Improper cause-of-death statements by specialty of certifying physician: a cross-sectional study in two medical centres in Taiwan

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ABSTRACT

Objective: To determine the frequency of various types of improper cause-of-death (COD) statements reported on death certificates and whether the frequency differed by specialty of the certifying physician.

Design: Cross-sectional descriptive study.

Setting: 2 medical centres in Tainan, Taiwan.

Participants: A total of 2520 death certificates issued by 230 physicians.

Main outcome measures: 4 types of improper COD statements based on the criteria of correctness of the COD causal sequence and the level of specificity of underlying COD selected.

Results: Of 2520 death certificates analysed, 502 (19.9%) had at least one type of improper COD statement. However, only 235 (9.3%) sustained major errors, that is, 91 (3.6%) reported incorrect causal sequence and 144 (5.7%) reported only mechanism(s) of death (such as respiratory failure, heart failure, sepsis and acidosis). The improper reporting rate was highest among nephrologists (53%, 24/45), followed by infectious diseases physicians (45%, 29/65) and was lowest among oncologists (6%, 57/995).

Conclusions: About one-fifth issued death certificates sustained improper COD statements and only one-tenth had noteworthy errors that would threaten the quality of COD statistics. The frequency varied by specialty of the certifying physician because physicians in different specialties manage different types of diseases and conditions with contrasting complexities in terms of determining the causal sequence and specificity of COD statements.

INTRODUCTION

Recording cause-of-death (COD) statements on the death certificate is a common practice of medical physicians. Good quality COD statement is prerequisite for good quality COD statistics. Good quality COD statistics are cornerstones for good quality health policy making and medical researches. The tabulation of COD statistics are based on the underlying COD, which has been defined as (1) the disease or injury that initiated the train of morbid events leading directly to death or (2) the circumstances of the accident or violence which produced the fatal injury (see WHO,1 page 23). This definition is from the standpoint of prevention of death; it is necessary to break the chain of events or to affect a cure at some point, and the most effective public objective is to prevent the precipitating cause from operating.

To facilitate the selection of the underlying COD when two or more COD are recorded, an international standard form of death certificate (figure 1) has been designed and recommended by the WHO1 (see pages 23 and 24). Part I of the form is for diseases

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related to the train of events leading directly to death, and part II is for unrelated but contributory conditions. It is the responsibility of the medical practitioner signing the death certificate to indicate which morbid conditions led directly to death and to state any antecedent conditions giving rise to this cause.

However, on some occasions, certifying physicians might not report correct causal sequence between diseases or conditions on line a, b, c or d (see examples 10–12 in table 1), the Selection Rules set by the WHO should be used to standardise the process in selection of the underlying COD. Sometimes, the selected underlying COD might not reflect the real intent underlying COD of certifying physician and the derived COS statistics might be biased. Furthermore, if certifying physicians do not provide specific information on the death certificate, it is difficult to provide useful information for the prevention of death.

Different classification schemes were used in previous studies to identify different types of improper COD statements (appendix 1). Reporting incorrect COD causal sequence and reporting only mechanism(s) of death are two major errors indicated in every study. Despite many studies demonstrating various types of improper COD statements on death certificates, very few studies have examined the frequency of improper COD statements by specialty of the certifying physician. Information on which specialties have a higher percentage of recording improper COD statements is essential for the education and training of physicians and to properly complete COD statements. There were two objectives in this study: (1) to determine the frequencies of various types of improper COD statements on death certificates reported by certifying physicians in two medical centres in Tainan, Taiwan, and (2) to examine whether the frequency of improper reporting differed by specialty of the certifying physician.

METHODS
Setting and data source
This descriptive cross-sectional study was conducted in Tainan, a major city located in southern Taiwan with a population of 1.87 million. There are only two medical centres in Tainan. In 2009, there were 1150 beds in the Chi-Mei Medical Center and 1100 beds in the National Cheng Kung University Hospital. We retrospectively reviewed all death certificates issued from 1 January 2009 to 31 December 2009 in these two medical centres.

Determination of improper COD statements
We used two criteria—correctness of the COD causal sequence and level of specificity—to define four types of improper COD statements. Examples of proper and four types of improper COD statements are illustrated in table 1. Determination of the correctness of the COD causal sequence is according to Decision Table D in the Instruction Manual Part 2c compiled by the US National Center for Health Statistics, which includes all acceptable causal sequences between diseases or morbid conditions.

