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Severe acute maternal morbidity: use of the Brazilian Hospital Information System

ABSTRACT

OBJECTIVE: To estimate the prevalence of severe acute maternal morbidity and identify its associated hospital procedures.

METHODS: Data from the Hospital Information System, obtained from the Municipal Secretariat of Health of the city of Juiz de Fora, Southeastern Brazil, for the years 2006 and 2007, were used. The studied women included those admitted to the hospital for obstetric procedures (n = 8,620), and whose primary diagnosis was included within chapter XV: pregnancy, childbirth and puerperium of the International Classification of Diseases, 10th revision. Codes for routine procedures, special procedures, and professional acts that fulfilled the World Health Organization's criteria for severe acute maternal morbidity were identified, as well as other procedures infrequently employed during pregnancy and the postnatal period. Logistic regression analysis was employed to identify associations between the outcome and selected variables.

RESULTS: Prevalence of maternal morbidity was 37.8/1000 women, and that of mortality was 12/100,000 women. Hospitalization for more than 4 days was 13 times more frequent among women with some form of morbidity. After adjustment, predictors of severe acute maternal morbidity were: duration of hospitalization, number of hospitalizations, and stillbirths, and the most frequent procedures and conditions were blood product transfusions (15.7/1,000), "extended stay" (9.5/1,000) and severe pre-eclampsia/eclampsia (8.2/1,000).

CONCLUSIONS: Prevalence of severe acute maternal morbidity was high, and was related especially to hospitalization and to newborn variables. The criterion for identifying cases and the use of the National Hospital Information System proved to be useful for monitoring maternal morbidity and mortality and increasing our knowledge of its related aspects, contributing to the improvement of the quality of pregnancy and delivery care.

DESCRIPTORS: Pregnancy Complications, prevention & control. Morbidity. Hospitalization. Maternal Mortality. Hospital Information Systems. Maternal Health Services.

INTRODUCTION

The maternal mortality ratio is a sensitive and relevant indicator of the quality of women's health and health care, and provides a measure of human and social development and of the quality of life of a population.

Elevated maternal mortality is associated with other problems such as high maternal morbidity and perinatal and infant mortality. For every maternal death, several cases of severe morbidity are registered, many of which lead to permanent sequelae. Brazilian national estimates indicate that 16 debilitating

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complications are registered for every fatal case, with special emphasis on sterility and urinary incontinence.^a

Conditions leading to death are in general less frequent, and information on these cases is expected to have little impact on maternal mortality. Physical and psychological sequelae of iatrogeny and institutional violence imposed on women during pregnancy and delivery are difficult to quantify, and are therefore not computed within the causes of maternal death.

Danel et al² (2003) reported that, between 1993 and 1997, 43% of pregnant women in the United States showed some type of morbidity during pregnancy, most of which were preventable.

The concept of *near miss*, or severe acute maternal morbidity (SAMM), encompasses procedures not used in routine delivery care or interurrences that involve a risk to the woman's life. According to Souza, et al¹⁸ (2006), in a thorough review of the literature, the a number of criteria are used to define SAMM, including transfer to intensive care, hysterectomy, and clinical severity criteria (complexity of management, organ malfunction, and other signs and symptoms). Sheikh et al¹⁴ (2006) used loss of blood greater than 1,500 ml as a criterion for SAMM. Other authors have used mixed criteria.⁴ Mantel et al⁷ (1998) used as criteria emergency hysterectomy; hypovolemia requiring blood transfusion; pulmonary edema; transfer to intensive care; renal, cerebral, respiratory, metabolic, hepatic, and coagulatory dysfunction; and anesthesia accidents.

Geller et al⁴ (2004), using data from patient charts and other sources of information from a teaching hospital in Chicago, United States, measured three classes of obstetric indicators: diseases and health conditions, events indicative of disease severity, and procedures or interventions. These authors detected 11 factors that could be used in quantitative studies for classification of SAMM cases. Clinical classification of cases was carried out after analysis of patient charts and considered as the gold standard. Cases were classified taking into account the sensitivity and specificity of the criteria employed. While criteria were more specific, the clinical criteria derived from databases were more sensitive. All cases classified as SAMM using clinical criteria were identified using the quantitative criteria (100% sensitivity).

