Improving the quality of external cause of death data in Brazil: evaluation and validation of a new form to investigate garbage codes

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Research

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Abstract

Background: Accurate cause of death (COD) data are essential for policy and planning. Garbage codes (GCs), such as external causes with no further specific information, are commonly used as an indicator of poor quality of COD information. The investigation of GC using an effective instrument is necessary to convert them into useful data for public health. **Aim:** This study was conducted to analyze the effectiveness of the new investigation of deaths from external causes (IDEC) form, proposed by Ministry of Health, Brazil, to improve the quality of COD. **Methods:** The study compared the performance of the IDEC form on 164 external GC deaths with a stratified matched sample of 2,283 external GC deaths that used the existing standard GC form. The percentage of GCs that were reclassified into valid causes was calculated. Analyses according to subgroup (age, type of external cause) and exploration of the reclassifications of deaths between different cause groups were conducted. Qualitative data on the feasibility of the form were recorded by form users. **Results:** Investigation using the new form reduced all external GCs by 93% (95% confidence interval [CI] -97%, -88%), while the existing form decreased GCs by 66% (95% CI -68%, -64%). The IDEC form was most effective for external-cause GCs not of undetermined intent. Deaths that remained GCs were mainly due to a lack of detailed information on the circumstances of death, primarily poisoning and unspecified vehicle accidents occurring in a residence or on a road without witnesses. The IDEC form was found to be satisfactorily feasible in general, with specific suggestions for further improvement determined. **Conclusions:** The new form was more effective than the current standard form in reducing GCs and improving the quality of external causes. Feedback from the fieldwork highlighted opportunities for further improvement of external cause data.

Introduction

Reliable information on causes of death (COD) can provide useful epidemiological evidence to support decision-making and inform public policies.(1) In Brazil, such data can help address the current wide disparities in mortality between states and socio-demographic groups. A major public health concern in Brazil are external causes (injuries), which comprise a higher percentage of deaths (12%) compared with other countries.(2)

The main source of cause of death (COD) data in Brazil is the Mortality Information System (SIM), established in 1975. Brazil recorded more than 1.31 million deaths in 2017, accounting for over 96% of all deaths; of these deaths, 36.5% were garbage codes (GCs).(3–5) GCs are a classic indicator of the quality of health information systems,(6–8) and have been used as an indicator of the level of comprehensiveness and specificity of information on death certificates.(9) It is not uncommon for records to not specify a valid COD, requiring in-field collection of supplementary information.(10) Where such supplementary information is difficult to obtain or does not exist, algorithms exist to redistribute garbage codes to other specific COD.(11) Brazil has important differences in quality of COD data between regions, observing less favorable situations in the poorest regions, such as North and Northeast.(12) However, improvement over the years has reduced these differences.(13–15)

In 2017, injuries were the cause of 158,658 deaths in Brazil. Over one-quarter of the original cause for these deaths was a GC.(16) In recent decades, Brazil has been applying efforts to improve the quality of data in SIM, including investigation of GCs.(17–21) As a result of investigation by municipal health departments, GCs from injury deaths has now been halved to 13%.(16) It is important to note that 81% of injury GCs were issued by forensic institutes, indicating inadequacies in many of these services in writing a death certificate that can be understood by coders and therefore correctly coded; this was found to be particularly true in small and medium-sized municipalities.(4, 10, 22)

In 2017, Brazil, with support from the Data for Health Initiative, implemented actions to improve the diagnosis of COD in cooperation with death surveillance teams in 60 municipalities.(5, 21) One of the actions developed was to investigate external GCs from different sources of information including forensic institutes and hospitals using a standard investigation form (investigation of deaths from external causes [IDEC] form).(16) Previously, external-cause GCs have been investigated with the same form as all GCs. The use of a specific form could improve the quality of external COD data in Brazil. The purpose of this study was to analyze the performance and suitability of the IDEC form to improve the quality of external COD data in Brazil.

Methods

An observational analytical study of investigations of garbage coded deaths due to injuries was performed using the newly developed IDEC form. In Brazil, there has been a long-standing process to investigate GCs using a standardized procedure and form. The investigations of deaths by injury comprise collecting information about the circumstances of the event at forensic institutes and hospitals; in addition to collecting information from other sources, such as police stations, toxicology units and the public emergency transport service. These investigations are conducted according to the exact type of accident or violence that produced (motivated) the injuries leading to death.

