Original scientific article

Trend analysis of "garbage codes" as the underlying cause of cancer death: Joinpoint Analysis

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ABSTRACT

Introduction: The quality of cause-of-death data is commonly assessed by determining the percentage of unspecified, ill-defined or "garbage" causes of death. The objective of the paper was to determine percentage of the "garbage codes" (GCs) coded as the underlying cause of cancer death. **Material and methods:** The data base of all deceased from the Nišava District was retrospective analyzed. The observed period was 2000-2016. Joinpoint regression analyses was performed. **Results:** The total number of deceased was 19598 (11247 men and 8351 women) and the total percentage of GCs was 6.2%. The significantly decreasing trend of GCs by 5.6% yearly ($p<0.05$) between 2000 and 2006 and by 2.9% per year ($p<0.05$) between the 2006 and 2016. In men, the statistically significantly decreasing trend of GCs by 6.1% per year ($p<0.001$) from 2000 up to 2013 was determine. In women, significant decreasing trend by 7.5% yearly ($p<0.005$) was registered from 2008 to 2016. There were statistically significant decreasing trends of GCs both in deceased under 65 ($p<0.001$) and above 65 years of age ($p<0.05$). The significant decreasing trend of GCs by 6.2% yearly ($p<0.01$) for deceased in HSIs, was observed from 2000 to 2009. From 2004 to 2016 there was the significant decreasing trend of GCs by 4.6% yearly ($p<0.01$) among deceased out of HSIs. **Conclusion:** The significantlly decreasing trend of GCs was recorded from 2000 to 2016 and the change in trend was in 2006. Continuous education of the staff and control of data quality of medical death certificates are needed.

Key words: cancer, mortality, garbage codes, trend analysis

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INTRODUCTION

The routine cancer mortality statistics provide data which are widely used for identifying public health problems and developing health care strategies [1, 2]. Because of the varied uses of these data, it is important that mortality data be reliable and accurate [3].

The quality of cause-of-death data is commonly assessed by determining the percentage of unspecified or ill-defined [4] or "garbage" causes of death [5]. Murray and Lopez introduced the term "garbage coding" for the practice of assigning deaths to causes that are useless for public health analysis [6].

This term "garbage codes" refers to all ill-defined or incomplete diagnoses consisted of codes from the 10th International Classification of Disease (ICD-10) for underlying causes of death. "Garbage codes" don't indicate the specific cause of death and they don't have any value for public health because they can't be the underlying cause of death [7, 8] and the appearance of "garbage codes" limits the public health utility of cause of death data [9].

This term "garbage codes" refers to all ill-defined or incomplete diagnoses consisted of codes from the 10th International Classification of Disease (ICD-10) for underlying causes of death.

According to the ICD-10 the underlying cause of death is: "(a) the disease or injury which initiated the train of morbid events leading directly to death, or (b) the circumstances of the accident or violence which produced the fatal injury" [10]. Despite this clear ICD definition of underlying cause of death it is very often difficult to apply it in everyday practice [12, 13].

Mathers et al. (2005) classified Serbia and Montenegro in the group of countries with medium mortality quality data and that means that "the completeness of data was 70-90% or ill-defined codes appear on 10-20% registrations or completeness >90% and ill-defined codes appear on <10% of all registrations" [14].

The system for vital registration and medical certification of deaths in Serbia is characterized by almost 100% coverage of civil registration of the underlying causes of death. Serbia implemented the International Classification of Disease-the tenth revision in 1997, and since then, all medical death certificates issued in the country must be filled in with the original three digit codes – ICD-10 codes.

This system of producing mortality data in Serbia has been decentralized 2006. The reporting of cancer in the Republic of Serbia is obligatory by the law [15]. Data about incidence and mortality of the cancer are collected by hospital-based and population-based cancer registries. The following data are entered into the population cancer register of Central Serbia: descriptive characteristics of new cases or of deceased, possible appearance of multiple primary tumors, date of determination of current illness, diagnostic methods, tumor characteristics (primary and secondary anatomy localization, histology type, stage), outcome of the disease, as well as data on the health institution reporting the cancer [16].

Mortality data collection in Serbia is based on filling in the medical death certifications by physicians-certifiers [17] and the law allows only a physician to fill in the medical death certifications [18] using the codes of ICD-10.

The objective of the paper was to assess the quality of cancer mortality data by determining and analyzing the percentage of "garbage codes" on the medical death certificates coded as the underlying cause of death in the Nišava District, Serbia.

