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DEATH CODING ERRORS AND LINKAGE TO AUTOPSY IN TERTIARY HEALTHCARE INSTITUTION IN SERBIA

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Abstract: Although death certification belongs to obligatory physicians' duties, many report uncertainties about the proper completion process. Medical death certificates (MDC) are of relatively low quality and not valuable for creating medical policy.

This research aims to determine the MDC frequency and error types and identify factors associated with their inaccuracies. A secondary goal was to investigate how frequently findings of medical autopsies influence the underlying cause of death (UCD).

Our research included a sample of 318 patients who died during hospitalization at the University Clinical Center Niš. Errors are divided into two categories: MAJOR and MINOR errors.

Two hundred and sixty four (83%) of all death certificates recorded errors that were significantly more common among the elderly deceased and MDCs requesting an autopsy. Autopsy findings caused the number of cancer diagnoses (C00-D99) to increase while garbage codes decreased significantly. The observed disagreement of 3-digit ICD-10 coded underlying condition after an autopsy was 57 (62.6%), while 23.1% of UCD resulted in an ICD category change. Our results signify a high rate of errors during death certification. The low quality of death certificates can be found in a lack of formal training and reduced health workers' awareness about the importance of certification for health policies. A high percentage of ICD changes in disease categories indicate that autopsies remain an essential aid for mortality statistics.

Keywords: medical death certification, major errors, minor errors, autopsy, hospital settings.

INTRODUCTION

The medical death certificate (MDC) is a legal document with various and comprehensive applications. It also contains medical and epidemiological data essential for formulating vital statistics and proper public health resources planning. Regardless of whether death certificates are regarded as open or closed records, the death certifier should report the cause of death as wholly, objectively, and accurately as possible based on information available at the time. Although death certification belongs to the obligatory physicians' duties, many report uncertainties about the proper completion process. Derived data on the causes of death in many hospitals from an MDC are of relatively low quality, which is not valuable for creating medical policy [1-3]. There are many reasons for the poor quality of death certificates: insufficiently educated doctors, lack of training, inadequate equipment, and limited understanding of the importance of filling out MDC [4, 5]. The inaccuracy of death certificate information can occur due to errors at a number of steps during certification. Data derived from death statistics are prone to various sources of errors, but from an epidemiological perspective, it often provides priceless information on trends in a population's health status. The usefulness of data depends on many factors, including the completeness of records and the accuracy in assigning the underlying cause of death (UCD) especially in older people whose autopsy rates are often low [6].

The classification system for death coding is based on the latest Revision of the International

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Classification of Diseases and Related Health Problems (ICD-10) and guidelines established by the World Health Organization (WHO) [7]. However, despite the development of guidelines by the WHO and other organizations, errors in death certification are frequent and recorded worldwide [8, 9].

Although medical diagnostics has made significant progress in recent years, an autopsy represents a medical examination performed to determine the UCD as a quality assurance of the medical treatment provided to the patient. Unfortunately, a previous meta-analysis points out that approximately one-third of death certificates are not accurate, and half of the performed autopsies produced findings that were not suspected before death [10].

Our research aims to determine MDC frequency and error types and identify factors associated with death certification inaccuracies. A secondary goal was to investigate how frequently findings of medical autopsies influence the determination of UCD.

METHODS

This cross-sectional study evaluated all original MDC patients who died during May and June of 2019 at the University Clinical Center Niš during hospitalization. The death was ascertained by the attending physician, who filled out an MDC. All death manners (natural, violent, and death of unknown origin) were taken into account. In addition, according to WHO guidelines, certificates were examined for terminology sequence of events that led to death [11].

