DOI: 10.1590/1980-549720190003.supl.3

ORIGINAL ARTICLE / *ARTIGO ORIGINAL*

Quality of data on causes of death in southern Brazil: the importance of garbage causes

*Qualidade dos dados de causas de morte no Sul do Brasil: a importância das causas **garbage***

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ABSTRACT: ***Introduction*:** The study objective was to analyze the quality of data on causes of death in southern Brazil. ***Methods*:** Mortality Information System (SIM – Sistema de Informações sobre Mortalidade) data were used to evaluate the occurrence of *Garbage* Causes (GC) in death certificates (DCs) of residents of South states and their capitals between 2015 and 2016. The GC of each state were compared to the other states and grouped by severity level (N1 to N4, according to decreasing potential impact on mortality profile). We evaluated the N1 and N2 GC in the 0-74 years, in accordance with local of occurrence and attesting professional. ***Results*:** The occurrence of GC ranged from 29 to 31% among the three states, below the national average (34%). The GC of levels N1 and N2 were similar between states and heterogeneous between capitals. Most deaths were in-hospital, between 55%-64% of N1 and N2 GC occurred in the states and 39%-55% in the capitals. As for home deaths, this number ranged between 25%-31% and 25%-40%, respectively. More than 30% of the attesting professionals (except in Florianópolis) were declared as "others" in the corresponding DC field. Physicians from the Forensic Medical Institute (IML) and Death Verification Service (SVO) attested 15 to 24% of N1 and N2 GC in the states and 33 to 66% in the state capitals. ***Conclusion*:** The improvement of mortality data should involve strategies aimed at hospital physicians, in accordance with the volume of deaths and the IML and SVO services in addition to support for the emission of home DC, due to the importance in generating more severe GC.

***Keywords*:** Mortality registries. Public health surveillance. Health information systems. Health planning. Cause of death.

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Conflict of Interest: Nothing to Declare – **Funding Source:** Vital Strategies as part of the Bloomberg Philanthropies Data for Health initiative (Project 23998 Fundep/UFMG). The supporting institution had no role in study design, data collection, analysis and interpretation, or manuscript writing and presentation for publication.

RESUMO: ***Introdução*:** O objetivo do estudo foi analisar a qualidade dos dados sobre causas de morte na região Sul do Brasil. ***Métodos*:** Foi utilizado o Sistema de Informação sobre Mortalidade para avaliar a ocorrência de causas *garbage* (CG) nas declarações de óbito (DO) de residentes nos estados e capitais da região Sul entre 2015 e 2016. As CG foram comparadas com os demais estados e agrupadas por nível de gravidade (N1 a N4, segundo potencial decrescente de impacto sobre o perfil de mortalidade). Foram avaliados os CG de N1 e N2 na faixa etária de 0 a 74 anos, segundo local de ocorrência e médico atestante. ***Resultados*:** A ocorrência de CG geral variou de 29% a 31% entre os três estados, abaixo da média nacional (34%). As CG N1 e N2 foram semelhantes nos estados e heterogêneas nas capitais. A maioria dos óbitos foram hospitalares, onde ocorreram 55% a 64% das CG N1 e N2 nos estados e 39% a 55% nas capitais. Nos óbitos domiciliares, esta proporção variou de 25% a 31% e de 25% a 40%, respectivamente. Mais de 30% dos médicos atestantes (exceto em Florianópolis) não identificaram seu vínculo com o paciente, declarando-se como "outros" no campo correspondente da DO. Médicos de Instituto Médico Legal (IML) e Serviço de Verificação de Óbitos (SVO) atestaram 15% a 24% das CG N1 e N2 nos estados e 33% a 66% nas capitais. ***Conclusão***: A qualificação dos dados de mortalidade deve envolver estratégias voltadas aos médicos de hospitais, pelo volume de óbitos e para os serviços de IML e SVO, e suporte para emissão das DO domiciliares, pela importância na geração de CG de maior gravidade.