MATERIAL AND METODS

Descriptive study was done. The observed period was 2000 to 2016. The percentage of diagnoses C76 and C80 on the MDCs was analyzed as Naghavi et al. [9] and Mathers and al. suggested [14].

The diagnosis C97 is imprecise too, but it was not taken for the analysis, because since 2013 it cannot be taken as the underlying death cause according to the Instructions to the Physicians-Certifiers in Serbia [17].

Data base of the medical death certifications of the Institute for Public Health in Niš and data base of the Statistical Office of the Republic of Serbia were used in this study. These data bases consisted of deceased from cancer who were residents of the Nišava District. The observed period was from 2000 to 2016. The deceased were retrospective analyzed according to their gender, age and the place of death.

Deceased according to age were divided into two groups: under 65 years of age and above 65 years of age. The notified place of death was divided into: a) the deceased in the hospital stationary institution and b) the deceased out of the hospital stationary institution.

The underlying causes of death from the medical death certificates were accepted as accurate because as such they are published by the official state statistics according to the deceased's place of living and in Serbia doesn't exist the ''gold standard''.

Characteristics of the Nišava District population

According to the vital statistics the population of the Nišava District is very old [19] and it is getting older. According to the data from 2015, there were in average 20.5% persons older than 65 years of age.

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The rate of general mortality in the territory of Nišava District ranged 14.3/100 000 inhabitans in 2013 to 15.0 in 2014 and 2015. An increasing trend of general mortality was recorded. Depopulation tendencies of the population with negative growth and negative natural increase were recorded. It is well-known that aging is risk factor for cancer.

Statistical analysis

Trend of the percentage of the "garbage codes" with corresponding 95% confidence intervals (CI) were calculated by performing Joinpoint regression analyses [20]. For regression analyses, Joinpoint Regression software, version 4.2.0.2. was used (available through the Surveillance Research Program of the US National Cancer Institute Statistical Methodology and Application Branch). The trend was considered to be significant increasing (positive change) or decreasing (negative change) when (negative change) when the p-value was below 0.05 ($p < 0.05$).

In Joinpoint analysis, the best fitting points, called 'joinpoints', are chosen where the rate changes significantly. The analysis starts with the minimum number of joinpoints (e.g. zero joinpoints, which is straight line), and tests whether one or more joinpoints (up to three) are significant and must be added to the model. Each significant joinpoint that indicates a change in the slope (if any) is retained in the final model. To describe linear trends by period, the estimated annual percent change (APC) is then computed for each of those trends by fitting [21].

Joinpoint regression model analyses rates, proportions, or any other measure that can be considered (e.g., counts) over time in order to (i) identify the possible time point(s) at which any given trend changes, that is the joinpoint(s), and to (ii) estimate the regression function with joinpoint(s) previously identified. Specific interests were to whether two regression mean functions were parallel (test of parallelism) [22].

Results

In the 17th years observed period the total number of deceased in the Nišava District was 19598 (11247 men and 8351 women). The total number of "garbage codes" was 1217 (6.2%). The percentage of "garbage codes" ranged from 8.5% (2000) to 4.0% (2006).

In men perecentage of "garbage codes" ranged from 8.6% (2004) to 2.5% (2006), and in women ranged from 10.7% (2009) to 4.7 (2016).

The Joinpoint analysis showed statistically significant decreasing trend of "garbage codes" by 5.6% yearly (95% Confidence intervals [CI] =-9.7% to -1.3%; t=-2.632; p=0.0138; p<0.05) in the period 2000-2006 (Table 1, Figure 1).

In the period after the 2006 up to 2016 Joinpoint analysis determined statistically significant decreasing of "garbage codes" by 2.9% yearly (95% CI= -5.2% to -1.7%; t=-2.630; p=0.0139; p<0.05), (Table 1, Figure 1). According to the test of parallelism trends were similar both for men and for women. The Joinpoint analysis showed the change in trend in 2006. The total percentage of the "garbage codes"was the lowest in 2006 (Table 1).

Joinpoint analysis identified gender specific trends of "garbage codes". Men and women significantly differed for the trend in persistence. When parallelism was tested, considering the period from 2000 to 2016 trends were similar (in parallel) (p>0.05) to men and women with a change in 2006.

In men, the Joinpoint analysis showed a statistically significantly decreasing trend of "garbage codesby 6.1% per year (95% CI=-7.3% to -4.8%; t=-10.13; p=0.000; p<0.001) from 2000 up to 2013. The increase of "garbage codes" during 2013-2016 was not statistically significant (p>0.05).