SAMM rates are used as an indicator of the quality of maternal care in developed countries, given that maternal deaths are becoming increasingly rare.³

The World Health Organization (WHO) working group on Maternal Morbidity and Mortality classification defined a case of SAMM as "a woman who nearly

died but survived a complication that occurred during pregnancy, childbirth or within 42 days of termination of pregnancy."¹² Criteria for identifying SAMM cases considered by WHO included clinical and laboratory criteria and interventions/procedures. In an effort to optimize surveillance efforts, this group defined potentially fatal conditions as hemorrhagic diseases related to pregnancy and delivery, gestational hypertensive disorders, systemic diseases (pulmonary edema, shock, septicemia) and procedures indicative of severity (hysterectomy, central venous access, ICU admission, among others). This list is not definitive, however, since other non-specified complications may also be severe and lead to death.¹²

Information systems available in Brazil, including the System of Hospital Information (SIH-SUS) of the Unified Health Care System (SUS) and the System of Mortality Information (SIM), contain a large body of data that could contribute to studies of maternal mortality and morbidity. SIH-SUS refers only to admissions taken place in hospitals that see patients through SUS, whereas SIM detects all deaths. Maternal mortality is underreported in SIM, with variation between the Brazilian regions related to the active presence of maternal mortality committees and the quality of access to health services, among other factors.^b

A study of the reliability of SIH-SUS data showed an agreement (kappa) coefficient of 0.98 for pregnancy, delivery, and postnatal care in Maringá, Southern Brazil.⁸ Veras & Martins¹⁹ (1994) found up to 82% agreement between diagnoses in hospitals in the city of Rio de Janeiro, Southeastern Brazil, and a kappa of 0.907 when procedures were considered. Bitencourt et al¹ (2008) found kappa values of 0.94 and 0.95 for c-sections and mother's age, respectively, also in the city of Rio de Janeiro. SIH-SUS is used for the identification of masked or presumed maternal deaths,⁵ as a source of information to estimate neonatal mortality and stillbirth rates,¹³ and, in association with SIM, to identify maternal deaths.¹⁵

The aim of the present study was to estimate the prevalence of severe acute maternal morbidity and to identify hospital procedures associated with this outcome.

METHODS

Data from 2006 and 2007 were provided by the Secretariat of Health of the city of Juiz de Fora, Southeastern Brazil. SIM data were used to cross-reference the maternal mortality data obtained from SIH-SUS.

^a Maluf EMCP. Investigações de morbimortalidade materna: valorizando a dignidade materna. Curitiba: Secretaria Municipal de Saúde; 1996. p. 7-18.

^b Ministério da Saúde (BR). Manual dos comitês de mortalidade materna. 3. ed. Brasília; 2007.

The SIH-SUS database comprises the following spreadsheets: TB_AIH (which identifies user, hospital, manager, auditor, primary and secondary diagnoses, procedure, date of admission and discharge, death); TB_HPE (special procedures); and TB_HSP (codes of professional services performed and their cost). Common to the three spreadsheets is the user's hospital admission authorization number (AIH), which can appear multiple times within the database in case the user has undergone more than one procedure. The same procedure may be repeated when more than one professional is required to carry it out.

In the SIH-SUS database, the initial diagnosis at admission may not be confirmed, and new clinical conditions of greater severity or complexity may arise. In this case, a change of procedure is requested, which must be authorized by the general director, the clinical director, or the hospital management. The new procedure is then entered in the "Special Procedures" field. When a pregnant woman is admitted for vaginal delivery and requires a c-section, the c-section is registered as a special procedure. When more than five special procedures are entered into a single HAA, a new HAA is generated which bears the same number as the previous one. Several conditions exist in which a new HAA may be generated, including transfers from obstetrics to surgery and vice-versa; from obstetrics to obstetrics in case of two sequential obstetric interventions; from obstetrics to clinics in the case of delivery or surgical intervention, after the length of stay established in the spreadsheet is expired. The professional services spreadsheet provides information on services that are paid for in separate. The special procedure known as "extended stay" (*permanência a maior*) is authorized and recorded in the system when the admission period exceeds twice that predicted in the procedures chart.^c

Certain non-obstetric procedures are accepted under diagnoses included in Chapter XV of the International Classification of Diseases, Tenth Revision (ICD-10) for the purpose of payment of hospital admissions by SUS. Conversely, obstetric procedures accept certain admission causes that are outside Chapter XV.