***Palavras-chave*:** Registros de mortalidade. Vigilância em saúde pública. Sistemas de informação em saúde. Planejamento em saúde. Causas de morte.

INTRODUCTION

The mortality profile is essential for the assessment of populations and health services. Mortality analyzes are based on the underlying cause of death (UCoD) (disease or event that triggered the process leading to death[1]) derived from medical records. However, due to lack of knowledge about the correct filling of the death certificate (DC), many physicians record only intermediate or immediate causes of death, less useful for public health, for not allowing the identification of necessary actions to prevent similar deaths. These causes are called garbage causes (GC)[2,3] and they can be categorized into different severity levels according to inadequacy and potential compromise of the mortality profile. When the number of GC exceeds 10% of total deaths, mortality data are compromised, unable to represent the actual health status of the population[4]. The higher the number of deaths by GC, especially those with higher severity levels, the more compromised is the analysis of the mortality profile in a given region.

In Brazil, death data are organized in the Mortality Information System (SIM – Sistema de Informação sobre Mortalidade), fed from DCs filled by physicans and qualified by municipal health surveillance teams with state support. The quality of SIM is mostly measured by the number of deaths with a specified cause of death (SCoD), according to which the UCoD is adequately identified. However, the great heterogeneity in the coverage and quality of health services and the ability to capture and qualify information in the country can lead to reliability issues in the indicators, both national and local[5].

The southern region is composed of the states of Paraná (PR), Santa Catarina (SC) and Rio Grande do Sul (RS), which are among the six states with the highest Human Development Index (HDI) in the country[6]. Their capitals are Curitiba, Florianópolis and Porto Alegre, respectively. It is the smallest region in the country's territory, with the second largest Gross Domestic Product (GDP)[7], and the only one predominantly located in a temperate region, with lower temperatures than the rest of Brazil. These characteristics impact the coverage and quality of health services as well as the local morbidity and mortality profile. Each state has internal heterogeneity, with greater concentration of resources in the capitals. Thus, it is important to assess the quality of local mortality data and to know the main challenges required to overcome in order to qualify them.

The objective of this study is to analyze the quality of mortality data from the states and capitals of the South region of Brazil and to identify characteristics related to the occurrence of GC with the greatest potential impact on the mortality profile in order to support the qualification measures of SIM data.

METHODS

This is a descriptive ecological study of data on the deaths of residents in the South region between 2015 and 2016.

To build the database, information was extracted from the SIM through the TabWin software package (version 4.1.5). In order to create the category *"garbage* causes" and allow the classification of causes of death identified by the SIM, a conversion file was prepared with ICD 10 (International Classification of Diseases, 10th edition) codes according to the Global Burden Disease 2015. These were classified according to severity levels used in ANACONDA (Analysis of Causes of National Deaths for Action), an electronic tool developed by the University of Melbourne to assess the quality of mortality data[4]. These levels take into account the potential impact on the mortality profile:

- *Level 1* (very high): Codes with highly effect on mortality profile, as they represent an intermediate cause of death (ICoD) that could result from any of the three major groups of causes of death (GCoD): contagious diseases, noncommunicable diseases, or external causes such as septicemia or acute renal failure.
- *Level 2* (high): ICD that allows to assign UCoD to one of the major GCoD, but does not allow identifying the ICoD chapter or UCoD as essential hypertension or asphyxiation.
- *Level 3* (medium): ICoD that allows the cause of death to be attributed to one of the major GCD and to an ICD chapter, but not necessarily to a single disease or injury category. Examples: malignant neoplasm, without site specification, and unspecified chronic respiratory diseases.
- *Level 4* (low): ICoD with low impact on mortality profile, as it allows inferring that the UcoD is related to a single disease or injury, requiring only qualification. Examples: stroke, unspecified either as hemorrhagic or ischemic, and unspecified pneumonia.

The database was exported to the software package GNU PSPP version 1.0.1, where variables were categorized and statistical analyses were performed. The overall evaluation of data quality was made by comparing the occurrence of GC between the South states and other Brazilian states as well as the number of GC per age group between South states.

