Review article

DEATH CERTIFICATION ERRORS – PRACTICAL PROBLEMS IN EVERYDAY PRACTICE

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GREŠKE U POTVRDI O SMRTI – PRAKTIČNI PROBLEMI U SVAKODNEVNOJ PRAKSI

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Abstract

Accurate, precise, current and complete information about national mortality is necessary for planning, determining health priorities, distributing services, allocating budgets and delivering equitable healthcare services. Despite World Health Organisation guidelines, errors in death certificates (DC) have been observed in all regions and are very common. Many studies have pointed to various error types during death certification, focusing on the presence or absence of certain specific entities. Although there are many ways to stratify the errors, they are generally categorised into MAJOR and MINOR. MAJOR errors refer to errors that seriously impact the selection and classification of the underlying cause of death (UCD) (misclassification and definition of UCD, improper sequencing, mechanism of death without data of UCD, multiple and independent causes of death, insufficiently specific cause of death). In contrast, the MINOR errors have little impact on the classification of UCD (absence of time interval, abbreviations, specifying other significant conditions (comorbidities), more than one diagnosis on a line in Part I of DC, illegible handwriting). Completing the DC is an essential skill that physitians should possess. The key to reducing these errors lies in continuous training based on international guidelines, underlining the importance of ongoing education in this field.

Keywords: Death certificate, underlying cause of death, MAJOR errors, MINOR errors

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Sažetak

Tačne, precizne, aktuelne i potpune informacije o nacionalnim mortalitetnim podacima su neophodne za planiranje ciljeva, određivanje zdravstvenih prioriteta, raspodeli budžeta i pružanju adekvatne zdravstvene zaštite. Uprkos smernicama Svetske Zdravstvene Organizacije, greške u popunjavanju Potvrde o smrti (POS) primećene su u svim regionima sveta i veoma su česte. Mnoge studije su ukazivale na različite vrste grešaka tokom izdavanja POS, fokusirajući se na prisustvo ili odsustvo određenih specifičnih entiteta. Iako postoji mnogo načina za stratifikaciju grešaka, one su generalno kategorisane u VELIKE i MALE. VELIKE greške se odnose na greške koje ozbiljno utiču na izbor i klasifikaciju osnovnog uzroka smrti (OUS) (pogrešna klasifikacija i definicija OUS, nepravilan redosled dijagnoza, mehanizam smrti bez podataka o OUS, višestruki i nezavisni uzroci smrti, nedovoljno specifičan uzrok smrti). Nasuprot tome, MALE greške imaju mali uticaj na klasifikaciju OUS (odsustvo vremenskog intervala, skraćenice, navođenje drugih značajnih stanja (komorbiditeti), više od jedne dijagnoze na liniji u delu I POS, nečitak rukopis). Popunjavanje POS je važna veština koju lekar koji se bavi utvrđivanjem smrtnog ishoda treba da poseduje. Ključ za smanjenje ovih grešaka leži u kontinuiranoj obuci lekara primenom međunarodnih smernica, naglašavajući važnost stalne edukacije u ovoj oblasti.

Ključne reči: Potvda o smrti, osnovni uzrok smrti, VELIKE greške, MALE greške

Introduction

Accurate, precise, current, and complete information about national mortality is imperative. This information is necessary and the foundation for planning, determining health priorities, distributing services, allocating budgets, and delivering equitable healthcare services (1). Any deficiency in the quality of data reported on death certificates (DC) directly impacts the effectiveness of health management and politics. The medical section of DC, regularly completed by the attending physician or coroner, is the source of mortality data, making the accuracy of this information crucial.

The recognised factors in the occurrence of errors are clearly defined in three categories: the ability of the physician to fill in the DC accurately, the skill of the physician to code the condition from the DC accurately following the rules of the World Health Organisation (WHO), the separation of the underlying cause of death (UCD), and the application of clear statistical procedures and standards that convert individual UCD into mortality statistics (2, 3). The physician who determines the death and completes the DC represents the first link in determining the UCD. Corrections will not be needed if this step is done adequately, and the data will be high-quality.

Despite WHO guidelines, errors in the death certification have been observed in all regions and are very common (4-8). Many studies have shown that DC filling is often incomplete and inaccurate (9-14). The quality of mortality data is affected by several factors: the method of filling in and issuing the DC, the education of the physician who fills out the DC and who codes the UCD, the application of different versions of disease classifications, the application of inadequately grouped diagnoses, the application of different formats in which data are collected,

poor choice of International Classification Disease (ICD) -10 codes concerning the nature of the fatal outcome as well as the application of garbage codes (GC) (1, 3).

