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Death surveillance and contributions to an improved definition of the underlying cause of neonatal death

A vigilância do óbito e as contribuições para a melhoria da definição da causa básica do óbito neonatal

Vigilancia de la muerte y contribuciones para la mejoría de la definición de la causa básica de la muerte neonatal

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Abstract
Objective: To analyze the improvement of the definition of the underlying cause of neonatal deaths before and after death surveillance in Recife, Pernambuco. Methods: A descriptive study that used data from medical certificates of death, confidential data sheets, summaries of investigations. The profiles and the relocation of the underlying cause of death were compared before and after the investigation through specific chapters and groups of the Tenth Revision of the International Classification of Diseases. The agreement was analyzed using the Kappa index. Results: Of the total 144 deaths investigated, 95 (66.0%) had their underlying cause redefined. During the general analysis of the neonatal component, a reasonable agreement index was identified (0.311; CI95%: 0.272-0.350). All ill-defined causes were clarified after surveillance. There was an increment of the preventability potential for all neonatal deaths, with an emphasis on early deaths, which reached 100% causes registered as preventable. Conclusion: Death surveillance made it possible to improve the specificity of the underlying causes described in the medical certificate of death and may contribute to the reorientation of the strategies to reduce neonatal mortality from the perspective of preventability.
Keywords: Neonatal mortality; Causes of death; Information systems; Vital statistics; Epidemiological surveillance.

Resumo
Objetivo: Analisar a melhoria da definição da causa básica dos óbitos neonatais antes e após a vigilância do óbito no Recife, Pernambuco. Métodos: Estudo descritivo que se utilizou dados provenientes da declaração de óbito e das fichas confidenciais e sínteses de investigação. Comparou-se os perfis e a realocação da causa básica dos óbitos neonatais antes e após a investigação por meio dos capítulos e agrupamentos específicos da Décima Revisão da Classificação Internacional de Doenças. A concordância foi analisada pelo de índice Kappa. Resultados: Do total de 144 óbitos investigados, 95 (66,0%) tiveram a causa básica redefinida. Na análise geral do componente neonatal, foi identificado índice de concordância razoável (0,311; IC95%: 0,272-0,350). Todas as causas mal definidas foram esclarecidas após a vigilância. Houve incremento no potencial de evitabilidade para todos os óbitos neonatais, com destaque para os precoces que alcançaram 100% de causas registradas como preveníveis. Conclusão: A vigilância do óbito possibilitou melhoria da especificidade das causas básicas descritas na declaração de óbito e, pode contribuir para a reorientação das estratégias de redução da mortalidade neonatal, sob a perspectiva da evitabilidade.

Palavras-chave: Mortalidade neonatal; Causas de morte; Sistemas de informação; Estatísticas vitais; Vigilância epidemiológica.

Resumen

Objetivo: Analizar la mejoría de la definición de la causa básica de las muertes neonatales antes y después de la vigilancia de la muerte en Recife, Pernambuco. Métodos: Estudio descriptivo en el que se utilizó datos provenientes del certificado médico de defunción y de los registros confidenciales y las síntesis de investigación. Se compararon los perfiles y la reasignación de la causa básica de las muertes neonatales antes y después de la investigación mediante los capítulos y bloques específicos de la Décima Revisión de la Clasificación Internacional de Enfermedades. Se analizó la concordancia por el índice Kappa. Resultados: Del total de 144 muertes investigadas, 95 (66,0 %) tuvieron la causa básica redefinida. En el análisis general del componente neonatal, se identificó índice de concordancia débil (0,311; IC95%: 0,272-0,350). Todas las causas mal definidas se aclararon después de la vigilancia. Se incrementó la posibilidad de evitación de todas las muertes neonatales, con énfasis en las tempranas, que alcanzaron el 100% de causas registradas como evitables. Conclusión: La vigilancia de la muerte permitió mejorar la especificidad de las causas básicas descritas en el certificado médico de defunción y puede contribuir a la reorientación de las estrategias de reducción de la mortalidad neonatal, desde la perspectiva de la posibilidad de evitación.