The standard form, used by the mortality surveillance program to investigate causes of death GCs in hospitals,(23) was proposed and tested in 2017 to collect information from medical records in hospitals in order to assign the underlying-cause of death (Additional Material 3, Figure A.1).(21) However, this form does not have enough questions about the circumstances of injury deaths to accurately assign the underlying cause of death (UCD), also, does not include questions that would allow the determine the aggression's intention and the means used (e.g. firearm homicide or self-inflicted).

The IDEC form, developed by the mortality surveillance team at the Ministry of Health, with the support of the Graduate-Program in Public Health of the University of Brasília and Federal University of Minas Gerais, was devised to be prospectively used across the country for external-cause GCs investigations. (Additional Material 3, Figure A.2). This form differs from the previous one because it is introduced questions and variables that allow the collection of detailed data about the circumstance of death from external cause (Additional Material 3, Figures A.1 and A.2).

The IDEC form was tested in six Brazilian state capitals - Fortaleza, Recife, Goiânia, Rio de Janeiro, Belo Horizonte and Florianópolis - selected among the 60 cities of the Data for Health Initiative covering different regions of the country. The GCs for injuries were defined according to study GBD-2015.(8, 11, 24) The detailed list of type of GC is presented in the Annex (Additional Material 1).

The six state capitals reported 17,514 deaths from external causes, with 44% classified as GC. As part of the GC investigation, 85% were investigated: 6,382 using the current standard procedure and 212 with the IDEC form. Sixty of the 212 deaths were discarded for not reporting an underlying cause, while another 12 deaths from natural causes were also investigated using the new IDEC form, making a total of 164 deaths. A matched random sample of deaths that used the standard procedure made up a third group of 2,283 cases (Fig. 1); the derivation of this sample is described later in the paper.

Field testing of the new form was carried out in the second half of 2018 with death records from external causes notified with GCs in the SIM in 2017 and 2018. The cities had teams within the municipal health departments to investigate deaths, comprised of health service professionals with experience in mortality surveillance. Using the IDEC form, each team retrieved data in notifying units, such as forensic institutes and hospitals and were usually coordinated by physicians or nurses with experience in improving the diagnosis of COD in the Data for Health Initiative. After the investigation, the UCD was coded in each city, and it was reviewed by a senior coder at the national level, with extensive experience in external causes.

The reclassification of an original UCD by GC to a better qualified underlying-cause after investigation, was conducted according to the method proposed by França et al.(25) The results before and after the investigation and between the IDEC form against the results using the current standard procedure were conducted defining two comparative groups obtained from SIM, 2017: “total cases” and a “matched random sample”.

The matched random sample was stratified by causes (undetermined intent; all other GCs), sex (male, female) and age group (0 to 24 years, 25 to 44, 45 to 54, 55 to 64, 65 to 74, 75 or more), to provide a distribution very similar to that found in the 164 deaths investigated with the IDEC form (Fig. 1). The primary comparison was conducted between the IDEC form and the matched sample (results from the total cases are shown in the Additional Material 2). To characterize the GCs, the following variables were analyzed: age groups, sex, place of death (hospital, another health institution, residence, public road, others) and the original underlying COD before the investigation. We also verified the sufficiency of the collected data by identifying necessary and unnecessary variables presenting a synthesis of the feedback offered by field researchers after investigation using the IDEC form. Researchers’ comments recorded in a field diary were organized according to: strengths, difficulties or aspects to be improved and suggestions.

Statistical inference was estimated for the proportion of change from GCs to valid codes before and after the investigation by 95% confidence intervals (95% CI). Furthermore, the ratio of proportion of change using cases with the IDEC form as the reference (numerator) was calculated. Changes in the three groups were compared for the total number of GCs, undetermined intent and all other GCs. The interval estimation is given by the following formula: (see Formula 1 in the Supplementary Files)

Overall, 6,546 GCs were investigated using three analysis groups: (1) Current standard procedure (n = 6,382); (2) IDEC form (n = 164), of which 152 were injuries, and; (3) matched random sample of cases from the standard procedure group (n = 2,283).