Level of specificity was classified as specific COD, unspecific COD and mechanism of death. Specific COD is defined as providing specific information on the aetiology and body region, such as lung cancer, oesophageal varices bleeding, hepatitis B infection, cerebrovascular infarction. Unspecific COD denotes those
providing unspecific information on aetiology (stroke without specifying whether it is due to infraction or haemorrhage, tumour without specifying whether is benign or malignant and aspiration pneumonia without specifying whether it is milk or water or other foods) or on body region (gastrointestinal bleeding without specifying whether the bleeding occurred in the oesophagus, stomach, intestine or colon). Mechanism of death is defined as a physiological derangement or a biochemical disturbance produced by a COD, such as congestive heart failure, respiratory failure, various arrhythmias, bacteraemia, sepsis, acidosis. The mechanism of death does not provide aetiology-specific information and therefore should not be the underlying COD.16

Proper COD statements include one correct causal sequence and one specific COD reported on the lowest used line (see examples 1–3 in table 1). Type 1 improper COD statements comprise one correct causal sequence and one unspecific COD reported on the lowest used line (see examples 4–6 in table 1). Liver tumour (see example 4 in table 1) without specifying whether malignant or benign and stroke (see example 5 in table 1) without specifying whether it was infarction or haemorrhage. We also included cases in which mechanisms of death (eg, renal failure, sepsis, heart failure) were reported on the line below some specific COD (eg, cerebral infarction or acute myocardial infarction) in type 1 improper COD statements (see example 6 in table 1). For example, the true causal sequence might be cerebral infarction resulted in renal failure in example 6 in table 1; however, the reported causal sequence (renal failure resulted in cerebral infarction) is also acceptable according to Decision Table D in the Instruction Manual Part 2c.15 Therefore, the underlying COD selected would be the mechanism of death (ie, renal failure in example 6). In this situation, renal failure was less specific than cerebral infarction and were less useful from the point of view of disease prevention.

Type 3 improper COD statements contain two or more correct causal sequences reported (see examples 10–12 in table 1). In other words, there were more than one diseases or conditions reported on one line. According to the Selection Rules, the first-mentioned COD will be selected as the underlying COD, that is, diabetes in example 10, lung cancer in example 11 and sepsis in example 12. However, the intended underlying COD of the certifying physician might not be the first-mentioned COD.

Type 4 improper COD statements comprise only mechanism(s) of death reported (see examples 16–18 in table 1). In other words, there were more than one diseases or conditions reported on one line. According to the Selection Rules, the first-mentioned COD will be selected as the underlying COD, that is, diabetes in example 10, lung cancer in example 11 and sepsis in example 12. However, the intended underlying COD of the certifying physician might not be the first-mentioned COD.
COD (obstructive lung disease in example 13, lung cancer in example 14 and liver cancer in example 15). Because the specific COD on the lower line could not result in the specific COD on the upper line, therefore, the specific COD on the upper line will be selected as the underlying COD according to the Selection Rules. However, the intended underlying COD of the certifying physician might be the specific COD on the lower line.

Type 4 improper COD statements involve only mechanism(s) of death being reported (see examples 16–18 in table 1). This is the most serious error because mechanism of death could not provide aetiology-specific information for disease prevention.

Authors T-JC and T-HL reviewed all the death certificates to determine whether the COD statement was acceptable or sustained one of the five types of error. T-JC is a senior neurologist and T-HL is a senior family physician and both are in charge of teaching in how to correctly report COD statements on the death certificate for residents in the two medical centres.

### Data analysis
We first calculated the frequencies of the four types of improper COD statements among the death certificates analysed. We then computed the improper rate (containing at least one type of improper COD statement) and the major error rate (type 3 and type 4 improper COD statements combined) by specialty of the certifying physician. We classified 19 subspecialties in this study.

### RESULTS
In 2009, a total of 2520 death certificates were issued by 230 physicians in two medical centres in Tainan, Taiwan. There were 502 death certificates that sustained at least one type of improper COD statement, with an overall improper statement rate of 20% (502/2520). However, only one-tenth (235/2520) had major errors, that is, 91 (3.6%) reported incorrect causal sequence and 144 (5.7%) reported only mechanism(s) of death (table 2).

The improper rate varied greatly by specialty of the certifying physician, ranging from 53% (24/45) among nephrologists and 45% (29/65) among infectious diseases physicians to 6% (57/995) among oncologists (table 3). Major errors (type 3 and type 4 combined) were highest among nephrologists (27%, 12/45), followed by cardiologists (25%, 31/125).