Admissions whose primary diagnosis was included in Chapter XV of ICD-10 and/or admissions in which obstetric procedures were carried out were retrieved from the TB_AIH spreadsheet. We used the AIH number to link TB_AIH, TB_HPE, and TB_HSP. We identified the codes for routine procedures, special procedures, and professional services that could be classified as SAMM as defined by WHO, as well as of other procedures or conditions that are not routinely associated with pregnancy, delivery, abortion, or the postnatal period. All women displaying any of these

procedures was considered as SAMM (Table 1). The primary diagnosis upon admission was used as one of the criteria for selection, but was not considered in the classification of cases due to its lack of specificity – approximately 55% of admissions would be classified as SAMM if these criteria were adopted.

Duplicate AIH entries were eliminated to yield the total number of women who underwent the selected procedures. We calculated SAMM occurrence, lethality rate, and proportional maternal mortality, using as a denominator the number of women with maternal causes as primary diagnosis/procedure. We use the terms "proportional maternal mortality" as the number of maternal deaths divided by the number of women admitted due to maternal causes, and "maternal mortality ratio" in its traditional sense (number of maternal deaths divided by the number of live births in a given area and period).

Due to the possibility of recurrent hospitalizations, total duration of admission was obtained by adding the durations of all admissions recorded for each woman.

The following variables were included in the analysis: age, diagnosis upon admission, procedures administered, duration of admission, number of admissions per woman, newborn remaining hospitalized after mother's discharge, number of stillbirths, number of newborns who died before mother's discharge, and transfer of the newborn.

Women with and without SAMM were compared according to these criteria, and we carried out logistic regression analysis with variables that were statistically significant in bivariate analysis.

For analysis of maternal mortality, we selected deaths with codes pertaining to pregnancy, abortion, or the postnatal period in SIM. Comparison with SIH-SUS records was manual, given that the low frequency of such events.

Data analysis was carried out using SPSS software, version 15.

The research project was approved by the Research Ethics Committee of the Federal University of Juiz de Fora (protocol no. 468/2007).

RESULTS

In the studied period, 8,620 women were hospitalized due to primary diagnoses included in ICD-10 Chapter XV, and/or underwent obstetric procedures. In total, 39,305 professional services, 15,644 special procedures, and 70,162 routine procedures were administered. Of

^c Ministério da Saúde (BR). Secretaria de Atenção à Saúde. Departamento de Regulação, Avaliação e Controle. Manual do Sistema de Informação Hospitalar/ Atualização. 1. Brasília; 2006. v.1. p. 110.

all hospitalized women, 326 showed clinical conditions and/or procedures classified as SAMM, and one woman died. The proportional maternal mortality in SUS hospitals of Juiz de Fora was 12.0 per 100,000 women, lethality was 3.1 per thousand women, and prevalence of SAMM was 37.8 per thousand women.

Age ranged from 12 to 54 years for women without SAMM and 13 to 54 for those with SAMM. Median age was 24 and 27 years for these two groups, respectively.

Roughly 13% of women without SAMM were admitted more than once in the period, whereas this proportion was 45.7% for SAMM cases. Mean duration of hospitalization was 3.5 and 10.5 days (median three and seven days) for women with and without SAMM, respectively.

Hospitalization for more than four days was 13 times more frequent among women with SAMM. SAMM cases were four times more likely to have multiple admissions than non-SAMM cases. Prevalence of newborn remaining hospitalized after mother's discharge, stillbirth, and newborn death before mother's discharge were higher among SAMM cases (prevalence ratios of 2.52, 4.86, and 4.41, respectively) (Table 2). Duration of hospitalization, number of admissions, and stillbirth were predictors of SAMM in logistic regression analysis ($p < 0.001$) (Table 3).