This study was approved by the Research Ethics Committee of the Federal University of Minas Gerais (CAEE 75555317.0.0000.5149). Non-nominal secondary data for the current standard procedure was used, according to Resolution No. 510 of April 7, 2016, which provides for research standards.(26)

Results

Table 1 shows the characteristics of deaths investigated in the new form e current standard procedure (matched sample). In both groups were more frequent in men, in hospitals and in older age groups. As designed, the IDEC form and matched sample had very similar characteristics. Among the specific injury GCs investigated, the most common cause of death was ‘undetermined intent’, at a frequency of 44% in the IDEC form and 70% in the current standard procedure (Table 2). Although this is a significant difference, further analyses disaggregated the results by whether the cause was ‘undetermined intent’ or not. The next most common cause was ‘unintentional-unspecified’: 17% in the IDEC form group and 10% in the current standard procedure. The other unspecific injury codes were 20% in the IDEC form group and 17% in the standard procedure. Road injuries unspecified was 11% in the IDEC form group and 6% in the standard procedure. The IDEC form was also used to investigate deaths from natural causes considered suspect or likely to be injury (7%), as well as investigation of valid injury codes (11%) to confirm the cause (Table 2).

Table 1: Frequency of deaths investigated by age, sex and place of death, six Brazilian state capitals, 2017

Characteristic	Cases with IDEC form		Current standard procedure*	
	nº.	%	Matched sample	
			nº.	%
Age group				
0 - 14	5	3.1	36	1.6
15 - 24	25	15.2	256	11.2
25 - 34	20	15.2	332	14.5
35 - 44	21	12.8	246	10.8
45 - 54	17	10.4	297	13.0
55 to 64	17	10.4	187	8.2
65 to 74	20	12.2	288	12.6
75 or +	37	22.6	641	28.1
Ignored	2	1.2	-	-
Sex				
Male	107	65.2	1,429	62.6
Female	56	34.2	853	37.4
Ignored	1	0.6	-	-
Place of death				
Hospital	116	70.7	1,545	67.7
Another health institution	2	1.2	92	4.0
Residence	16	9.8	196	8.6
Public road	19	11.6	237	10.4
Others ^(a)	7	4.3	212	9.3
Ignored	4	2.4	1	0.04
Total number	164	100	2,283	100

(a) e.g. death due to drowning at sea/lake/river; death in an ambulance during transport to hospital etc.
Source: Mortality Information System/Ministry of Health of Brazil*.

Table 2: Frequency of cause of death before investigation, six Brazilian state capitals, 2017

Deaths investigated (ICD-10 codes)	Cases with IDEC form		Current standard procedure*	
	n°.	%	Matched sample	
			n°.	%
Road injuries unspecified ^(a)	18	11.0	129	5.7
Transport injuries unspecified (V99)	5	3.0	121	5.3
Unintentional injuries unspecified (X59)	27	16.5	230	10.1
Injuries by interpersonal violence unspecified (Y09)	10	6.1	135	5.9
Injuries by undetermined intent (Y10-Y34)	72	43.9	1,598	70.0
Other injuries by garbage code ^(b)	1	0.6	70	3.1
Unintentional injurie ^(c)	6	3.7	-	-
Self-harm (X60-X84)	2	1.2	-	-
Interpersonal violence (X85-Y08)	10	6.1	-	-
No injuries (A00-R99)	12	7.3	-	-
Chapter 19 (S00-T99)	1	0.6	-	-
Total	164	100,0	2,283	100

Note 1 (a, b, c): in Additional material 1

Table 3 present the extent of change of classification of GCs of external causes to valid codes after the investigation. Due to this delimitation in the data, the IDEC form showed 133 cases. Investigation of the GC with the IDEC form reduced GCs of injuries by 92.5% (95% CI -97%, -88%), while deaths investigated by the current standard procedure only decreased GCs by 66% (95% CI -68%, -64%) (Table 3). The reduction in GCs using the IDEC form was 1.40 times higher than in the standard procedure. The GC reduction ratio was relatively low for deaths of undetermined intent (i.e. 1.22), but was 2.09 among all other injury GCs.