### DISCUSSION

#### Main findings
The findings of this study indicate that about one-fifth of death certificates sustained at least one type of improper COD statement. However, only one-tenth had major errors that would have noteworthy threat on the quality of COD statistics. The improper rate varied by specialty of the certifying physician and was highest among nephrologists and infectious disease physicians and lowest among oncologists.

#### Table 2  Frequencies of the five types of improper cause-of-death (COD) statements among death certificates issued in two medical centres in Tainan, Taiwan, 2009

| Category                                      | N   | (%)  |
|-----------------------------------------------|-----|------|
| Total death certificates                      | 2520| 100.0|
| Proper COD statements                         | 2018| 80.1 |
| Improper COD statements                       | 502 | (19.9) |
| Type 1: one correct causal sequence and one unspecific COD reported on the lowest used line | 210 | (8.3) |
| Type 2: two or more correct causal sequences reported | 57 | (2.3) |
| Type 3: incorrect causal sequence reported    | 91  | (3.6) |
| Type 4: only mechanism(s) reported            | 144 | (5.7) |

#### Interpretations in relation to previous studies
Previous studies have presented different distributions of various types of improper COD statements. The most common error was found to be the reporting of an unspecific COD in four studies, the reporting of an incorrect COD causal sequence in two studies, and the reporting of mechanism(s) of death only in one study. One of the explanations of the above-mentioned variations are the differences in case-mix encountered in different medical settings. Another explanation is that certifying physicians in different medical settings have different COD certification behaviour patterns.

Consistent with previous Taiwanese study, unspecific COD statements were the most common improper COD statement. The major error rate was 9% in this hospital-based study, which was similar with previous national study in Taiwan (11%). One possible explanation of lower major error rate in this study was that there were more patients with cancer in two medical centres in this study in which the determination of underlying COD was more straightforward.

Despite many studies having examined improper COD statements, few have assessed the improper rate by specialty of the certifying physician. One Canadian study indicated that the overall and major error rates were 61% and 40% in medicine, 65% and 35% in surgery, 50% and 17% in oncology, 27% and 15% in family medicine, 38% and 30% in paediatrics, and 56% and 22% in the critical care trauma unit, respectively. Unfortunately, because of the small sample size, they did not further analyse the error rates by subspecialties. Consistent with the results of that study, the oncologists in this study had the lowest major error rate. Nevertheless, very few family physicians issue death certificates in medical centres in Taiwan.

Physicians of different specialties manage different types of diseases and conditions with contrasting complexities in terms of the determination of the underlying COD. For example, most patients treated by
oncologists have cancer, and the determination of the underlying COD is comparably straightforward. Oncologists, who issued largest amount of death certificates; nevertheless, had the lowest improper rate (9% in this study) compared with their counterparts specialists. On the contrary, physicians in department of nephrology, infectious diseases, critical care, cardiology and respiratory medicine work mostly with patients with diseases or conditions lacking a specific aetiology, such as renal failure, sepsis, heart failure, respiratory failure and/or thus sustained a higher error rate in the COD statements. As indicated by Kircher and Anderson,16 most physicians tend to confuse cause and mechanism because medical therapy often attempts to modify or ameliorate mechanisms rather than causes. For example, digoxin is often highly effective in ameliorating the symptoms of congestive heart failure (mechanism) but does nothing to modify the underlying coronary artery disease (cause). It is rather difficult for physicians of infectious diseases, respiratory medicine or nephrology to specify the etiological causes of sepsis, respiratory failure and renal failure.

There were some debates on whether to define pneumonia as a specific COD (see example 3 in table 1). Ideally, the certifying physician should specify whether the pneumonia was due to which type of virus, bacteria or other aetiologies. However, in reality, it was very difficult to get relevant information. Furthermore, pneumonia is a common final pathway to death, which in most occasions was not suitable as the underlying COD. According to Decision Table D in the Instruction Manual Part 2c, all diseases or conditions could result in pneumonia, similar to other mechanisms of death (such as sepsis, respiratory failure, acidosis).15

In the revision of International Selection Rule 3 in the Second Edition of the Instruction Manual of the International Classification of Diseases, Tenth Revision (ICD-10) set by the WHO, which denotes that ‘any pneumonia in ICD-10 code J12-J18 should be considered an obvious consequence of conditions that impair the immune system. Pneumonia in ICD-10 code J18.0 and J18.2-J18.9 should be considered an obvious consequence of wasting diseases (such as malignant neoplasm and malnutrition) and diseases causing paralysis (such as cerebral haemorrhage or thrombosis), as well as serious respiratory conditions, communicable diseases and serious injuries. Pneumonia in ICD-10 code J18.0 and J18.2-J18.9, J69.0 and J69.8 should also be considered an obvious consequence of conditions that affect the process of swallowing’ (see WHO,1 page 29).