Many studies have pointed to various error types, focusing on the presence or absence of certain specific entities. Although there are many ways to stratify the errors, they are generally categorised into MAJOR and MINOR (Table 1) (9, 11, 15-17). The first refers to errors that seriously impact the selection and classification of UCD. In contrast, the second one refers to errors that have little impact on the classification of UCD. However, their absence may help in more precise determination and classification of the underlying aetiology of the fatal outcome.

Table 1. Classification of most common errors

MAJOR errors	MINOR errors
Misclassification and definition of UCD	Absence of time interval
Improper sequencing	Abbreviations
Mechanism of death without data of UCD	Specifying other significant conditions (comorbidities)
Multiple and independent causes of death	More than one diagnosis on a line in Part I of DC
Insufficiently specific cause of death	Illegible handwriting

II MAJOR errors

Misclassification and definition of UCD - Ill-defined UCD

Incorrect classification and definition of UCD is classified as a group of MAJOR errors. Namely, the indication of UCD may be missing or indicated on an inappropriate line in the DC or even in another medical part of the DC (17). From the public health perspective, the most effective strategy in preventing and controlling diseases and injuries is correctly identifying UCD since disease trends are based on that data (18). Therefore, wrong identification of OUS can lead to incorrect decisions and interventions at the national level. Misidentification is directly related to filling out the DC. When determining the death in a violent manner, doctors very often neglect

and do not mention the external circumstances of the injury that lead to the fatal outcome. The consequences of such mistakes are enormous. The absence of external circumstances of injury leads to masking of the accurate picture of the frequency of certain types of violent death (Example 1). As a result, death of violent origin is masked by some other, very often cardiovascular causes (ICD I00-I99) or undetermined causes of death (ICD R00-R99), which automatically changes the manner of death and the pattern of dying**.**

Example 1:

Medical data:		WRONG	ACCURATE
Part I *Cause* *of* *death*	*a)* *immediate* *cause*	R40.2 Coma, unspecified	R40.2 Coma, unspecified
	b) *Intermediate* *cause*		S06.5 Traumatic subdural haemorrhage
	c) *Underlying* *cause*	S06.5 Traumatic subdural haemorrhage	V29.4 The driver injured in a collision with another unmarked motor vehicle in a traffic accident
Part II *Other significant* *conditions contributing* *to death*		E10.9 Type 1 diabetes mellitus without complications	E10.9 Type 1 diabetes mellitus without complications

 Improper sequencing

The death certification delivers the ability to differentiate the time sequence of diseases that may have led to fatal outcomes. The improper sequence in immediate, intermediate and underlying causes of death belongs to the group of MAJOR errors since the correct sequence of events plays a crucial role in correctly selecting different causes. Inadequate sequence of events is the most frequently reported error in the literature (0.7%-94.6%) (5). Studies from India (19, 20) and Iran (21) have shown that inadequate sequencing is the most common mistake made by physicians. An acceptable sequence may be chronic kidney disease, congestive heart failure, and, finally, acute pulmonary oedema (Example 2). An improper sequence is an error that accounts

unacceptable sequences, such as acute pulmonary oedema, chronic kidney disease, and congestive heart failure.

Example 2:

Medical data:		WRONG	ACCURATE
Part I Cause of death	*a) immediate cause*	I50.0 Congestive heart failure	J81.0 Acute pulmonary oedema
	b) Intermediate cause	N18.5 Chronic kidney disease	I50.0 Congestive heart failure
	c) Underlying cause	J81.0 Acute pulmonary oedema	N18.5 Chronic kidney disease
Part II Other significant conditions contributing to death		E66. 9 Obesity	E66.9 Obesity

Mechanism of death without data of UCD

The mechanism of death is not part of the disease process and should not be considered the UCD (9). Mechanism of death was listed as the fifth most common error in a meta-analysis (22). It belongs to garbage diagnosis with no analytical value, and many diagnoses belong to the first severity level in public health decision-making. For this reason, the mechanisms are not usable in practice, and the UCD cannot be analysed based on them, nor can adequate prevention measures be applied. Many physicians identify cardiovascular events, most commonly cardiac arrest (I46.9), syncope (R05.4), as well as unspecified respiratory insufficiency (J96.0), and asphyxia (R09), as the UCD without understanding that it is a pathophysiological process that represents the terminal outcome. The Framingham study found that cardiovascular causes of death were overestimated in at least 24% of death certificates. (23) At the same time, Behrendt et al. concluded that nearly two-thirds of physicians use nonspecific cardiovascular mechanisms to code OUS (24).