Palabras clave: Mortalidad neonatal; Causas de muerte; Sistemas de información; Estadísticas vitales; Vigilancia epidemiológica.

1. Introduction

Neonatal mortality is regarded as a sensitive indicator of social determinants of health (Ruiz et al., 2015; Maia et al., 2020). It is a relevant public health event, and the majority of death are easily preventable (Ruiz et al., 2015). Additionally, they are sentinel events, because their occurrence is unnecessary and reveals poor effectiveness of the actions of healthcare services (Sala & Luppi, 2020). Studies conducted in Brazil evidence that about 70% of neonatal deaths are due to preventable causes (Teixeira et al., 2019; Dias et al., 2019).

Reducing neonatal mortality is part of the Sustainable Development Goals (Grove et al., 2015). In order to effectively monitor the progress of the goals agreed in the global health agendas, it is essential to recognize the importance of the proper availability of vital statistics data (Mikkelsen et al., 2015). In Brazil, progress have been identified with respect to vital statistics data (Rodrigues et al., 2019; Almeida & Szwarcwald, 2017; Szwarcwald et al., 2019). However, there are still problems with the completeness of variables and inaccuracies when attesting the cause of death among infants (Silva et al., 2013; Maia et al., 2017; Pedraza, 2021).

Brazil has been developing strategies to enhance information on vital statistics and improve the maternal and child healthcare network. Among these strategies, attention is called to the Infant and Fetal Death Surveillance (VOIF), which became mandatory, as of 2010, in the healthcare services (public and private) that form part of the Unified Health System (Brasil, 2010). Given the legal regulatory basis, investigations of fetal and infant deaths became recognized as another tool that enables the identification of the real causes and circumstances of death, aiming at reducing preventable deaths (Vanderlei & Navarrete, 2013; Oliveira et al., 2017).

In Recife, PE, the implementation of the VOIF has a confidential and critical-reflective approach (Oliveira et al., 2017). It is conducted by the technical management group, composed of healthcare professionals, the epidemiological surveillance team, and healthcare managers, differing from other initiatives that take these actions linked to the Death Prevention Committees (Oliveira et al., 2017). The steps of the investigation enable: a) identification of infant deaths; b) epidemiological investigation; c) discussion of deaths; and d) referral of proposals for promotion, healthcare, and correction of vital statistics (Oliveira et al., 2017).

The surveillance process is a management and social control tool. It provides more specific information on the causes of death and on vital statistics, supporting the planning and orientation of guidelines that promote effective child health care. This study aimed to analyze the improvement of the definition of the underlying cause of neonatal deaths before and after

death surveillance in Recife, Pernambuco.

2. Methodology

This is a descriptive study carried out in Recife, PE, located in the Northeast region of Brazil. The city covers a land area of 218.5 km2 and in 2014 it had an urban concentration of 1,608,488 inhabitants (Brasil, 2014). The study population was composed of all neonatal deaths involving mothers residing in the city (except for those resulting from congenital anomalies), investigated and discussed by the VOIF. The deaths due to congenital malformations are not investigated by the VOIF, because of the lower potential for preventability.

The source of data was the Mortality Information System (SIM) and the confidential data sheets from the investigation of fetal and infant deaths. The SIM is based on a single document, the Medical Certificate of Death (DO), a standardized instrument intended to enable the comparison of data and rationalize activities based on record information. It consists of 59 variables distributed in nine sections, and one of them refers to the conditions and causes of death. In the DO, there is a specific section related to the underlying cause, which is defined as the disease or injury which initiated the train of events leading directly to death (Brasil, 2011).

The confidential data sheet of investigation of fetal and infant death contemplates sections related to the notification, identification, healthcare data, occurrence of death, classification, and analysis of the preventability factors. After data are collected at the domestic, ambulatory, and hospital environments, these data are summarized in the summary data sheet, which includes the recommendations and conclusions of the case, and typed on the SIM-Web module at the federal level for purposes of monitoring by the Ministry of Health – MS (Brasil, 2009).