### Implications of this study

As there were one-tenth of death certificates analysed had major errors, that is, reported incorrect causal sequence and only mechanism(s) of death reported improper COD statements.

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### Implications of this study

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### Table 3

Improper* and major error† rates in cause-of-death (COD) statements by specialty of the certifying physician in two medical centres in Tainan, Taiwan, 2009

| Specialty of certifying physician | Number of death certificates issued | Improper N (%) | Major error N (%) |
|----------------------------------|------------------------------------|----------------|------------------|
| Nephrology                       | 45                                 | 24 (53.3)      | 12 (26.7)        |
| Infection                        | 65                                 | 29 (44.6)      | 8 (12.3)         |
| Cardiology                       | 125                                | 49 (39.2)      | 31 (24.8)        |
| Emergency                        | 125                                | 42 (33.6)      | 22 (17.6)        |
| Others                           | 51                                 | 16 (31.4)      | 11 (21.6)        |
| Neurology                        | 44                                 | 13 (29.5)      | 6 (13.6)         |
| Other internal medicine          | 62                                 | 18 (29.0)      | 7 (11.3)         |
| Neurosurgery                     | 52                                 | 15 (28.8)      | 0 (0.0)          |
| Paediatrics                      | 56                                 | 16 (28.6)      | 9 (16.1)         |
| Critical care medicine           | 433                                | 118 (27.3)     | 54 (12.5)        |
| Gastroenterology                 | 157                                | 42 (26.8)      | 22 (14.0)        |
| General surgery                  | 161                                | 41 (25.5)      | 16 (9.9)         |
| Respiratory medicine             | 115                                | 18 (15.7)      | 6 (5.2)          |
| Cardiac surgery                  | 34                                 | 4 (11.8)       | 2 (5.9)          |
| Oncology                         | 995                                | 57 (5.7)       | 29 (2.9)         |
| Total                            | 2520                               | 502 (19.9)     | 235 (9.3)        |

*Improper denotes a death certificate containing at least one type of improper COD statement.
†Major error refers to death certificates that sustain type 3 ‘incorrect causal sequence was reported’ and type 4 ‘only mechanism(s) of death reported’ improper COD statements.

### Cheng T-J, Lee F-C, Lin S-J, et al. BMJ Open 2012;2:e001229. doi:10.1136/bmjopen-2012-001229

5
Improper cause-of-death statements

A study in the USA suggested that 51 of the 52 registration areas queried either demographic or COD information, and almost 90% of queries were returned. The underlying COD changed in approximately 68% of these cases. The Bureau of Health of Tainan city could query death certificates in which only the mechanism of death is reported to obtain more specific information to improve the quality of COD statistics.

Strengths and limitations

Compared with previous similar hospital-based studies, this study has the largest sample size, which allowed us to stratify the improper rates by subspecialties. This study used very detailed classification of types of improper COD statements, which could provide very practical information for the design of materials for medical education.

One of the limitations of this study was that we analysed only the death certificates issued in two medical centres, and the case-mix and physicians’ certification behaviours in the two medical centres studied might differ from those in other hospitals. Another limitation was that we were unable to differentiate whether COD statements were reported by junior residents or senior attending physicians because of the co-signature system used in the two medical centres studied. The four types of improper COD statements were by no means complete but were by far the most complete classification as compared with previous studies.

CONCLUSIONS

In conclusion, about one-fifth of death certificates sustained at least one type of improper COD statement. However, only one-tenth had major errors that would have noteworthy threat on the quality of COD statistics. The frequencies of improper COD statements varied greatly by speciality of the certifying physician because physicians with different specialties manage different types of diseases and conditions with contrasting complexities in terms of the determination of a specific COD. Educational intervention and queries should target specialties with a high frequency of improper COD statements.