Example 3:

Medical data:		WRONG	ACCURATE
Part I Cause of death	*a) immediate cause*	I46.9 Cardiac arrest, cause unspecified	I21.9 ST elevation (STEMI) myocardial infarction of anterior wall
	b) Intermediate cause		
	c) Underlying cause	I46.9 Cardiac arrest, cause unspecified	I21.9 ST elevation (STEMI) myocardial infarction of anterior wall
Part II Other significant conditions contributing to death		I21.9 ST elevation (STEMI) myocardial infarction of anterior wall I70.9 Other and unspecified atherosclerosis	I70.9 Other and unspecified atherosclerosis

Multiple and independent causes of death

This type of error refers to the existence of two or more causally unrelated, etiologically specific causes of death, listed in Part I of the DC (25). This error also occurs when several etiologically different diagnoses of the cause of death are written on one line. An example of such an error would be when entering on line a) a diagnosis of lung cancer (C34.1), on line b) thyrotoxicosis with goitre (E05.0), and on line c) Atrial fibrillation and flutter (I48). In that case, a diagnosis should be determined according to the ICD rules, representing the UCD, which would be lung cancer (C34.1).

Example 4:

Medical data:		WRONG	ACCURATE
Part I Cause of death	*a) immediate cause*	C34.1 lung cancer	C34.1 lung cancer
	b) Intermediate cause	E05.0 Thyrotoxicosis with diffuse goitre	
	c) Underlying cause	I48 Atrial fibrillation and flutter	C34.1 lung cancer
Part II Other significant conditions contributing to death			E05.0 Thyrotoxicosis with diffuse goitre I48 Atrial fibrillation and flutter

Insufficiently specific cause of death

WHO emphasises that specific causes should be used instead of general (non-specific) conditions (26). General and ill-defined conditions should not be listed as UCD since they have little value for public health analysis (27). Therefore, if there are more specific diagnoses, avoiding vaguely defined and general diagnoses is recommended. An example would be the diagnosis of an unspecified type of diabetes (E14.0- E14.9) or malignant neoplasm without specification of the site (C80.0). This error also occurs when entering three-digit instead of four-digit ICD codes if they exist in the codebook (e.g. J45 instead of J45.0).

II Minor errors

The absence of a time interval

The most common error reported in meta-analysis is the absence of a time interval, with a frequency ranging from 22% to 100% (22). Although the absence of a time interval belongs to the category of MINOR errors, it makes it difficult to determine the UCD accurately (28). This information is mainly used to assist the nosologist, who codes the causes of death, ensuring they are listed correctly: the newest terms first, then the older ones on each subsequent row below in Part I DC. The Serbian version of DC has no field for specifying the time interval when entering diagnoses of the underlying, previous, and immediate cause of death. This deficiency in the national DC can be one of the more critical prerequisites for reporting errors in the coding of UCD.

Abbreviations

The use of abbreviations is not so rare in DC (22). However, abbreviations are not permissible due to their ambiguity. Their use may lead to wrong interpretations and conclusions since DC is used for different purposes, such as forensic medical evidence for family members by public

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health researchers. The most commonly used abbreviations are AMI for acute myocardial infarction, DM for diabetes mellitus, CKD for chronic kidney disease and MS for multiple sclerosis (Example 5).

Example 5:

Medical data:		WRONG	ACCURATE
Part I *Cause* *of* *death*	a) *immediate cause*		
	b) *Intermediate cause*		
	c) *Underlying cause*	CKD	Chronic kidney disease
Part II *Other significant conditions contributing to death*		DM, AMI, MS	Diabetes mellitus, Acute myocardial infarction, Multiple sclerosis

Specifying other significant conditions (comorbidities)

Although most studies count comorbidities instead of UCD among MINOR errors, some classify this type as a MAJOR error (29). According to Alipur and Payandeh's research (22), there is a listing of other significant conditions (comorbidities) when filling out the DC. Comorbidities are entered in Part II of the DC and represent conditions and diseases that affect the development of events but do not directly lead to death. For this reason, comorbidities should not be coded instead of the UCD. Although other significant conditions do not directly affect the chain of events leading to death, analysing their association with UCD is of considerable value for policymaking and plans to reduce mortality.