Table 3: Change of classification of garbage codes, after investigation, six Brazilian state capitals, 2017

	Cases with IDEC form		Current standard procedure*	
	nº.	%	Matched sample	
			nº.	%
Total garbage codes before	133	100	2,283	100
Valid code after	123	92.5	1,506	66.0
Garbade code after	10	7.5	777	34.0
Percentage change(CI) ^(b)	-92.5 (-97.0; -88.0)		-66.0 (-67.9; -64.0)	
Ratio of change(CI) ^(c)	-		1.40 (1.38; 1.43)	
Undetermined intent (Y10-Y34)				
Total before	72	100	1,598	100
Valid code after	66	91.7	1,200	75.1
Garbade code after	6	8.3	398	24.9
Percentage change(CI)	-91.7 (-98.1; -85.3)		-75.1 (-77.2; -73.0)	
Ratio of change(CI) ^(c)	-		1.22 (1,17; 1,27)	
All other garbage codes^(d)				
Total before	61	100	685	100
Valid code after	57	93.4	306	44.7
Garbade code after	4	6.6	379	55.3
Percentage change(CI)	-93.4 (-99.7; -87.2)		-44.7 (-48.4; -40.9)	
Ratio of change(CI) ^(c)	-		2.09 (2.06; 2.13)	

(a) Only the garbage codes of external causes were considered to ensure the 3 groups were comparable; when we considered all the garbage codes investigated (n = 144), 10.4% (n = 15) still was of the same cause, and proportion of change equal to -89.6% (95%CI -94.6, -84.6).

(b) Percentage variation before and after and CI (Confidence Interval).

(c) Ratio of proportion of change using cases with IDEC form as the reference (numerator).

Note 2 (d): in Additional material 1

Source: Mortality Information System/Ministry of Health of Brazil*.

Table 4 shows a reclassification of deaths after investigation using the IDEC form. In this table, we consider all investigated causes: injury and natural causes GC, as well as the investigation of valid injury codes (11%) to confirm the cause, making a total of 164 cases. From undetermined injuries, 7% remained garbage codes, 56% became falls, 13% became self-harm and 8% became interpersonal violence. For

unintentional injuries unspecified, 7% remained garbage, 33% became pedestrian road injuries, 30% motorcyclist injuries, and 19% falls. As expected, road injuries unspecified were almost all reclassified to pedestrian, cyclist, motorcyclist or motor vehicle road injuries.

Unspecified transport injuries, interpersonal violence and unintentional injuries were all reclassified to specific causes. Overall, 30% of investigated causes were reclassified as falls, 33% as a specific road injury and 15% as specified interpersonal violence (Table 4).

Table 5 shows a reclassification of deaths initially with a GC of injuries, after investigation of the matched sample using the current standard procedure. Of the most common causes, undetermined injuries, 22% remained GCs after the reclassification, but this was higher for most of the less common causes: 73% for unspecified transport injuries, 45% for unspecified unintentional injuries, 76% for unspecified interpersonal violence, and 91% for other GC injuries. For specific causes, 32% of cases were reclassified into falls, 14% into interpersonal violence and 13% into road injuries (much lower than 33% using the IDEC form). Overall, in the IDEC group, 94% of the investigated GC were attributed a valid cause, compared with only 68% for the matched sample. (See Tables 4 and 5 in the Supplementary Files)

Table 6 presents a summary of the feedback offered by field researchers after investigation with the IDEC form. Field researchers provided feedback after testing the form by collecting information in hospitals and forensic institutes. Figures A.2 and A.3 show the IDEC form before and after the modifications were implemented based on testing and feedback. Advantages mentioned were standardization of the instrument for investigating death from external causes and improved potential for retrieving the true COD. However, a limitation of was that the longer IDEC form takes on average 30 minutes to complete.

Based on the feedback from field researchers, several modifications were made to the form to make it more intuitive, simple, objective and clear (Table 6). One was standardizing the terminology for the variables to be consistent with other forms such as the death certificate and violence notification form. Secondly three items/questions which were found to be redundant were removed. The sequence is important as the form is meant to be used in different settings. Hence, the sequence of questions was made to group questions relevant to the different institutions involved and be more logical; policy data, followed by hospital data, followed by data from forensic institutes. Finally, additional items were included, including complementary information about violence and accidents to facilitate the specification of the victim, the means and the other party involved in the case of transport accidents, etc.