The most common procedures/conditions were transfusion of blood products (15.7/1,000), "extended stay" (9.5/1,000) and severe pre-eclampsia/eclampsia (8.2/1,000) (Table 4).

DISCUSSION

Prevalence of SAMM (37.8/1,000) was similar to that reported in a systematic review of studies using different criteria to define SAMM cases.⁹ Souza et al¹⁷ (2010) used admission to intensive care, blood transfusion, eclampsia, and cardiac and renal complications as markers, arriving at rates of approximately 34.31/1000 births in Latin-American countries. The estimate for Brazil was 40.67/1,000. Souza et al (2008),¹⁵ using the cause of death registered in SIM and diagnoses and procedures from SIH-SUS, found rates that ranged from 33 to 42 per 1,000 live births in the capital cities of the Brazilian Southeast Region. The SAMM ratio was 6.8/1,000 deliveries in a public maternity ward in Campinas, Southeastern Brazil.¹⁶ Martins^d (2007), using criteria based on clinical conditions and procedures among black women, found rates of 2.65% in the municipalities of Araucária and 3.3% in Lapa, both within the metropolitan area of Curitiba, Southern Brazil. Prevalence of SAMM according to selected criteria

Table 1. Diagnoses and/or clinical conditions and procedures, registered in the Hospital Information System, selected as indicative of severe acute maternal morbidity.

Diagnoses and/or clinical conditions	Procedures
Anaphylactic shock	Admission to intensive care unit
Adult cardiogenic shock	Human albumin
Adult hypovolemic shock	Cardioversion
Septic shock	Red blood cell concentrate
Complications of surgical or medical procedures	Leukocyte concentrate
Coagulation defects	Platelet concentrate
Eclampsia	Postnatal hysterectomy
Acute pulmonary edema	Cardiac defibrillator implant
Hemorrhage during pregnancy	Pacemaker implantation
Abdominal wall infection	Circulatory assist device
Infection, delivery and postnatal	Exploratory laparotomy
Acute renal insufficiency	Laparotomy for hysterorrhaphy
Acute respiratory insufficiency	Other hysterectomy
Clinical intercurrent during secondary care of high-risk pregnancy	Extended stay
Clinical intercurrent during high-risk pregnancy	Individual plasma
Obstetric intercurrent during secondary care of high-risk pregnancy	Resuture of abdominal wall
Pyelonephritis	Total blood
Severe pre-eclampsia	Conservative treatment for intracerebral hemorrhage
Thrombocytopenic purpura	
Obstetric intercurrent during high-risk pregnancy	
Septicemia	
Thyroiditis	
Thyrototoxicosis	

was higher for blood product transfusion (15.7/1,000) and "extended stay" (9.5/1,000), and, among clinical conditions, for eclampsia (8.2/1,000). Say et al,¹¹ (2004) found that prevalence varied according to the criteria used. Rates ranged from 0.8% to 8.2% in studies in which specific diseases were used, from 0.01% to 2.99% when procedures were the criterion, and from 0.38% to 1.09% when organ dysfunction was considered. Although the prevalence ratio was significant for

^d Martins AL. "Near miss" e mulheres negras em três municípios da região metropolitana de Curitiba [tese de doutorado]. São Paulo: Faculdade de Saúde Pública da USP; 2007.

Table 2. Prevalence ratios for severe acute maternal morbidity according to selected variables among pregnant/postnatal women hospitalized through the Unified Health Care System. Juiz de Fora, Southeastern Brazil, 2006,2007

Variable	SAMM		PR	95%CI
	Yes	No		
Duration of hospitalization, mother				
≥ 4 days	275	2083		
< 4 days	51	6211	14.32	10.66;19.23
Number of hospital admissions, mother				
> 1	149	1090		
1	177	7204	5.01	4.07; 6.18
Newborn remained hospitalized after mother's discharge				
Yes	10	97		
No	316	8197	2.52	1.38; 4.59
Stillbirths				
≥1	13	60		
None	313	8234	4.86	2.94; 8.06
Neonatal death				
Yes	7	50		
No	319	8244	4.41	1.63; 6.65

SAMM: Severe acute maternal morbidity

all variables analyzed, multiple regression analysis showed that hospitalization for longer than four days, more than one admission during pregnancy, and stillbirths were strongly associated with SAMM. SAMM is

an important factor in premature birth.^{6,10} In the present study, we found 2% neonatal deaths and 4% fetal deaths among SAMM cases.