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REFERENCES

1. World Health Organization. International Statistical Classification of Diseases and Related Health Problems, Tenth Revision. Volume 2 Instruction Manual the Second Edition. Geneva: World Health Organization, 2004. http://www.who.int/classifications/icd/ICD-10_2nd_ed_volume2.pdf (accessed 8 Sep 2010).
2. Leadbeatter S. Semantics of death certification. J R Coll Physicians Lond 1986;20:129–32.
3. Zumwalt RE, Ritter MR. Incorrect death certification—an invitation to obfuscation. Postgrad Med 1987;81:245–54.
4. Jordan JM, Bass MJ. Errors in death certificate completion in a teaching hospital. Clin Invest Med 1993;16:249–55.
5. Peach HG, Brumley DJ. Death certification by physicians in non-metropolitan Victoria. Aust Fam Phys 1988;27:178–82.
6. Lu TH, Shou WY, Shih TP, et al. Factors associated with errors in death certificate completion: a national study in Taiwan. J Clin Epidemiol 2001;54:232–8.
7. Swift B, West K. Death certification: an audit of practice entering the 21st century. J Clin Pathol 2002;55:275–9.
8. Weeramanthri T, Beresford B. Death certification in Western Australia—classification of major errors in certificate completion. Aust J Public Health 1992;16:431–4.
9. Pritt BS, Hardin NJ, Richmond JA, et al. Death certification errors at an academic institution. Arch Pathol Lab Med 2005;129:1476–9.
10. Armour A, Bharucha H. Nosological inaccuracies in death certification in Northern Ireland. Ulster Med J 1997;66:13–17.
11. Myer KA, Farquhar DRE. Improving the accuracy of death certification. CMAJ 1998;158:1317–23.
12. Burger EH, van der Merwe L, Volfink J. Errors in the completion of death notification form. S Afr Med J 2007;97:1077–81.
13. Katsakiori PF, Panagiotopoulou EC, Sakellaropoulou GC, et al. Errors in death certificates in a rural area of Greece. Rural Remote Health 2007;7:822.
14. Lu TH, Anderson RN, Kawachi I. Trends in frequency of reporting improper diabetes-related cause-of-death statements on death certificates, 1985 to 2005: an algorithm to identify incorrect causal sequences. Am J Epidemiol 2010;171:1069–78.
15. National Center for Health Statistics. Instruction Manual Part 2c- ICD-10 ACME Decision Tables for Classifying Underlying Causes of Death, 2008. Hyattsville, MD: National Center for Health Statistics, 2008. http://www.cdc.gov/nchs/data/dvs/2008Final2C.pdf (accessed 1 May 2012).
16. Kircher T, Anderson RE. Cause of death: proper completion of the death certificate. JAMA 1987;258:349–52.
17. Hanzlick R. The Medical Cause of Death Manual: Instructions for Writing Cause of Death Statements for Death Due to Natural Causes. Northfield, IL: College of American Pathologists, 1994.
18. Aung E, Rao C, Walker S. Teaching cause-of-death certification: lessons from international experience. Postgrad Med J 2010;86:143–52.
19. Hoyert DL, Lima AR. Querying of death certificates in the United States. Public Health Rep 2005;120:288–93.

APPENDIX 1

Types of improper cause-of-death statements used by previous studies

Leadbeatter2 (1986)
1. No cause given
2. Multiple causes given—sequence not clear
3. Single cause given—relevant detail absent
4. Single cause given—error in layout

Zumwalt and Ritter3 (1987)
1. Only mechanism(s) of death listed in part I
2. Information in part I reversed
3. Only cardiac arrest listed
4. Cause of death listed in part II instead of part I
5. Complications of cause of death listed in part II
6. Inappropriate material included

Weermanthri and Beresford (1992)
1. Mechanism only
2. Reversed logical sequence
3. Illogical sequence
4. Web
5. Underlying cause in part II

Jordan and Bass (1993)
1. Mechanisms without explanation
2. Sequencing errors
3. 2 causes of death
4. No time interval recorded
5. Inappropriate information recorded

Armour and Bharucha (1997)
1. Mode of dying

2. Poor terminology
3. Clinical term or symptom
4. Sequence error
5. Non-existent terminology

Myers and Farquhar (1998)
1. Mechanism only
2. Improper sequencing
3. Competing causes

Lu et al (2001)
1. Only mechanism(s) of death given
2. Multiple causal sequences given in part I
3. Single causal sequence given but not specific enough
4. Single causal sequence given but the order was incorrect

Katsakiori et al (2007)
1. The mechanism but not the cause of death is given
2. Multiple causal statements are given
3. A single but non-precise cause is given
4. A single causal sequence with incorrect order is given