Sometimes it was found that investigated causes did not always clarify the circumstances of death due to the lack of information in the data collection from relevant sources, for example the absence of data from police investigations or the non-registration of the circumstances of death in hospital records. For all the 11 GC deaths that were not classified to a valid cause, details regarding circumstances were not available neither in hospital records nor in police reports.

Table 6: Feedback from field researchers after investigation with IDEC form in six Brazilian state capitals, 2017

Type of investigation	Types of causes investigated	Field Investigator's comment		
		Strengths	Difficulties/Aspects to be improved	Suggestions
Hospitals	Most of the deaths referred to femur fracture due to fall from one's own height or bed.	<ul style="list-style-type: none"> - Standardization of the instrument for investigating death from external causes; - High potential for retrieving information that supports the definition of the cause of death and circumstance of the event. 	General <ul style="list-style-type: none"> - Average investigation time of each death using the form was 30 minutes; - Form too long; it is suggested to revise the form to be simpler and more objective, facilitating the work of researchers; - Some questions seem to repeat themselves or they are not clearly saying which source or data type you refer to. 	Inclusion of variable: <ul style="list-style-type: none"> • To collect information from the media and/or social networks, which are potential sources of information; • Occupation; • No medical record; • Author of violence includes agent/police; • Modifying civil police to police only is more comprehensive.
Scientific tests	Different types of garbage codes (GCs) of accidents and violence, and ill-defined causes.		Specific <ul style="list-style-type: none"> - No note in the medical record about: possible aggression or neglect; gender, race, marital status or degree of study (Information little valued in injuries); - Poisoning information is rarely found in FI and hospitals; 	Exclusion of variables: <ul style="list-style-type: none"> • Name of father, age, address, end reductive information within parentheses in some variables;
Municipal scientific technique	Different types of GC of accidents and ill-defined causes.		<ul style="list-style-type: none"> - Without access to information from the technical-scientific police expertise of the event scene in the municipality; - The following variables are not included in the records of the IML or other health services: sexual orientation, gender identity, death motivation (e.g. racism, femicide, 	<ul style="list-style-type: none"> • Item 22, because the causes of death in the coroner's registry are the same as those transcribed to the death certificate

		homophobia) and perpetrator of violence; - The form has few lines to write a detailed account of the event and not very hospital specific.	
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Discussion

This is the first study comparing the effectiveness of a new form for investigating garbage codes for external causes in Brazil. Use of the new IDEC form obtained statistically significant percentage reductions in GC from external causes that were greater compared to the current standard procedure; only 7.5% of IDEC form deaths remained garbage with the new form compared to 34% in the matched sample. The performance of the IDEC form resulted in double the proportion of GC deaths not from undetermined intent being reclassified to non-garbage codes compared with deaths of undetermined intent. The IDEC form was particularly good at reclassifying GCs into falls, road injuries and interpersonal violence.

The characteristics of the matched sample, composed from the current standard procedure, was mostly similar with the 164 cases investigated using the IDEC form, with the exception of the IDEC form having a lower proportion of deaths of undetermined intent; however, we disaggregated our findings into this group and other GCs. The characteristics were compatible with previous studies, and showed a higher frequency of death in men, both younger and older, and deaths occurring in hospital for injury deaths than other deaths.(16, 20, 27)

The investigation with the IDEC form reduced the number of GCs by more than 90%. The results may vary due to the composition of localities, information sources and types of GC. GC reductions for external causes ranged from 39–83% in certain studies, which typically used data from forensic institutes as a central source.(28–30) Better results have been shown for unspecified accidents in some studies, (28, 29) and for undetermined intent in others(30). Recently a multi-source study reduced GC with undetermined intent by 84% and reclassified 11% of undetermined natural causes to external causes, pointing to greater contribution to the data from police, press, and forensic institutes. (16, 27) Interestingly, it was possible to qualify 67% of undetermined intent deaths relying on newspaper reports alone.(31)

We also verified a reclassification of cases between external causes and natural causes as well as the reclassification of unintentional injury to other valid codes. This was most evident when looking at reclassification of ill-defined causes to external causes, obtained from national and local data;(10) where forensic institutes accounted for 20% of the ill-defined causes in 2010.(12) The frequency of GC in hospitals was still high, although it was lower in specialized hospitals, particularly those treating trauma. (20)