The GC of severity levels 1 and 2 were selected for analysis, given their higher impact on the mortality profile. The age group of interest was 0-74 years, following the concept of preventable deaths[8], and the categories used were: < 1, 1-14, 15-44 and 45-74 years. The situation of the most frequent DC and GC was also evaluated.

In order to identify factors potentially associated with the occurrence of GC and verify whether the quality of the data was similar between the three states and between the three capitals, the following was evaluated: age of the victims, GC severity, local of death and type of attesting physician. To compare the proportions we used the χ squared test with Bonferroni[9] correction and confidence intervals; for comparison of means, Student's t-test, with $p<0.05$ being statistically significant. The charts were created using Excel 2010.

This study was approved by the Ethics Research Committee of the Federal University of Minas Gerais (CAEE 75555317.0.0000.5149) and developed according to the ethical precepts established under Ordinance No. 466/2012 of the National Health Council.

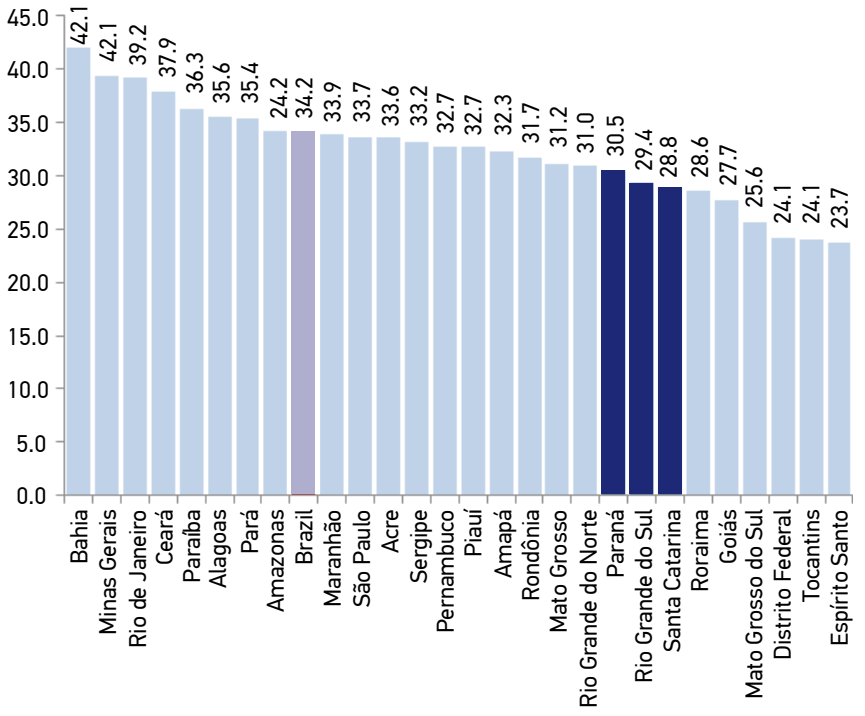
RESULTS

In the comparison between Brazilian states, only six presented lower number of GC than those of the South region. Among these, SC presented the lowest proportions (28.8%), followed by RS (29.4%) and PR (30.5%), all below the national average (34.2%) (Graph 1).

Graph 2 shows the proportion of UCoD and GC per age group in the South states. The mean age in the GC death group was higher than that of UCoD (71.5 and 58.4 years, respectively; $p < 0.001$). Between 1 and 14 years, all states presented GC above 20%, with a lower proportion in RS ($p < 0.01$).