Say a person who appears to have died from a combination of cryptococcal myocarditis and pneumocystis pneumonia, which occur as complications of human immunodeficiency virus (HIV) infection (Example 6). The instructions tell us not to list two states on the same line in part I. Furthermore, cryptococcal myocarditis and pneumocystis pneumonia should not be listed on separate lines in Part I because one did not cause or lead to the other. Since HIV infection causes

both diseases, it should be written on the c) line as a UCD, and one of the mentioned diseases should be put in Part II.

Example 6:

Medical data:		WRONG	ACCURATE
Part I Cause of death	*a) immediate cause*	Cryptococcal myocarditis	Cryptococcal myocarditis
	b) Intermediate cause		
	c) Underlying cause	Pneumocystis pneumonia	Human immunodeficiency virus infection
Part II Other significant conditions contributing to death		Human immunodeficiency virus infection	Pneumocystis pneumonia

More than one diagnosis on a line in Part I of DC

More than one diagnosis per line in the first part of the DC results in multiple sequences of events leading to death and makes the choice of UCD difficult. Therefore, this type of error should be avoided as much as possible. In Example 7, Osteoporosis, Acute gastric ulcer with haemorrhage, and Benign neoplasm of the parotid gland are written in line c). According to the WHO rules, only Acute gastric ulcers with bleeding can be UCD, and the other two will be written in Part II.

Example 7:

Medical data:		WRONG	ACCURATE
Part I Cause of death	*a) immediate cause*		K25.0 Acute gastric ulcer with haemorrhage
	b) Intermediate cause		
	c) Underlying	K25.0 Acute gastric ulcer with haemorrhage	K25.0 Acute gastric ulcer with haemorrhage

	cause	M81 Osteoporosis D11.0 Benign neoplasm of parotid gland	
Part II *Other significant conditions contributing to death*			D11.0 Benign neoplasm of parotid gland M81 Osteoporosis

Illegible handwriting

This type of error is specific to paper-based death certification systems. The illegibility of information recorded in DC significantly influences the interpretation of the cause of death determination of the UCD and cause coding death. Computerising the death certificate form and planning the system prevents the registration of abbreviations instead of the causes of death, and the mandatory completion of the necessary fields can be a crucial step in reducing the number of death certificate completion errors in countries that continue to use the paper-based death certificate form.

Conclusion

Errors in filling out death certificates are common in both undeveloped and developed countries. Classification errors into MAJOR and MINIOR groups helps prioritise issues related to DC completion and planning to improve the quality of cause-of-death documentation. Continuous training of physicians based on international guidelines, providing standard instructions for DC filling, implementing quality control mechanisms, providing feedback, and correcting existing errors can potentially reduce death certification errors.

Literature

1.   Setel P. W., Macfarlane S. B., Szreter S., Mikkelsen L., Jha P., Stout S., *et al*. A scandal of invisibility: making everyone count by counting everyone. The Lancet, 2007. 370(9598): p. 1569-1577.

2.   Global, regional, and national age-sex specific mortality for 264 causes of death, 1980-2016: a systematic analysis for the Global Burden of Disease Study 2016. Lancet, 2017. 390(10100): p. 1151-1210.

3.   Mikkelsen L., Iburg K. M., Adair T., Fürst T., Hegnauer M., von der Lippe E., *et al*. Assessing the quality of cause of death data in six high-income countries: Australia, Canada, Denmark, Germany, Japan and Switzerland. Int J Public Health, 2020. 65(1): p. 17-28.

4.   Gamage U. S. H., Adair T., Mikkelsen L., Mahesh P. K. B., Hart J., Chowdhury H., *et al*. The impact of errors in medical certification on the accuracy of the underlying cause of death. PLoS One, 2021. 16(11): p. e0259667.

5.   Alipour J.Payandeh A. Common errors in reporting cause-of-death statement on death certificates: A systematic review and meta-analysis. J Forensic Leg Med, 2021. 82: p. 102220.

6.   Nyondo T., Msigwa G., Cobos D., Kabadi G., Macha T., Karugendo E., *et al*. Improving quality of medical certification of causes of death in health facilities in Tanzania 2014–2019. BMC Health Services Research, 2021. 21(1): p. 214.

7.   Adair T., Kippen R., Naghavi M.,Lopez A. D. The setting of the rising sun? A recent comparative history of life expectancy trends in Japan and Australia. PLoS One, 2019. 14(3): p. e0214578.

8.   Hart J. D., Sorchik R., Bo K. S., Chowdhury H. R., Gamage S., Joshi R., *et al*. Improving medical certification of cause of death: effective strategies and approaches based on experiences from the Data for Health Initiative. BMC Med, 2020. 18(1): p. 74.