In this study, most deaths of undetermined intent were reclassified into falls in both comparison groups, which may have been influenced to some extent by the demographic profile of the investigated GCs. There is evidence of more reclassification of undetermined intent for accidents, specifically falls;(28, 29) as well as more recent findings have shown more of these are classified to homicides.(16, 27, 30, 31) Evidence has indicated that the utilization of multiple sources of information improves the results of GC reclassification,(27, 30) although this still may not be sufficient for assigning a specific COD.(20) Thus, it was observed that certain sources contribute better to identifying a particular category of cause, e.g. police investigations identifying homicides, or newspaper reports of recent traffic accidents, etc.(10, 28, 31)

After more than 40 years of operation, SIM has its own challenges in modernization and in decentralizing in a relatively large country like Brazil; with some of its components being implemented partially inadequately.(32) The challenges may be greater in areas with poorer access to public services, especially small and medium-sized municipalities in countryside and rural areas.(10, 33) These challenges are compounded by the poor quality of death records for external causes, which has not been updated, highlighted by the poor agreement of the causes of death issued by forensic institutes compared with the Department of Health.(22) (34) Poor quality of death certificates may be partly due to forensic physicians' inclination to disregard the records related to the hospitalization period. A recent study found that there may be movements and discontinuities in the quality of the cause over time.(35) In other countries certain similarities related to some types of GC have been found in literature.(9)

The IDEC form generally collected enough data to improve the quality of external COD data in hospitals and forensic institutes. However, after the investigations, it was necessary to rearrange the logical sequence of the questions to make it more intuitive and possible to be used in different services. Causes that remained as a GC when there was no information on the circumstance of the death generally resulted from unavailability from police investigations. Most of these were due to poisoning (mainly by cocaine) and unspecified vehicle accidents, and where the locality of violence or accident was reported as having taken place in a private residence or public road without a witness. It was observed that events that occur at home are more likely to be classified with some type of GC.(20) The difficulty of defining a correct diagnosis for the external causes due to that they require additional information in order to determine the COD. If this is not part of the death registration, then misclassification may result.(36)

In addition to autopsy, the proper completion of the cause of death is, or should be, based on the availability of examinations and complementary data from the scene of the event, which remain the responsibility of specialized police and justice departments.(36, 37) Physicians from forensic institutes often document the nature of the injury, without specifying the circumstance of death, which results in a GC.(22, 28, 30) Findings from a preliminary police investigation into a violent death is sent along with the corpse to the forensic institute. The burial only occurs after release of the body with the death certificate and are linked to the same period of time, which should only be a short period of time following arrival at the forensic institute. However, when examinations and police investigation are continued for longer periods, possible new findings may be acquired which alter or clarify the cause and circumstance of the

event.(12, 34) Police information is generally limited to a brief description of the event, often sufficient to characterize violence, but insufficient to characterize accidental events such as falls and poisoning.(28)

These earlier findings reinforce the hypothesis that the difficulty in properly diagnosing external causes extend beyond the contextual and structural issues of service and medical training reported by previous studies, which noted as key issues the non-use of instructional materials, low value attributed by the certifiers and lack of ability to describe the chain of events.(22, 38, 39) The set of evidence suggests that different needs and ways of working of the legal/police and the epidemiology of health are part of the problem.(16, 27) This dual role is not a particular feature of the Brazilian medicolegal death investigation system, as for example, in the United States, the death investigations also carry broad societal importance for criminal justice and public health. We must also consider the potential of the autonomy of federated entities as one of the factors of production of multiple realities, of highly varied state and local systems for investigating deaths.(40)

Although these different systems have in common the protection and guarantee of rights(41), each institution has different priorities and ways of working. For instance, public health has its central focus the victim and the associated risk factors, demanding a faster pace and shorter time in view of the need to implement timely actions.(42–45) The legal/police logic of the public security and justice sector, on the other hand, is a normative system that prioritizes the victim-perpetrator binomial as its core of attention, expressly with a slower pace and timeframe, especially in violent deaths involving crimes.(46)