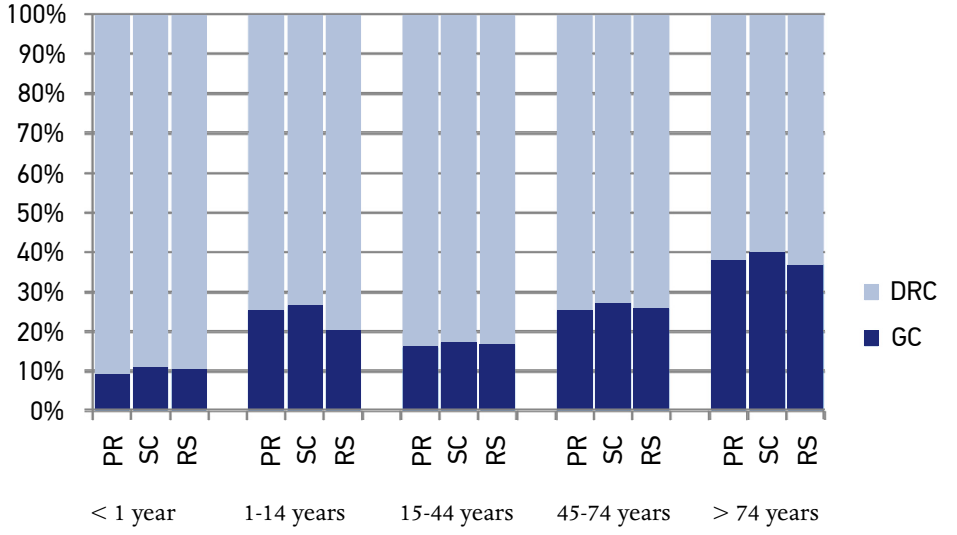
Graph 2 shows the proportion of UCoD and GC per age group in the South states. The mean age in the GC death group was higher than that of UCoD (71.5 and 58.4 years, respectively; $p < 0.001$). Between 1 and 14 years, all states presented GC above 20%, with a lower proportion in RS ($p < 0.01$).

In assessing the occurrence of GC in general and by level of severity, the results between states were similar in the GC level 1, with small differences observed in the other categories. The overall number of GC was different among the three capitals, with higher proportion in Curitiba and lower proportion in Florianópolis ($p < 0.01$). The distribution by severity levels also differed between each capital. Table 1 presents the number of GCs and severity levels per state and capital of the South region.



Graph 1. Proportion of garbage causes by state, Brazil, 2015-2016 (n=3,157,953).

Source: Sistema de Informações sobre Mortalidade, 2019.



Graph 2. Proportion of specified cause of death (SCoD) and *garbage* causes (GC) per age group, South region, 2015-2016 ($p < 0.01$; n = 393,795).

Source: Sistema de Informações sobre Mortalidade, 2019.

Table 1. Proportion of garbage causes and severity levels per state and capital of the South region, 2015-2016.