In women, based on the Joinpoint analysis, trend of "garbage codes" decreased from 2000 up to 2008 but not statistically significant (p>0.05). The Joinpoint analysis showed a change in trend for women in 2008. Trend of "garbage codes"statistically significant decreasing by 7.5% yearly (95% CI= -11.9% to -2.9%; t=-3,47; p=0.0046; p<0.005) in the period 2008-2016.

Table 1. The percentage of garbage codes (ICD-10, C76-C80) coded as the underlying cause of death (ICD-10, C00-D48), by gender, in the Nišava District from 2000 to 2016

Year	Total n*/N†	GCs %	Males n*/N†	GCs %	Females n*/N†	GCs %
2000	85/1004	8.5	38/563	6.7	47/441	10.7
2001	83/999	8.3	47/579	8.1	36/420	8.6
2002	82/992	8.3	45/570	7.9	37/422	8.8
2003	80/951	8.4	35/526	6.7	45/425	10.6
2004	80/979	8.2	48/556	8.6	32/423	7.6
2005	80/1083	7.4	40/616	6.5	40/467	8.6
2006	41/1031	4.0	15/593	2.5	26/438	5.9
2007	59/1176	5.0	30/689	4.4	29/487	6.0
2008	80/1156	6.9	37/665	5.6	43/491	8.8
2009	79/1255	6.3	36/709	5.1	43/546	7.9
2010	78/1238	6.3	38/698	5.4	40/540	7.4
2011	74/1254	5.9	43/751	5.7	31/503	6.2
2012	66/1372	4.8	37/794	4.7	29/578	5.0
2013	54/1218	4.4	26/692	3.8	28/526	5.3
2014	70/1325	5.3	32/750	4.3	38/575	6.6
2015	64/1268	5.0	35/733	4.8	29/535	5.4
2016	62/1297	4.8	37/763	4.8	25/534	4.7

*n= the number deceased with 'garbage codes', †N= the number of persons who died from cancer (C00-D48, ICD-10)

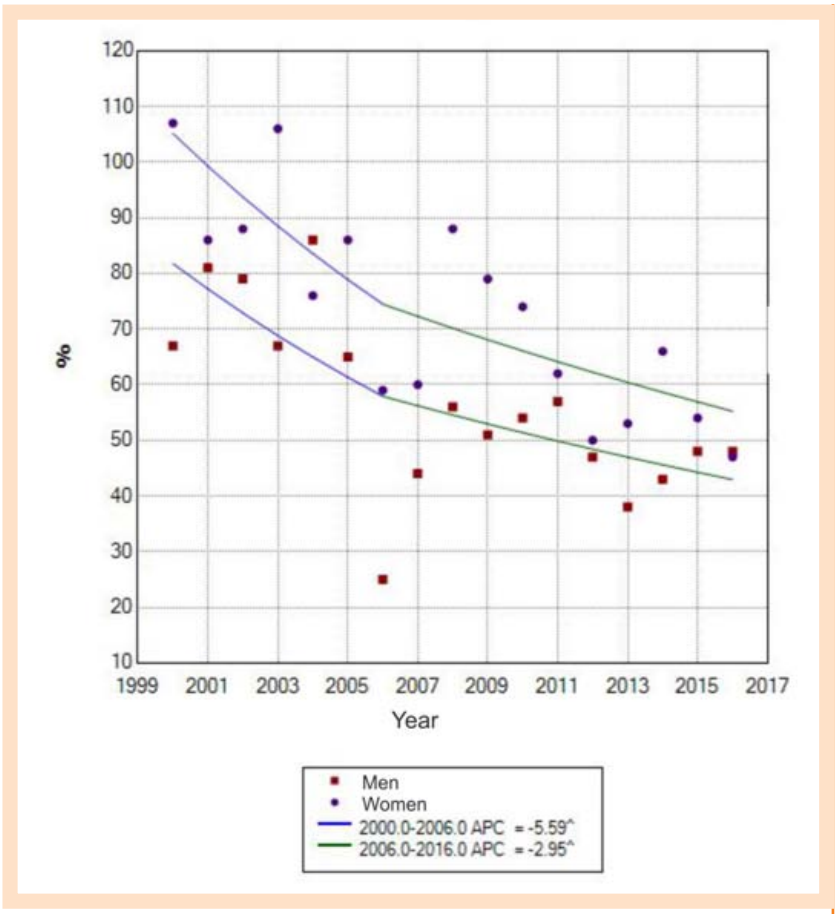


Figure 1.
The trend of garbage codes coded as the underlying cause of death in the cancer mortality data, by gender from 2000 to 2016 in the Nišava District