9.   Filippatos G., Andriopoulos P., Panoutsopoulos G., Zyga S., Souliotis K., Gennimata V., *et al*. The quality of death certification practice in Greece. Hippokratia, 2016. 20(1): p. 19.

10.   Middleton D., Anderson R., Billingsly T., Virgil N., Wimberly Y.,Lee R. Death certification: issues and interventions. Open Journal of Preventive Medicine, 2011. 1(03): p. 167-170.

11.   Myers K. A.Farquhar D. R. Improving the accuracy of death certification. Cmaj, 1998. 158(10): p. 1317-1323.

12.   Smith Sehdev A. E.Hutchins G. M. Problems with proper completion and accuracy of the cause-of-death statement. Arch Intern Med, 2001. 161(2): p. 277-84.

13.   Aung E., Rao C.,Walker S. Teaching cause-of-death certification: lessons from international experience. Postgrad Med J, 2010. 86(1013): p. 143-52.

14.   Haque A. S., Shamim K., Siddiqui N. H., Irfan M.,Khan J. A. Death certificate completion skills of hospital physicians in a developing country. BMC Health Serv Res, 2013. 13: p. 205.

15. Jordan J.Bass M. Errors in death certificate completion in a teaching hospital. Clinical and Investigative medicine. Medecine Clinique et Experimentale, 1993. 16(4): p. 249-255.

16. Naghavi M., Makela S., Foreman K., O'Brien J., Pourmalek F.,Lozano R. Algorithms for enhancing public health utility of national causes-of-death data. Population health metrics, 2010. 8: p. 1-14.

17. Sehdev A. E. S.Hutchins G. M. Problems with proper completion and accuracy of the cause-of-death statement. Archives of internal medicine, 2001. 161(2): p. 277-284.

18. Schuppener L. M., Olson K.,Brooks E. G. Death certification: errors and interventions. Clinical medicine & research, 2020. 18(1): p. 21-26.

19. Azim A., Singh P., Bhatia P., Baronia A. K., Gurjar M., Poddar B., *et al*. Impact of an educational intervention on errors in death certification: An observational study from the intensive care unit of a tertiary care teaching hospital. J Anaesthesiol Clin Pharmacol, 2014. 30(1): p. 78-81.

20. Patil A., Chaudhari V. A., Raskar K.,Bavlecha A. Audit of medical certificate of cause of death at a tertiary care teaching hospital. Journal of Indian Academy of Forensic Medicine, 2019. 41(3): p. 197-200.

21. Keyvanara M., Zardoeigolanbar S., Karimi S.,Saghaeiannejad Isfahani S. The quality of death certificates record in the educational and non-educational hospitals in Kermanshah, Iran. Health Information Management, 2011. 8(1).

22. Alipour J.Payandeh A. Common errors in reporting cause-of-death statement on death certificates: A systematic review and meta-analysis. Journal of Forensic and Legal Medicine, 2021. 82: p. 102220.

23. Brindle P., Emberson J., Lampe F., Walker M., Whincup P., Fahey T., *et al*. Predictive accuracy of the Framingham coronary risk score in British men: prospective cohort study. Bmj, 2003. 327(7426): p. 1267.

24. Behrendt N., Heegaard S.,Fornitz G. G. [The hospital autopsy. An important factor in hospital quality assurance]. Ugeskr Laeger, 1999. 161(40): p. 5543-7.

25. Gupta N., Bharti B., Singhi S., Kumar P.,Thakur J. S. Errors in filling WHO death certificate in children: lessons from 1251 death certificates. J Trop Pediatr, 2014. 60(1): p. 74-8.

26. WHO. International statistical classification of diseases and related health problems. 10th revision, Fifth edition, 2016 ed. 2015, Geneva: World Health Organization.

27. Hazard R. H., Chowdhury H. R., Adair T., Ansar A., Quaiyum Rahman A. M., Alam S., *et al*. The quality of medical death certification of cause of death in hospitals in rural Bangladesh: impact of introducing the International Form of Medical Certificate of Cause of Death. BMC Health Serv Res, 2017. 17(1): p. 688.

28. Lu T. H., Shau W. Y., Shih T. P., Lee M. C., Chou M. C.,Lin C. K. Factors associated with errors in death certificate completion. A national study in Taiwan. J Clin Epidemiol, 2001. 54(3): p. 232-8.

29. McGivern L., Shulman L., Carney J. K., Shapiro S.,Bundock E. Death certification errors and the effect on mortality statistics. Public Health Reports, 2017. 132(6): p. 669-675.

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