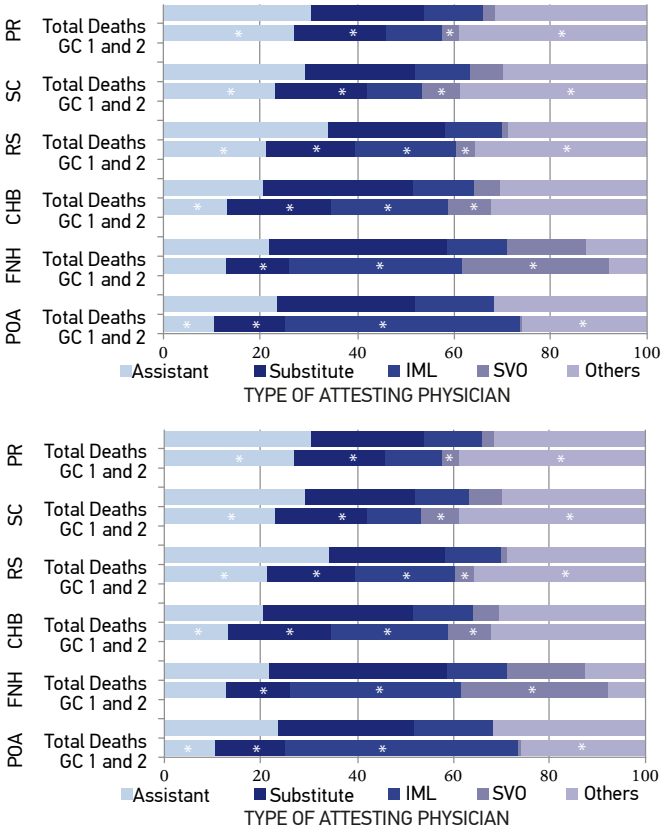
Site	Total deaths(n)	GC n (%)	Level			
			Very High 1 n % (95%CI)	High 2 n % (95%CI)	Medium 3 n % (95%CI)	Low 4 n % (95%CI)
South Region	393,765	116,902 (29.7)	39,607	13,866	13,281	50,148
			10.1	3.5	3.5	12.7
			(9.9-0.1)	(3.5-3.6)	(3.3-3.4)	(12.6-12.8)
Paraná	145,616	44,361 (30.5)	14,687	5,817	4,513	19,344
			10.1	4	3.1	13.3
			(9.9-10.2)	(3.9-4.1)	(3-3.1)	(13.1-1.5)
Santa Catarina	78,217	22,566 (28.8)	7,779	2,944	2,809	9,034
			9.9	3.8	3.6	11.5
			(9.7-10.2)	(3.6-3.9)	(3.5-3.7)	(11.3-11.8)
Rio Grande do Sul	169,932	49,975 (29.4)	17,141	5,105	5,959	21.77
			10.1	3	3.5	12.8
			(9.9-10.2)	(2.9-3.1)	(3.4-3.6)	(12.6-13)
Curitiba	21,544	4,735 (22)	1,194	480	555	2,506
			5.5	2.2	2.6	11.6
			(5.2-5.8)	(2-2.4)	(2.3-2.7)	(11.2-12.1)
Florianópolis	4,763	776 (16.3)	206	60	117	393
			4.3	1.3	2.5	8.2
			(3.8-4.9)	(0.9-1.6)	(2-2.9)	(7.5-9)
Porto Alegre	23.73	4,349 (18.3)	2,747	985	1.28	4,848
			5.7	1.9	2.6	8.2
			(5.4-6)	(1.7-2)	(2.4-2.8)	(7.9-8.6)

GC: garbage causes.

Source: Sistema de Informações sobre Mortalidade, 2019.

Regarding the context of DC emission, in both states and capitals, most deaths occurred in hospitals, ranging from 66% in PR to 73.7% in RS, among states; and 64.4% in Curitiba to 72% in Porto Alegre, among capitals. As for the attesting physician profile, the assistant was the most frequent DC attesting in the states, with 30.6% in PR and 34.3% in RS. Among the capitals, the substitutes stood out, with 28.3% in Porto Alegre and 37% in Florianópolis. Among the states and capitals, the category "others" accounted for about 30% of the DC, except in Florianópolis (12.6%).

For GC level 1 and 2 between 0 and 74 years (Graph 3), there was a lower participation of hospitals ($p < 0.001$), although they still accounted for 55.2% to 64.2% (PR and SC, respectively) of these cases. Household deaths, on the other hand, showed a proportion of 25% (SC) to 30% (RS and PR) of GC in this local, reaching approximately 40% in Porto Alegre and Florianópolis. Regarding the category of attesting physician, assistants and substitutes had a lower participation ($p < 0.001$, except for assistants in Florianópolis). On the other hand, the Forensic Medical Institute (IML) in RS and the capitals and the Death Verification Service (SVO) in Florianópolis stood out, as they were responsible of 30.4% of GC level 1 and 2 in this age group.



Graph 3. Situation of garbage causes (GC) levels 1 and 2 (0-74 years) in the states and capitals of the South region, 2015-2016.

*p < 0.001 when comparing total deaths with GC A+MA GC 1 and 2: GC as level 1 (very high), or 2 (high). IML: Instituto Médico Legal; SVO: Serviço de Verificação de Óbito. n = 26,8472 estados; 1,985 capitais.
Source: Sistema de Informações sobre Mortalidade, 2019.