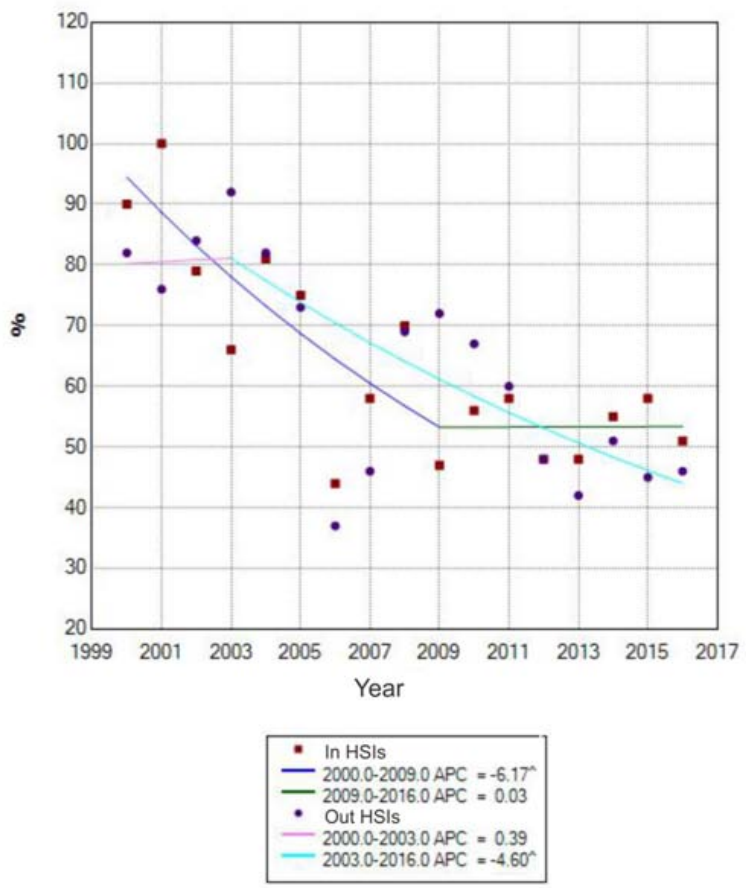
Table 2. The percentage of cancers coded as the underlying cause of death with (C00-D48, ICD-10) in the hospital stationary institutions and among deceased out of the hospital stationary institutions, by age, in the period 2000-2016 in the Nišava District

Year	HSIs‡	GCs	Out of HSIs‡	GCs	<65	GCs	65+	GCs
	n*/N†	%	n*/N†	%	n*/N†	%	n*/N†	%
2000	29/324	9.0	56/680	8.2	39/417	9.4	46/587	7.8
2001	30/301	10.0	53/698	7.6	29/385	7.5	54/614	8.8
2002	22/277	7.9	60/715	8.4	32/406	7.9	50/586	8.5
2003	19/288	6.6	61/663	9.2	33/369	8.9	47/502	9.4
2004	28/346	8.1	52/633	8.2	36/384	9.4	44/595	7.4
2005	29/389	7.5	51/694	7.3	26/450	5.8	54/633	8.5
2006	16/363	4.4	25/668	3.7	15/411	3.6	26/620	4.2
2007	24/417	5.8	35/759	4.6	24/468	5.1	35/708	4.9
2008	25/358	7.0	55/798	6.9	24/468	5.1	56/688	8.1
2009	21/448	4.7	58/807	7.2	23/476	4.8	56/779	7.2
2010	24/432	5.6	54/806	6.7	33/480	6.9	45/758	5.9
2011	27/465	5.8	47/789	6.0	25/488	5.1	49/766	6.4
2012	25/519	4.8	41/853	4.8	30/579	5.2	36/793	4.5
2013	22/455	4.8	32/763	4.2	20/450	4.4	34/768	4.4
2014	30/542	5.5	40/783	5.1	30/510	5.9	40/815	4.9
2015	30/514	5.8	34/754	4.5	20/444	4.5	44/824	5.3
2016	27/534	5.1	35/763	4.6	21/433	4.8	41/864	4.7

*n = the number deceased with 'garbage codes', †N= the number of persons who died from cancer (C00-D48, ICD-10)

‡HSIs = hospital stationary institutions (state and private hospital institutions)

Figure 2.
Trend of GCs in deceased in the hospital stationary institutions and among deceased out of the hospital stationary institutions in the period 2000-2016 in the Nišava District



The total number of deceased in HSIs was 6982 and the total number of "garbage codes" was 428 (6.1%). The percentage of "garbage codes" ranged from 10.0% (2001) to 4.4% (2006). Every tenth diagnosis of cancer as the underlying cause of death in HSIs was coded by "garbage codes" (Table 2).