The agreement of the underlying cause was analyzed considering the fields related to the conditions and causes of death, and the conclusions of the relevant instruments. Data were grouped by components of neonatal mortality, early (0 to 6 days of life) and late (7 to 27 days of life), and tabulated through the Tabwin version 3.6b, program used for local extraction and analysis of databases of interest to health, available at the Informatics Department of the Brazilian Unified Health System (DATASUS).

The profiles and the relocation of the underlying cause of death were compared through specific chapters and groups of the International Classification of Diseases, tenth revision (ICD-10). In order to define the causes according to the potential for preventability, the criterion recommended by the List of Causes of Death Preventable through SUS Interventions was adopted, where deaths are classified as preventable, ill-defined, and other causes of death (not clearly preventable) (Malta et al., 2010).

In the assessment, we used the agreement observed and adjusted according to the Kappa index in association with the respective confidence intervals (CI95%). The classification proposed by Landis and Koch (1977) is interpreted through the following parameters: no agreement (< 0), poor (0 to 0.19), reasonable (0.20 to 0.39), moderate (0.40 to 0.59), substantial (0.60 to 0.79), and excellent (0.80 to 1.00). The analyses were conducted with the aid of the software Statistical Package for the Social Sciences (SPSS) version 15.0.

The research was approved by the Research Ethics Committee of the Joaquim Nabuco Foundation (Certificate of Presentation for Ethical Consideration (CAAE): 67387117.0.0000.5619).

3. Results

During the study period 198 neonatal deaths were recorded, of these 41 (20.7%) showed severe or lethal congenital malformation. Thus, of the 157 eligible deaths, 144 investigation data sheets were located and provided by the Health

Department, 94 (65.3%) were related to the early neonatal component and 50 (34.7%) to the late neonatal component.

There was a predominance, in both components of neonatal mortality, of the underlying causes included in chapter XVI, regarding conditions originating in the perinatal period, notified in the original DO (n = 133; 92.4%) and after the investigation (n = 137; 95.1%). After the investigation, some causes were clarified and relocated from chapters (Table 1).

Table 1. Distribution of neonatal deaths according to ICD-10 chapters informed before and after the investigation carried out by the Infant and Fetal Death Surveillance. Recife, PE, 2014.

ICD-10 Chapters	Neonatal death			
	Early *(n = 94)*		Late *(n = 50)*	
	DO	VOIF	DO	VOIF
	n (%)	n (%)	n (%)	n (%)
I – Certain infectious and parasitic diseases	2 (2.1)	2 (2.1)	2 (4.0)	2 (4.0)
X – Diseases of the respiratory system	-	-	1 (2.0)	-
XVI – Certain conditions originating in the perinatal period	91 (96.8)	92 (97.9)	42 (84.0)	45 (90.0)
XVII – Congenital malformations, deformations, and chromosomal abnormalities	1 (1.1)	-	1 (2.0)	-
XVIII – Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified	-	-	1 (2.0)	-
XX – External causes of morbidity and mortality	-	-	3 (6.0)	3 (6.0)

Note: No deaths were identified for the remaining ICD-10 chapters.
Source: Data Sheet for Investigation of the Infant and Fetal Death – Summary, conclusions, and recommendations. Recife, PE (2014).

Almost all early neonatal deaths showed equivalence in the chapters after the investigation (n = 93; 98.9%). However, the same pattern was not observed in late neonatal deaths, in which case only deaths included in chapter XX, classified as external causes of morbidity and mortality, had no changes (n = 3; 6.0%). The other causes were corrected after the investigation by the VOIF, and the specific chapters of origin were modified (Table 2).

Table 2. Relocation of the ICD-10 chapters of neonatal deaths reported in the original death certificate and the one defined after the investigation. Recife, PE, 2014.