Table 2 shows the main causes of levels 1 and 2 in deaths between 0 and 74 years old in the states and capitals of the South region of Brazil. From < 1 year to 44 years, the most frequent GCs of level 1 and 2 were sepsis, cerebral palsy and ill-defined causes (ICD-10 R99), with slight variations between states and capitals. In the population between 45 and 75, in addition to sepsis and ill-defined causes, hypertension and heart failure stood out.

Table 2. Main GC of levels 1 and 2 (0-74 years) in the states and capitals of the South region of Brazil (n = 26,8472 states; 1,985 capitals).

Site	< 1 year		1-14 years		15-44 years		45-74 years	
	Cause (ICD 10)	%	Cause (ICD 10)	%	Cause (ICD 10)	%	Cause (ICD 10)	%
PR	Ill defined (R99)	24.8	Cerebral Palsy (G80)	34.1	Ill-defined (R99)	11.8	Heart failure (I50)	18.8
	Sepsis (A41)	22.4	Ill-defined (R99)	10.5	Cerebral Palsy (G80)	8.7	Essential Hyper (I10)	15.3
SC	Ill-defined (R99)	29.2	Cerebral Palsy (G80)	25.6	Ill-defined (R99)	21.9	Essential Hyper (I10)	16.9
	Sepsis (A41)	16.9	Sepsis (A41)	17.1	Sepsis (A41)	8.9	Heart failure (I50)	15.1
RS	Ill-definedR99)	38.8	Cerebral Palsy (G80)	31.3	Ill-defined (R99)	29.1	Ill-defined (R99)	28.9
	Sepsis (A41)	25.9	Ill-defined (R99)	13.6	Sepsis (A41)	6.4	Heart failure (I50)	11.8
CTB	Cerebral Palsy (G80)	25	Cerebral Palsy (G80)	66.7	Cerebral Palsy (G80)	14.3	Sepsis (A41)	15.1
	Sepsis (A41)	25	Streptococcus Sepsis (A40)	5.6	Nuf, suf int n det (Y20)	9.8	Heart failure (I50)	10.8
FNL	Tr encéfalo (G93)	50	Encefalopathy (G93)	50	Int narc aluc n espec (X42)	18.6	Ill-defined (R99)	19.4
	Cont obj cont int não det (Y29)	50	Muscle disorders (M62)	25	Ill-defined (R99)	18.6	Ill-specified heart issues (I51)	17.9
POA	Ill-defined(R99)	60	Cerebral Palsy (G80)	57.7	Ill-defined (R99)	33.9	Ill-defined (R99)	41.6
	Sepsis (A41)	20	Tr encéfalo (G93)	15.4	Cerebral Palsy (G80)	11.1	Hip Essential (I10)	8.3

Source: Sistema de Informações sobre Mortalidade, 2019.

DISCUSSION

As the Southeast region[10], the South region has historically highlighted by the highest SIM coverage in the country, which demonstrates the potential use of the system in building useful statistics for health-related decision-making. However, this potential may be affected by the number of GCs. Therefore, knowing the occurrence profile of GC in the states and capitals of the region is essential to implement local data quality improvement policies.

Between 2015 and 2016, the number of deaths by GC in the South states and capitals was below the Brazilian average. But approximately ⅓ of deaths that occurred in the states of the South region presented a proportion considerably above that considered critical to obtain reliable data[4]. We found a value of 34.2% of GC for Brazil, ranging from 23.7% to 42.1% between states, where only 3 had less than 25% of GC. These data are compatible with worldwide estimates of GC occurrence in developing countries, which indicates proportions between 12% and 55%, with 32% in South America[2]. However, according to Abouzahr et al.[11], the number of deaths coded as GC should not exceed 10% in individuals 65 years and older and it should be less than 5% at younger ages.