Certain experiments have shown promise in the field of qualifying the COD, such as the use of an online death certification system to improve the cause of death record, especially when accompanied by a training program.(47) When errors are encountered on the COD in the death certificate, it is proposed to recapture the causes using the multiple COD, which can provide strong clues about the valid cause.(19, 48) A strategy implemented by other countries has been to postpone filling the cause in the death certificate until up to six days after death, facilitating the incorporation of test results and police investigations. This requires a prior death certificate to be issued, leaving out the circumstances of death until a full certificate can be issued following the conclusion of outstanding investigations.(27)

Some limitations were present in this study. In particular, the low number of cases, the geographical locations and the variety of codes investigated may have affected the results. Although testing was performed only in state capitals, the selection of deaths to review allowed us to investigate some cases from the interior of the states, which have distinctive epidemiological patterns.

Conclusions

The new form for the investigation of deaths from external causes (IDEC form) was more efficient in reducing garbage codes than the current standard procedure in the studied Brazilian locations, resulting in a much better performance for the unspecified garbage codes. The form proved to be appropriate to improve the quality of cause of death data, although further adjustments are necessary to make it more intuitive and useful for collecting data from different sources. It is desirable that the new form be more

widely tested to observe its performance in the reclassification of different types of garbage codes from external causes in different areas of Brazil. The IDEC form should also be applied to sources of information not tested yet, such as police stations. There are plans to roll it out in the future. As long as problems with GCs persist in cause of death reporting, best practices for searching and recapturing information through standardized procedures and validated instruments are necessary to improve the quality of external cause of death data and the production of useful statistics and evidence for policy formulation in public health in Brazil.

List Of Abbreviations

ANACONDA: Analysis of Causes of National Deaths for Action

COD: Cause of death IDEC form: Form for the investigation of deaths from external causes

DC: Death Certificate

CI: Confidence Interval

FI: Forensic Institutes

GC: Garbage codes

GBD: Global Burden of Disease

ICD-10: International Classification of Diseases

SIM: Mortality Information System

UCD: underlying cause of death

Abbreviations

Availability of data and materials

The data of Mortality Information System (SIM) that support the findings of this study are public and available on the following sites of Ministry of Health of Brazil: <http://datasus.saude.gov.br/informacoes-de-saude/tabnet/estatisticas-vitais> or <http://svs.aids.gov.br/dantps/centrais-de-conteudos/paineis-de-monitoramento/mortalidade/codigos-garbage/>

More specific and detailed data from the 164 investigations conducted with the IDEC form are available from the authors upon request and with permission of the Department of Health Surveillance (Ministry of Health of Brazil).

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

AMSF, PKBM and TA contributed to the study design and analysis. Specifically, AMSF worked on data acquisition and interpretation. RBL, EMH, MFMS, LM and all other authors contributed to the conception and the drafting of the draft versions, approved the final version of the article, and declared themselves responsible for all aspects of the work to ensure that issues related to the accuracy or completeness of any part of the work are properly investigated and resolved.

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Additional Material Legends

Additional material 1: Garbage code details

Additional material 2: Additional results

Table A.1: Frequency of deaths investigated by age, sex and place of death, six Brazilian state capitals, 2017

Table A.2: Frequency of cause of death before investigation, six Brazilian state capitals, 2017

Table A.3: Change of classification of garbage codes, after investigation, six Brazilian state capitals, 2017

Table A.4: Reclassification of deaths before and after investigation in total cases (standard procedure), in six Brazilian state capitals, 2017*

Table A.5: Classification of garbage codes by severity, before and after the investigation, by condition to investigation, in six Brazilian state capitals, 2017

Additional material 3: Investigation forms

Figure A.1: Standard form for investigating garbage codes deaths in hospitals.

Figure A.2: Form for the investigation of deaths from external causes (IDEC), field tested version

Figure A.3: Form for the investigation of deaths from external causes (IDEC), modified version after field testing

Figures

Figure 1

Flow chart of the investigated deaths in six Brazilian state capitals, 2017 (a) 149 (91%) deaths occurred in 2017 and (9%) in 2018. (b) Cases discarded for not reporting original underlying cause. (c) Suspected cases of injuries. (d) According to the stratification of form deaths by cause (undetermined intent; all other GC), sex and age group.

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