapted easily to other residency programs.

We thank Mr. Rahi Victory, medical student at Queen's University, for performing the audit of the death certificates. We also thank Dr. Benoit Bechard, Regional Coroner for Eastern Ontario, for reviewing the case scenarios used in the seminars and for attending 2 of the 3 seminars.

This study was supported by a grant from the Office of Postgraduate Education, Queen's University.

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ICES Practice Atlas

ISBN 0-920169-79-1 (354 pp) 1996

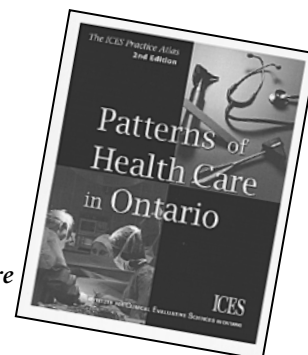
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