DO Chapters	Total	*Relocation by chapters after investigation*					
		I	X	XVI	XVII	XVIII	XX
Early neonatal							
I	**2**	2	-	-	-	-	-
XVI	**91**	-	-	91	-	-	-
XVII	**1**	-	-	1	-	-	-
Late neonatal							
I	**2**	-	-	2	-	-	-
X	**1**	1	-	-	-	-	-
XVI	**42**	1	-	41	-	-	-
XVII	**1**	-	-	1	-	-	-
XVIII	**1**	-	-	1	-	-	-
XX	**3**	-	-	-	-	-	3
Total	**144**	**4**	**-**	**137**	**-**	**-**	**3**

Source: Data Sheet for Investigation of the Infant and Fetal Death – Summary, conclusions, and recommendations. Recife, PE (2014).

Of the total deaths investigated, 95 (66.0%) had their underlying cause redefined. Initially, 137 (95.1%) neonatal deaths were notified in the original DO as preventable. After the investigation, there was an increment of the preventability potential for all age components, with an emphasis on early deaths, which reached 100% causes registered as preventable. The changes were more significant in the categories of deaths that may be reduced through proper care to women during pregnancy and to the newborn (Table 3).

Table 3. Comparison of the underlying causes of death of neonatal components before and after investigation by the Infant and Fetal Death Surveillance, according to the Brazilian List of Preventable Causes of Death. Recife, PE, 2014.

Preventability	**Early** *(n = 94)*		**Late** *(n = 50)*	
	DO	**VOIF**	**DO**	**VOIF**
	n (%)	***n (%)***	***n (%)***	***n (%)***
Preventable causes	90 (95.7)	94 (100.0)	47 (94.0)	49 (98.0)
That may be reduced through immunization	- (-)	- (-)	- (-)	1 (2.0)
Pertussis (A37.9)	- (-)	- (-)	- (-)	1 (2.0)
That may be reduced through proper care to women during pregnancy	52 (55.3)	73 (77.7)	20 (40.0)	37 (74.0)
Congenital syphilis (A50.0, A50.2)	2 (2.1)	2 (2.1)	- (-)	1 (2.0)
Maternal conditions not necessarily related to the current pregnancy				
Hypertensive disorders (P00.0)	6 (6.4)	18 (19.1)	4 (8.0)	8 (16.0)
Urinary tract infection (P00.1)	5 (5.3)	8 (8.5)	1 (2.0)	10 (20.0)
Other conditions (P00.2, P00.3, P00.8, P00.9, P04.1, P04.4)	6 (6.4)	15 (16.0)	- (-)	9 (18.0)
Maternal complications of pregnancy				
Cervical incompetence (P01.0)	4 (4.3)	10 (10.6)	- (-)	1 (2.0)
Premature rupture of membranes (P01.1)	3 (3.2)	9 (9.6)	3 (6.0)	2 (4.0)
Multiple pregnancy (P01.5)	2 (2.1)	- (-)	- (-)	- (-)
Complications that can affect the placenta and fetal membranes (P02.2, P02.7)	10 (10.6)	6 (6.4)	7 (14.0)	3 (6.0)
Disorders related to short-term pregnancy and low birth weight (P07.1, P07.2)	10 (10.6)	2 (2.1)	1 (2.0)	- (-)
Other causes (P05.9, P22.0, P26.9, P77)	4 (4.3)	3 (3.2)	4 (8.0)	3 (6.0)
That may be reduced through proper care to women during labor	13 (13.8)	8 (8.5)	4 (8.0)	3 (6.0)
Placenta previa and placental abruption (P02.0, P02.1)	4 (4.3)	4 (4.3)	2 (4.0)	2 (4.0)
Perinatal hypoxia/asphyxia (P20.1, P21.0, P21.9)	4 (4.3)	1 (1.1)	- (-)	- (-)
Birth trauma (P15.9)	1 (1.1)	1 (1.1)	- (-)	- (-)
Neonatal aspiration of meconium (P24.0)	3 (3.2)	- (-)	- (-)	- (-)
Other causes (P02.5, P03.0, P03.6, P03.8, P24.9)	1 (1.1)	2 (2.1)	2 (4.0)	1 (2.0)
That may be reduced through proper care to the newborn	25 (26.6)	13 (13.8)	17 (34.0)	5 (10.0)
Neonatal respiratory disorders (P22.9, P23.9, P28.0)	13 (13.8)	8 (8.5)	- (-)	1 (2.0)
Neonatal infections (P36.9, P38, P39.3)	12 (12.8)	4 (4.3)	17 (34.0)	3 (6.0)
Other causes (P70.0, P70.1, P78.0)	- (-)	1 (1.1)	- (-)	1 (2.0)
That may be reduced through proper diagnosis and treatment	- (-)	- (-)	2 (4.0)	- (-)
Respiratory infections (J18.1, J21.9, J69.0)	- (-)	- (-)	1 (2.0)	- (-)
Other causes (A41.8, A41.9, N39.0)	- (-)	- (-)	1 (2.0)	- (-)
That may be reduced through health promotion actions	- (-)	- (-)	4 (8.0)	3 (6.0)
External causes (Y21.0, Y21.9, Y34.9, W78.0, W78.9)	- (-)	- (-)	3 (6.0)	3 (6.0)
Other infectious diseases (B99)	- (-)	- (-)	1 (2.0)	- (-)