The MDC section template is based on references to the WHO and consists of two parts. Serbian version of MDC Part I contains three lines labeled (c), (b), and (a), respectively, used to record the UCD, intermediate, and immediate causes of death. Part II is used to record other significant medical conditions contributing to death. MDC has no part for time intervals between UCD, intermediate, and immediate causes of death. All MDCs issued by medical doctors were sent to the Office of Statistics, Public Health Institute, where two coders (MAA and AI) reviewed all MDCs, selected UCD, and evaluated MDCs using the criteria applied in previous studies [2, 3, 12, 13]. According to the criteria, errors are divided into two categories: MAJOR and MINOR errors. MAJOR errors were classified for the cases which have an impact on the accurate identification of the UCD. These errors included one of the following mutually exclusive criteria. Type I: Poorly defined and specified codes have no value for public health and not provide valuable information for decision-makers to help them create preventive health programs. The UCD is defined as a symptom or signs such as cardiac arrest, abdominal pain, cardiorespiratory insufficiency, cold or rhinitis, etc. The UCD leads to eventual death by such mechanisms. Type II: Improper sequencing represents an incorrect order of immediate, intermediate, and underlying causes of death. Type III: Diagnoses are listed in no logical order – immediate, intermediate, and UCD- which are not temporally and causally related (neoplasms and chronic obstructive pulmonary disease). Type IV: Lack of UCD: cases where the external cause of the violent death is not stated as a UCD (such as a traffic accident, accidental fall in the house, opiate self-poisoning, etc.).

MINOR errors are categorized as less likely to lead to misclassification of the UCD. MINOR errors were the following: Type I: Incomplete diagnoses have four characters written with only three characters (example: I63 instead of I63.1). Type II: Using abbreviations (HTA, DM, etc.) and illegible handwriting. In this case, there is a great chance that coders may misinterpret the abbreviation and code the death to the wrong code. Type III: The UCD is not written in the C line in Part I of MDC but in the line for immediate and intermediate death or in part II. Using garbage diagnoses (GD) or codes is another category of errors that were analyzed. Garbage diagnoses cannot be considered a UCD due to not adequately identifying actions for preventing and controlling diseases and health disorders [14-16]. In addition, GD results from physicians' poor diagnostic practice, with very limited value for conducting health policy. The GD selected for analysis were: septicemia (ICD-10, A40–A41), hypertensive diseases (I10), heart failure (I50), cerebrovascular diseases, unspecified (UNS) as hemorrhagic or ischemic (I62.1, I62.9, I64, I67.4, I67.8, I67.9, I68.8, I69.4, I69.8, I69.9), UNS pneumonia (J15.9, J17.0, J17.1, J17.2, J17.3, J17.8, J18.0, J18.1, J18.2, J18.7, J18.8, J18.9), other perinatal causes (P96.9), UNS congenital anomalies (Q10.0, Q10.1, Q10.2, Q10.3, Q36.0, Q36.1, Q36.9, Q89.9, Q99.9), ill-defined causes from Chapter XVIII-ICD 10 (R00-R99), UNS traffic accidents (V87.0, V87.1, V87.4, V87.5, V87.6, V87.7, V87.8, V87.9, V88.0, V88.1, V88.4, V88.5, V88.6, V88.7, V88.8, V88.9, V89.0, V89.1, V89.2, V89.3, V89.4, V89.9), external causes classified as events of undetermined intent (Y10–Y34).

To evaluate the accuracy of UCD in MDCs, we sourced autopsy reports of 91 death cases. After that, we compared those diagnoses with the diagnoses ascertained by physicians at the moment of death.

Autopsy diagnoses are listed the same way as diagnoses on the MDC, though diagnoses are based on the morphological changes caused by a disease or injury. Therefore, the autopsy aimed to highlight discrepancies in UCD that may have impacted mortality statistics.

Statistical analysis

Data were analyzed using R software [17], and the results were presented in tables with textual commentary. Descriptive statistics were calculated as absolute numbers with percentages, mean, and standard deviations for continuous values. Furthermore, the Student's t-test was used to compare the numerical and Chi-square test for categorical values. Finally, the statistical hypothesis was tested at the significance level for risk of $\alpha = 0.05$.