Proportionally, more than 20% of deaths between 1 and 14 years were caused by GC, which demonstrates the data weakness in the early age group, when the probability of avoidable death is higher. However, the results coincided with Naghavi et al.[2], who have noted that the lowest number of GCs occurs in children under 1 year (about 15%), and the highest over 84 years (30%), followed by the age group between 1 and 14 years (over 25%). The higher occurrence of GCs at older ages can be explained by the presence of comorbidities in the elderly, making it difficult to identify UCoD[12]. In the South states, the GC proportion in children under 1 year of age was around 10%, possibly reflecting the investigation of infant deaths, mandatory in Brazil since 2010[13], impacting on the significant improvement of data in the country[14].

Through their assistance and surveillance services, the capitals contribute to the quality of state data, considering the volume of data they provide, and the fact that municipal databases tend to be of better quality than those with higher aggregation levels[15]. In this study, among the capitals, although heterogeneously the GC proportion was lower than states, corroborating the literature[16]. The number of GCs was similar between the larger capitals (Curitiba and Porto Alegre) and lower in Florianópolis. The size of local investigation teams compared to the number of deaths to be investigated, access to and organization of health services (including medical records), access to IML and SVO, and training routines for physicians, investigators and coders are factors that may explain these local differences, affected by the SIM decentralization process to municipalities[17].

These results strengthen the need to implement actions aimed at improving the quality of UCoD information. In this sense, in recent years, several initiatives have been developed to qualify mortality data in Brazil[18]. Among them is the Data for Health Initiative (D4H) project: the investigation of *garbage* codes whose goal is to qualify the

UCoD in the municipalities involved. Another initiative is the availability of the tool ANACONDA (Analysis of Causes of Death for National Action)[4], which allowed this study to be done by enabling databases to evaluate data completeness and the qualification of UCoD, enabling monitoring of occurrence and GC profile with classification by major death groups and severity levels. However, while providing useful reports and graphs for evaluation and monitoring, the tool does not give access to absolute numbers, limiting some evaluative analyses.

These initiatives are important but insufficient to improve the overall quality of mortality data. In the South region, primary quality problems are almost overcome. The SIM coverage has been complete since the 80's[10], and data from states and capitals in the region ever since 2011 indicate less than 5% of deaths from ill-defined causes (ICD10 chapter R), which is considered a low proportion[12]. The challenge now is to trigger a new quality leap, improving understanding of the GC recording process to support local data qualification strategies. For this reason, it is important to prioritize the qualification actions of the GC, since in locations with the highest number of deaths, qualification strategies are hampered by the amount of work involved in the process, and in smaller locations, as they correspond to smaller municipalities, the available resources are limited.

During evaluation of the most critical GC (severity levels 1 and 2, 0–74 years old), hospitals remain as the main place of their records, as they were the local of death in more than half of cases. This strengthens the need of special attention to these services[19]. On the other hand, household deaths, which had less impact on the overall number of deaths in the states and capitals of the region, had a large participation in the generation of critical quality GC. This finding indicates the need for support and training for physicians who provide support in these situations. Thus, in addition to the expansion and qualification of the SVO, it is essential to make physicians aware of the epidemiological importance of DC, valuing the information recorded in the medical records, from family members and from verbal autopsy[20].

Regarding the type of attesting physician, assistants and substitutes played a key role in the total number of deaths, but their participation was lower in the production of critical GC. On the other hand, the number of DC with GC of critical levels in the IML and SVO was higher than for the total, especially in the capitals. It is necessary to point out that, where there is no SVO, the IML, responsible for certifying deaths by external causes, also act in the assessment of deaths by natural causes, impacting the profile of the DC in these services, as occurs in Porto Alegre. Because the SVO is responsible for clarifying deaths from natural causes without diagnosis, in municipalities that have this service, it is possible to reduce the burden of investigation in the IML. In Florianópolis, for example, both services are available, facilitating the investigation of causes of death. This may be one of the reasons for the difference in findings regarding IML and SVO among capitals.