ILL-DEFINED CAUSES	1 (1.1)	- (-)	1 (2.0)	- (-)
Other causes (not clearly preventable)	3 (3.2)	- (-)	2 (4.0)	1 (2.0)

Source: Data Sheet for Investigation of the Infant and Fetal Death – Summary, conclusions, and recommendations. Recife, PE (2014).

The actions resulting from the investigation showed greater sensitivity to the changes in the causes that may be reduced through proper care to women during pregnancy, in which, in the early neonatal component, a 40.4% increase was verified, from 52 (55.3%) to 73 (77.7%) registrations. The conditions associated with hypertensive disorders tripled (n = 18; 19.1%) and the factors related to short-term pregnancy and low birth weight, included in the maternal complications of pregnancy section, reduced from ten (10.6%) to two (2.1%) cases (Table 3).

Among the causes that may be reduced through proper care to women during labor (n = 8; 8.5%), there was a decrease in early deaths by perinatal hypoxia (n = 1; 1.1%), and those related to meconium aspiration were all redefined. The effective care to the newborn evidenced a decline from 12 (12.8%) to four (4.3%) cases of neonatal infections. All ill-defined and not clearly preventable causes were clarified (Table 3).

In the late neonatal component, a notification of pertussis was observed (n = 1; 2.0%), a cause that may be reduced through immunization. Regarding proper care during the gestational period, there was a record of congenital syphilis (n = 1; 2.0%) and an increase in urinary tract infections, from one (2.0%) to ten (20.0%) cases. Placenta and membrane complications had a decrease corresponding to 42.8%, from seven (14.0%) to three (6.0%). Factors related to the quality of care during labor, such as placenta previa and placental abruption, remained equivalent after conclusion of the case, accounting for 4.0% (n = 2) of the deaths (Table 3).

Neonatal infections (which represented all cases sensitive to care to the newborn), decreased from 17 (34.0%) to three (6.0%) notifications of late deaths. All causes included in the group of proper diagnosis and treatment actions, as well as ill-defined ones, were rectified and clarified after the investigation. Only one death (2.0%) remained under the category of other causes not clearly preventable (Table 3).

Upon about 70% of the underlying causes changed after the investigation, a reasonable Kappa agreement index was revealed (0.311; $CI_{95\%}$: 0.272-0.350) in the general assessment of mortality. Among the age groups, the lowest agreement was assessed in the late neonatal component (0.247 = reasonable; $CI_{95\%}$: 0.188-0.306) (Table 4).