Table 1. The baseline characteristics of the diseased

		n	%
Gender	Male	160	50.3
	Female	158	49.7
Age categories	0-15 years	7	2.2
	16-30 years	5	1.6
	31-65 years	81	25.5
	>65 years	225	70.8
Manner of death	Natural	295	92.8
	Non contagious	288	90.5
	Contagious	7	2.3
	Violent	20	6.3
	Accident	13	4.1
	Suicide	3	0.9
	Other	4	1.3
	Unknown/ indeterminable	3	0.9
Autopsy	No	227	71.4
	Yes	91	28.6

RESULTS

The research included 318 MDC patients who died during May and June 2019 in the University Clinical Center Niš, Serbia. The sex distribution was 160 (50.3%) men and 158 (49.7%) women. The mean age of the entire population was 69.97 ± 16.98 years, with a median of 72. Most of the deceased were over 65 (70.8%).

Based on the manner of death, the most significant number of deaths was due to natural causes, 295 (92.8%), most of whom died of non-communicable diseases (90.5%), while 20 (6.3%) people died as a result of violent death. The cause of death was indeterminable in three (0.9%) deaths. From the group of violent deaths, the majority was the consequence of an accident – 13 (4.1%); three (0.9%) people committed suicide, while in four (1.3%) cases, the cause of death was from the group of other causes (Table 1).

After a detailed review of all MDCs, it was found that 264 (83%) of all death certificates had some errors. There were 145 (45.5%) errors in the MAJOR group. The most common error from this group was improper sequencing (44.9%), followed by diagnoses that were not arranged in a logical order (23.4%), incorrectly stated UCD (21.4%), and not specified UCD (10.3%). Errors from the MINOR group were registered in 119 (37.4%) death certificates. The most represented

Table 2. Type of errors found in the death certification form

Errors		n	(%)
Major errors	The incorrect underlying cause of death	31	21.4
	Improper sequencing	65	44.9
	Diagnoses listed in no logical order	34	23.4
	Without an underlying cause of death	15	10.3
	Σ	145	100.0
Minor errors	Incomplete diagnoses	47	39.5
	Use of abbreviations and illegible handwriting	28	23.5
	The underlying cause of death is not in the C line in Part I	20	16.8
	Garbage diagnoses	24	20.2
	Σ	119	100.0

Table 3. Distribution of errors according to the age, required autopsy, and manner of death

		Errors		p
		No (n=54)	*Yes (n=264)*	
Age	*Years*	64.68±22.58	71.75±14.25	0.010
Autopsy	*No*	46(20.3)	181(79.7)	
	Yes	8(8.7)	83(91.2)	0.013
Manner of death	Natural	78(26.4)	217(73.6)	
	Violent	2(10.0)	18(90.0)	
	Unknown/indeterminable	0(0.0)	3(100.0)	0.157

error from the MINOR group was an incomplete diagnosis code (39.5%). Other errors had the following distribution: abbreviations and illegible handwriting (23.5%), the use of garbage diagnosis (20.2%), and UCD not listed on line C (16.8%). In 62 (19.5%) death certificates, both types of errors were present (Table 2).

Errors were significantly more common among the elderly deceased (t = 3.270; p = 0.010). A statistically significant difference was found in the number of errors depending on the required autopsy ($\chi 2$ = 6.065; p = 0.013). Errors are more prevalent in MDCs requesting an autopsy. There is no significant difference in the distribution of errors depending on the manner of death (Table 3).

The underlying causes of death according to ICD-10 in the entire examined population and UCD based on autopsies are shown in Table 4. Most diagnoses of the UCD belong to the category ICD I00-I99, 132(41.5%). The next most common diagnoses are C00–D99, where every fifth diagnosis represents neoplasms (22.0%). Finally, every ninth diagnosis belongs to the garbage diagnosis category (9.1%).

Of all 318 MDCs, 91(28.6%) were issued upon autopsies, among which 44 (48.4%) were men and 47

Table 4. Underlying causes of death for all deaths and deaths examined by autopsy, according to International Statistical Classification of Diseases and Related Health Problems, 10th Revision