One maternal death was identified among all hospital admissions, and was classified as SAMM. According to SIM data, there were six maternal deaths in Juiz de Fora during the studied period. Cross-referencing the list of deaths in the two systems (SIM and SIH-SUS) showed that one death took place at home, two were reported in SIH-SUS but did not include a maternal cause or obstetric procedure upon the second hospitalization that preceded death. In the two remaining cases, the hospitalization that preceded death was not included in the SIH-SUS database, even though previous admissions were included, most likely due to the AIH being presented later or to the occurrence of a non-SUS admission.

Limitations related to the use of SIH-SUS are inherent to the purpose for which the system was created: the payment of health service providers. Since different procedures have different costs, there may be a propensity for preferential registration of procedures with higher cost. Another limitation is the lack of adequate training of professionals that enter the codes for cause of hospitalization, procedures, and professional services into AIH. Incomplete or missing data for secondary diagnosis, schooling, antenatal appointments, risk pregnancies, and address makes the full understanding of cases difficult.

Table 3. Logistic regression analysis for women with severe acute maternal morbidity hospitalized through the Unified Health Care System. Juiz de Fora, Southeastern Brazil, 2006-2007.

Variable	Coefficient	p	OR	95%CI
Hospitalization ≥ 4 days	2.5280	0.0000	12.52	9.67; 16.23
More than one admission	1.3839	0.0000	3.99	3.13 5.10
Newborn remains after mother's discharge	-0.1018	0.7753	0.90	0.45; 1.82
Stillbirths	1.1910	0.0032	3.29	1.49; 7.26
Neonatal death	0.4312	0.4120	1.54	0.55; 4.31

Table 4. Procedures or diagnoses considered as criteria for severe acute maternal morbidity among women hospitalized through the Unified Health Care System. Juiz de Fora, Southeastern Brazil, 2006-2007.

Diagnosis and/or clinical condition	n	%	SAMM rate/1000	Procedures	n	%	Morbidity rate/1000
Complications of surgical or medical procedures	11	3.4	1.3	Admission to intensive care	2	0.6	0.2
Eclampsia/severe pre-eclampsia	71	21.8	8.2	Hysterectomy	10	3.0	1,2
Hemorrhage during pregnancy	10	3.1	1.2	Transfusion of blood products	136	41.7	15.7
Clinical/obstetric intercurrent during secondary care of high-risk pregnancy	28	8.6	3.4	Extended stay	82	25.1	9.5
Total SAMM cases	326	100.0	37.8				

^a Plasma, total blood, red blood cells, human albumin
SAMM: Severe acute maternal morbidity

The present method still shows low sensitivity for capturing cases of maternal death, given that many of these may occur in the postnatal period or in emergency settings. In cases of re-admission, the reason for hospitalization does not always refer to the postnatal state of the mother. A search through patient charts and interviews with women aimed at confirming cases and understanding factors contributing to maternal morbidity would be required in order to confirm the criteria for defining SMM.

The consistency of our findings with those reported in the literature shows that cross-referencing of SIH-SUS spreadsheets has great potential as a tool for identifying

SMM cases. The system used for identifying cases is feasible and may contribute to surveillance of maternal morbidity and mortality, furthering our understanding of certain aspects of these conditions. This in turn may contribute to improvement in the quality of care provided to women during pregnancy, delivery and the postnatal period.

Use of SIH-SUS for capturing cases of SMM allows for their rapid and timely identification. Its use, if adopted by managers (as is the case for mandatory notification diseases), could generate timely and automatic information for surveillance of maternal morbidity and mortality and evaluation of obstetric care.

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