Anyway, the high number of GC deserves attention. It has been described that pathologists and coroners usually record anatomopathological changes and lesions

to the detriment of UCoD in the filling of the DC[21]. It is possible that the concept of cause of death is not clear in these services, which contributes to the registration of GC. Another possibility is the difference in the profile of victims referred to these services. Cases referred for clarification by UCoD or victims of suspected death may have less information available to define the cause of death compared to cases in the hospital or at home. However, Laurenti et al.[12] consider that, although necropsy is a gold standard in identifying the cause of death, in practice this does not occur, especially due to problems in the DC filling. According to the authors, autopsy results are not sufficient to identify the causal sequence of death and the underlying cause. As these services have great potential to contribute to data quality, it is essential to invest in the qualification of pathologists and coroners, seeking to bring them closer to the discussion about qualifying information on cause of death. These services also need to be integrated with other health services in order for them to receive the information they need to progress in their investigations and have adequate laboratory support.

Another important finding was the frequency of the "other" type among attesting physicians. This is an exclusion category that should be used in special situations when the attesting physician does not fit into the other categories. However, with the exception of Florianópolis, about ⅓ of the deaths were certified by physicians who declared themselves "others". Considering the number of DC emitted in hospitals, IML and SVO, it is likely that this category was misused. In all states, the participation of the category was higher in the registration of GC type 1 and 2 than in the general filling of DC, which was not observed among the capitals. Physicians should be informed about the proper use of typologies so that the data can more accurately reflect the actual situation.

In addition to identifying where and by whom GC level 1 and 2 are produced, the main GC must be identified[2]. In this study, in almost all age groups evaluated, the ill-defined causes stood out, even in small numbers. Strategies are also needed to qualify sepsis, cerebral palsy, external causes, heart failure, and essential hypertension data, qualifying both attesting physicians and coders.

Some limitations should be taken into account, for instance: the analyses were performed exclusively with secondary SIM data, without further investigation of deaths or evaluation of possible typing or coding errors. Similarly, all deaths recorded with SCoD were considered quality records, without verifying the adequacy of the UCoD recorded by the physician. However, the aim of this paper was to evaluate the databases upon which official local and national mortality statistics are built. These databases have already been considered qualified and closed by the Ministry of Health, so potential weaknesses, if any, are inherent to their routine process. However, we consider it important to evaluate these operational aspects, which should be the subject of further studies.

CONCLUSION

The states and capitals of the South region of Brazil are historically recognized for the coverage and quality of mortality databases. However, although the data from the capitals presented better results than from states, the number of GC was significant. Thus, measures are required to qualify mortality data in the region.

These results also indicate the need to formulate action strategies aimed at hospital, IML and SVO professionals. In addition to training for physicians, which is important for all three services, their approximation towards hospital death committees and medical record committees would be expected. These services have the potential to support local teams in investigating deaths, as well as assist in the continuing education of institution staff regarding DC filling. Also important is the local definition of flows to referral services, which include the IML and SVO, ensuring that relevant information follows the case and supports DC filing. The creation of support to physicians for the DC filling in deaths occurring at home can contribute to reduce errors in filling.

Finally, the identification of GC with the greatest impact on mortality profiles and health policy planning should make physicians and coders aware of the proper recording of information. This information should be used in all contact opportunities and training, disclosing the need to qualify such information.

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Received: 06/12/2019
Final version presented: 07/31/2019
Approved: 08/02/2019

Acknowledgments: To all the Epidemiological and Death Surveillance teams in the states of Santa Catarina, Paraná and Rio Grande do Sul, for their daily efforts to qualify mortality data. To Dr. Eleonora Walcher, for the support at the beginning of this project, and to Renato Teixeira, for his help with the analyses.

Authors' contributions: Vidor AC participated in study conception, database assembly, statistical analysis, manuscript writing and critical review. Conceição MBM participated in study conception, database assembly, manuscript writing and critical review. Luhm KR participated in study conception, interpretation of the data, manuscript writing and critical revision. Alves MFT participated in interpretation of the data, manuscript writing and critical review. Arceno A participated in study conception, database assembly, manuscript writing and critical review. França EB participated in study conception, analysis of the results and final review of the manuscript. Abreu DMX participated in the analysis of the results and final review of the manuscript.