Mortality trends determined by the Joinpoint analysis differs for deceased in HSIs and those who died out of the HSIs. Based on the Joinpoint analysis there was statistically significant decreasing trend of "garbage codes"by 6.2% yearly (95% CI=-9.8% to -2.4%; t=3.683; p=0.003; p<0.01) for deceased in HSIs, from 2000 to 2009. After the 2009 trend of percentage of "garbage codes" has been stagnated (p>0.05). Parallelism is excluded (p = 0.0129; p <0.05). The trends do not behave similarly (parallel) to the place of death.

According to the Joinpoint analysis among deceased out of the HSIs there were two time periods. The first was from 2000 to 2003. The percentage of "garbage codes" varied and it was not statistically significant (p>0.05). The Joinpoint analysis showed the change in trend in 2003. From 2004 to 2016 there was a statistically significant reduction in percentage of "garbage codes" in the cancer mortality by 4.6% yearly (95 % CI= -7.7% to -1.4%; t=-3.139; p=0.008; p<0.01).

In deceased under the 65 years of age Joinpoint analysis determined the statistically significant decreasing percentage of "garbage codes" was from 2000 to 2006 by 5.6% yearly (95%CI=-10.0% to -0.8%; t=-2.4; p=0.023; p<0.05). There was significant decreasing trend of "garbage codes" from the 2006 up to 2016 by 3.6% yearly (95% CI= -5.0% to -2.1%; t=-5.1; p<0.001).

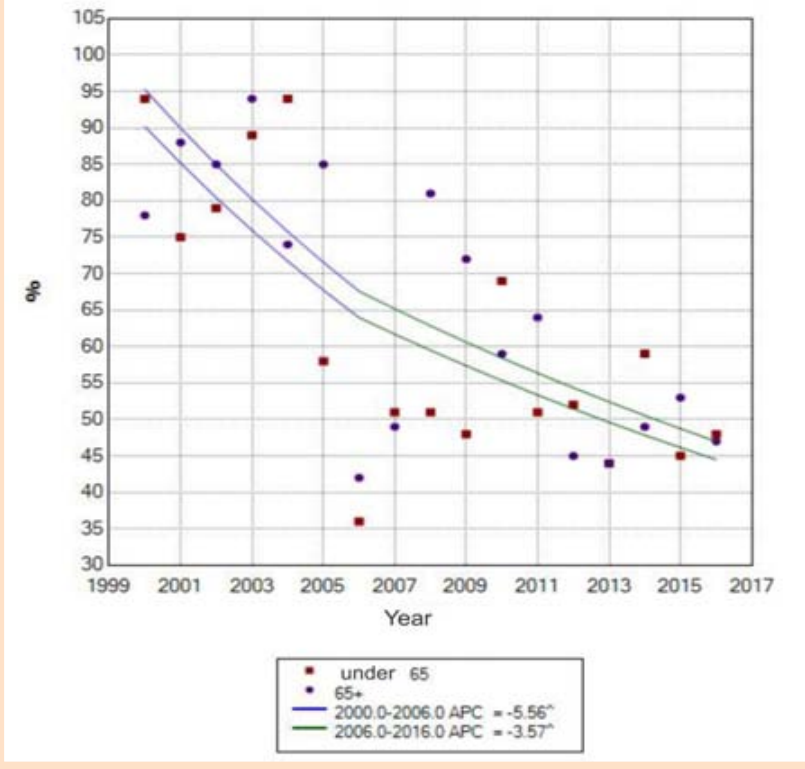


Figure 3.
Trend of percentage of garbage codes coded as underlying cause of death in deceased under 65 years of age and in deceased over the 65 years of age in the period 2000-2016 in the Nišava District

The Joinpoint analysis showed statistically significant decreasing percentage of "garbage codes" in cancer mortality data from 2000 to 2006.