ICD Chapter	All deaths (n=318)	MDC going to autopsy (n=91) UCD (Death certificate)	UCD (Based on autopsy)
A00-B99: Certain infectious and parasitic diseases	8 (2.5)	1 (1.1)	2 (2.2)
C00-D99: Neoplasm	70 (22.0)	3 (3.3)	11 (12.1)
E00-E90: Endocrine, nutritional and metabolic diseases	8 (2.5)	1 (1.1)	/
F00-F99: Mental and behavioral disorders	5 (1.6)	1 (1.1)	/
G00-G99: Diseases of the nervous system	8 (2.5)	1 (2.2)	/
I00-I99: Diseases of the circulatory system	132 (41.5)	44 (48.4)	48 (52.7)
J00-J99: Diseases of the respiratory system	16 (5.0)	5 (5.5)	3 (3.3)
K00-K93: Diseases of the digestive system	22 (6.9)	10 (11.0)	10 (11.0)
L00-L99: Diseases of the skin and subcutaneous tissue	1 (0.3)	/	/
M00-M99: Diseases of the musculoskeletal system and connective tissue	2 (0.6)	/	/
N00-N99: Diseases of the genitourinary system	17 (5.3)	5 (5.5)	3 (3.3)
P00-P96: Certain conditions originating in the prenatal period	4 (1.3)	2 (2.2)	2 (2.2)
Q00-Q99: Congenital malformations, deformations and chromosomal abnormalities	2 (0.6)	/	/
R00-R99: Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified	7 (2.2)	5 (5.5)	1 (1.1)
S-Y: External causes, total	16 (5.0)	13 (14.3)	11 (12.1)
Garbage diagnoses*	29 (9.1)	19 (20.9)	6 (6.6)
Σ	318 (100.0)	91 (100.0)	91 (100.0)

* Within all ICD categories.

Table 5. Change in three-digit ICD-10 code in the UCD after autopsy according to the ICD10th Revision (n=91)

ICD Chapter	No (%) with 3-digit change	No (%) with no change
A00-B99: Certain infectious and parasitic diseases	1 (1.1)	
C00-D99: Neoplasm	2 (2.2)	1(1.1)
E00-E90: Endocrine, nutritional and metabolic diseases	1 (1.1)	
F00-F99: Mental and behavioral disorders	1 (1.1)	
G00-G99: Diseases of the nervous system	1 (1.1)	
I00-I99: Diseases of the circulatory system	26 (28.6)	18 (19.8)
J00-J99: Diseases of the respiratory system	5 (5.5)	
K00-K93: Diseases of the digestive system	7 (7.7)	3 (3.3)
N00-N99: Diseases of the genitourinary system	4 (4.4)	1 (1.1)
P00-P96: Certain conditions originating in the prenatal period	2 (2.2)	
R00-R99: Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified	4 (4.4)	1 (1.1)
S-Y: External causes, total	3(3.3)	10 (11.0)
Σ	57 (62.6)	34 (37.4)

(51.6%) women, with an average age of 69.05 ± 18.72 years. The most common are diagnoses from circulatory system diseases 44 (48.4%) and external causes 13 (14.3%). The autopsy findings led to a significant increase in cancer diagnoses (C00–D99) (3.3% on MDC *vs.* 12.1% on autopsy: $\chi 2 = 6.710$; $p = 0.009$). The number of deaths caused by diseases of the circulatory system increased by 3.2%, while the number of UCD caused by diseases of the respiratory and genitourinary systems decreased by 2.2% but without statistical significance. Deaths from the ICD groups E00–E90, F00–F99, and G00–G99 were no longer recorded after the autopsy findings. The garbage codes decreased significantly after an autopsy (20.9% on MDC vs 6.6% on autopsy; $\chi 2 = 7.836$; $p = 0.005$).

The cause of death was agreed on if UCD in the MDC and autopsy were assigned the same three-digit code in ICD-10. The observed disagreement of 3-digit ICD-10 coded UCD in the hospital settings and after an autopsy was 57 (62.6%) (Table 5).

Of the 91 UCDs, 27 (23.1%) resulted in an ICD category change after autopsy. The UCD before autopsy contained 19 (20.9%) cases with garbage codes. Most of the garbage diagnoses (57%) were recoded into circulatory system diseases, while one case of unknown cause of death (R961) remained the same.