Table 4. Agreement (Kappa index) of the underlying cause by component of neonatal mortality before and after the investigation. Recife, PE, 2014.

Type of death	Kappa Index	Cl[a]	$CI_{95\%}$[b]
Early neonatal	0.343	Reasonable	0.293-0.393
Late neonatal	0.247	Reasonable	0.188-0.306
Total	**0.311**	**Reasonable**	**0.272-0.350**

Notes: a) Classification; b) CI95%: confidence interval. Source: Authors.

4. Discussion

In the general assessment of neonatal deaths, it was verified that there were no significant changes when analyzing the relocation of the chapters informed in the original DO. However, approximately 70% of the underlying causes were relocated. By validating data beyond the general mortality groups, we can make a retrospective analysis of the care pathway, improving its specificity and redefining the potential for preventability (Santos et al., 2015; Oliveira et al., 2017; Helps et al., 2020).

In this study, a significant proportion of neonatal deaths was classified as preventable death after the surveillance activities. The progress in strengthening the primary care actions (Dieleman et al., 2013, 2016), expansion of the Family Health Strategy coupled with the improvement of the housing and basic sanitation conditions (Rasella et al., 2013; Lourenço et al., 2014) did not prove sufficient to overcome the disparities in the health-disease process (Vanderlei & Navarrete, 2013).

In the late neonatal component, there were records of pertussis, which is a cause that may be reduced through immunoprevention. The introduction, in 2014, of diphtheria, tetanus, and acellular pertussis (DTaP) vaccine, adsorbed in the vaccination schedule for pregnant women characterized a prevention strategy. Given that it enables transplacental protection, extended until the child begins the recommended vaccination coverage (Matlow et al., 2013). Additionally, the allocation of resources in order to reinforce the campaigns for update of the vaccine card becomes essential (Domingues & Teixeira, 2013). Considering the important impact that complications and high lethality rates have on the group of children that were abandoned or whose immunization is delayed.

The contribution of death surveillance enabled a better definition of the underlying cause and the increment in preventable causes in the gestational period. Deficiencies in the quality of prenatal care reflect shortages of supplies and drugs, difficulties in carrying out medical check-ups, and failures to consolidate the referral and counter-referral systems (Cavalcante et al., 2016). Ineffective treatment or even the occurrence of preventable causes, especially hypertensive disorders, syphilis, and urinary tract infections, refer to a sentinel event in healthcare and affect negative outcomes for the mother-child binomial (Paris et al., 2013; Leal et al., 2015; Oliveira et al., 2021).

The results evidenced improved care provided during labor and to the newborn, with a decrease in perinatal hypoxia, meconium aspiration, and neonatal infection indexes. This refers to a configuration of the qualified care network during the pregnancy-postpartum cycle, supporting progress in the comprehension of maternal specificities (Silva et al., 2013). In association, the professional practice based on scientific evidence, strengthening of intersectoral services, adoption of protocols, and healthcare qualification plans ensure children the right to safe birth and healthy growth and development (Lansky et al., 2014).

Ill-defined causes and those not clearly preventable were reduced. Together with the high percentage of deaths that were rectified after the VOIF investigations, such causes explain the reasonable Kappa agreement index. This indicates the effectiveness of the investigation stages (Bensaid et al., 2016; Halim et al., 2016; Masson et al., 2016).

5. Conclusion

The results of the study showed the contribution of the infant and fetal death surveillance to the improvement of the definition of the underlying causes of neonatal deaths. We add that there was an increment in the potential for preventability of early and late neonatal deaths, and the ill-defined causes were clarified. The agreement between the underlying causes before and after the surveillance was classified as reasonable. Death surveillance enables a thorough review of neonatal deaths, improved specificity of the underlying causes described in the DO, and reorientation of healthcare strategies from the perspective of preventability, recommending practices aiming at the prevention of similar deaths.

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