Parallelism can't be excluded (p>0.05). In other words, trends behave similarly (in parallel) for deceased under than 65 and the older than 65. The year of a change was 2006.

According to the Joinpoint analysis there were statistically significant decreasing frequency of "garbage codes" in deceased under 65 years of age (t=2.0; p=0.019; p<0.05) from 2000 to 2006. After the 2006 up to 2016 there was statistically significant decreasing trend (t=5.369; p=0.0000; p<0.001).

In deceased older than 65 years of age the Joinpoint analysis didn't determine the year when change in trend has been occurred. There was a statistically significant decreasing trend of "garbage codes" in deceased over 65 years of age by 3.7% per year (95%CI=-4.0% to -3.4%; t=-26.34; p=0.000; p<0.001).

DISCUSSION

It is important to register every death that occurred but it is also important to determine the exact cause of death. In all European countries death certification is mandatory as it is in the Republic of Serbia. The diagnosis on the medical death certificate doesn't always reflects the real underlying cause of death [23].

Cancer can be misattributed as the underlying cause of death on medical death certificates [1]. In some countries, up to 50% of cancer deaths are coded to C80, the non-specific category with no indication given of the primary site [2]. It is well known that the cause of death can't be always determined. Autopsy is often considered as the "gold standard", but autopsies are infrequently undertaken [11].

Our study described trends of "garbage codes" coded as underlying cause of death on the medical death certifications for the population of the Nišava District in the 17-years. The Joinpoint analysis showed statistically significant decreasing percentage of "garbage codes" in cancer mortality data from 2000 to 2006. According to the Joinpoint analysis the change of trend occurred in 2006 when the total percentage of the "garbage codes" was the lowest. The significant decreasing trend of "garbage codes" in cancer mortality statistics has been recorded in the whole observed period.

Since 2006, the cooperation has been started between the physician of the Centre for biostatistics and informatics of the Institute for Public Health Niš and epidemiologists from the same Institute that take care of the population cancer register. There were less percentage of "garbage codes" and the quality of cancer mortality data has been higher.

Mortality trends determined by the Joinpoint analysis differs for deceased in HSIs and those who died out of the HSIs. Based on Joinpoint analysis the percentage of "garbage codes" decreased in the whole mortality data had a very high proportion of "garbage codes" [12, 20, 27, 28]. It is the same in the hospitals in the Nišava District despite that the physicians have to certify the underlying cause of death when a

death occurs in a hospital by the law [15]. Generally in every day practice the nurse not the physician or even community health worker certifies the cause of death. That is one of the reasons of poor death certification practice in the stationary health institutions in the Nišava Dstrict.

Decreasing trend of "garbage codes" was observed in deceased out of HSIs in 13 years of all 17-observed years. There was not statistically significant difference in the distribution of "garbage codes" on the medical certifications of cancer death between physicians of secondary and tertiary HSIs and coroners who set the diagnosis of death out of HISs.

According to the literature in many developing countries more than half of all deaths occur outside of hospitals and 'gold standard' for the underlying cause of death doesn't exist [26, 27]. The most deaths that occur outside of the HISs are assigned to ill-defined causes [2, 5, 28] and the percentage of "garbage codes" are higher on the medical death certifications filled in by coroner.

A higher proportion of "garbage codes" in the older age groups has noticed by other authors [12, 27, 28]. As for the age group of 60 years and over also found a higher proportion of "garbage codes" deaths at higher ages [24, 29]. These results may be due to the greater occurrence of comorbidities in the elderly, which make it difficult to establish the correct underlying cause that led to death [29, 30].

In years of the law changing, introduction of the new recommendations for coding and the change of the personnel, there were more cases of "garbage codes" as the underlying cause of death. An exceptionally beneficial effect on the quality of data was achieved by the cooperation with epidemiologists that were in charge of the population cancer register, as well as frequent educations of clinical doctors and medical personnel.

CONCLUSION

The significantly decreasing trend of "garbage codes" coded as underlying cause of cancer death was recorded from 2000 to 2016. Decreasing trend of "garbage codes" was observed in both deceased men and women, and in both deceased under the 65 years of age and in deceased above 65 years of age. The percentage of "garbage codes" decreased in the whole observed period in deceased in the stationary hospital institutions. Continuous education of the staff and control of data quality of medical death certificates are needed.

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CONFLICTS OF INTEREST: The authors declare that no conflicts of interest exist.

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ETHICAL APPROVAL: Ethical approval was not required.

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