DISCUSSION

Mortality data are widely used for public health research, planning, and health care monitoring. They are comprehensive, continuously collected, and cover long periods in a wide range of countries. However, many studies have pointed out quality problems associated with mortality data, especially inaccuracies in death certification [18, 19]. The process of death certification is a complex and challenging task and requires proper education.

To our knowledge, this is the first study dealing with errors in determining the cause of death in Serbia. Serbian data quality was rated as medium-low quality during the assessments due to a high proportion of ill-defined death causes (15–20%) by WHO (20). Our results signify that almost half of the MDC had MAJOR errors, the same or higher percentage of errors than other countries reported in the literature [3, 12, 21]. Improper sequencing was the most common recorded error in every fifth (20.4%) death certificate in this group. This percentage is relatively high compared to other studies [4, 22, 23]. We have noticed that physicians often do not consider the sequence of events that lead to a fatal outcome and the time interval between causing events. Physicians perpetually copy admission diagnoses and comorbidities on MDC, not considering causal relationships. The time interval between events that lead to death does not exist in the Serbian version of the MDC. This imperfection remains an essential drawback; hence, we suggest changing its form. In 10% of these errors, the UCD is not even listed, which is unacceptable for a single health facility. As the most common error from the MINOR group, preliminary diagnoses are evidenced in almost 40% and 15% of all MDC. The interpretation of doctors' manuscripts and their frequent use of abbreviations also caused significant coding problems, similar to the study from India [22]. We recommend that MDC be written with clear handwriting so coders can assign the appropriate code and escape misinterpretations.

Further, implementing an electronic coding system would reduce the possibility of making these errors. Garbage codes have been recorded in 9.1% of all certificates, less than in the Brazilian study [15]. However, compared to the Brazilian study, the lower proportion of ill-defined diagnoses is due to our sample being used only from MDC in the university hospital. However, we must emphasize that physicians commonly use diagnoses such as A409, A419, I10, I469, I509, and J180, which belong to GD. These findings indicate that physicians are unfamiliar with the term GD, which further requires education. Our findings also show that the frequency of errors was more prevalent in the elderly. We assume this is due to more comorbidities in the elderly, incomplete diagnostic procedures, and physicians' uncertainty when determining death and further requesting an autopsy.

A wealth of literature emphasizes the usefulness of autopsies in providing worthy clinical data and accurate mortality statistics [24-28]. Regardless of the modern clinical diagnostic methods, autopsies remain crucial in detecting post-mortem errors in approximately 30% of cases of UCD [24]. We have found a noticeable increase in the neoplasm's UCD. We believe that neglecting the primary diagnosis of carcinoma and giving preference to some garbage diagnoses and mechanisms of death led to this result. As in a Norwegian study [26], the increase of UCD from circulatory system diseases was observed without statistical significance after an autopsy. Our results showed that autopsy caused a change in UCD, the three-digit ICD-10 code in 62% of cases, while the shift within the ICD chapter was recorded in 29.7% of the cases, similarly as in previous studies [26, 29-31].

Also, our findings are in agreement with the results of previous studies conducted in Serbia [31, 32].

The limitations of our study should be mentioned. First, this study referred to one university hospital designed as a pilot study. Second, our study included a relatively small number of MDCs. Also, we did not consider the length of hospitalization, which can influence the assessment of UCD and autopsy requests.

In conclusion, our results signify a high rate of errors during the death certification. The low quality of filling out MDC can be found in a lack of formal training and a reduction in health workers' awareness about death certification for health policies. Modifying the currently valid MDC by adding a time interval between events would improve the quality of death certification. A high percentage of ICD changes in disease categories indicate autopsies remain an essential aid for mortality statistics. Introducing mandatory training may improve the quality and reliability of death certification in Serbia, especially in hospital settings. The health facilities should also introduce strategies, including incentives for physicians and administrative staff to adhere to the rules of filling out MDC. Implementing an electronic coding system would reduce the possibility of making errors. Our further goals would be to expand the research to multicenter institutions to obtain as relevant data as possible for national purposes.

Conflict of interest

The authors declare that they have no conflict of interest.

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Ethical Approval

The study was approved by the Ethics Committee of Public Health Institute, Niš, under the number 07-670/1 from March 12, 2021.

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