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# Description of the contributing factors to deaths secondary to hypertensive disorders associated with pregnancy in Antioquia, Colombia (2012-2020)

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**Abstract:** Objective: To describe the characteristics of the affected population and the delays that contributed to maternal mortality secondary to hypertensive disorders of pregnancy. Materials and Methods: Descriptive and retrospective study based on the epidemiologic surveillance of sentinel cases of early maternal deaths of women residing in Antioquia, Colombia, during pregnancy, delivery and the 42 days after delivery occurring in the period 2012-2020. A database was created in Microsoft Access 2007 (Microsoft, Redmond, WA, USA), and data were analyzed in Microsoft Excel and SPSS version 22. Results: There were 266 maternal deaths, of which 38 were secondary to hypertensive disorders of pregnancy. Eclampsia was the cause of 15 deaths; 12 due to HELLP syndrome, 9 due to intracerebral hemorrhage, and 2 due to placental abruption and disseminated intravascular coagulation. In 13 of the 38 cases, there was no adequate magnesium sulfate regimen, 19 did not receive indicated antihypertensive treatment, and 17 did not have adequate antihypertensive control. Conclusion: Antenatal care is a critical opportunity for detection, prevention, and risk stratification. All obstetric care centers should be prepared to manage emergencies associated with hypertensive disorders of pregnancy. Outcomes improve with the use of standardized, organized emergency protocols and the participation of multidisciplinary teams that ensure quality care and a positive impact on preventable maternal morbidity and mortality.

**Key words:** maternal mortality; hypertensive disorders of pregnancy; maternal deaths; pregnancy; eclampsia; HELLP syndrome; intracerebral hemorrhage; placental abruption; magnesium sulfate; antihypertensive

## 1 Background

Hypertensive disorders associated with pregnancy complicate 2 to 4% of pregnancies and are responsible for approximately 14% of direct maternal deaths annually worldwide and 26% in Latin America and the Caribbean [1-4]. In Colombia, in 2022, 433 maternal deaths were reported, of which 148 were direct deaths, and hypertensive disorders were the leading cause of direct maternal mortality at 26.7% [5].

Preeclampsia is a disease characterized by overlapping pathogenic theories involving endothelial dysfunction, vasospasm, placental abnormalities, angiogenic-antiangiogenic imbalance, oxidative stress, changes in immune response,

and generalized inflammation [6]. Mild preeclampsia involves the coexistence of hypertension (≥ 140-159/90-109 mmHg) or proteinuria (≥ 300 mg in 24 h). Severe preeclampsia is defined as blood pressure exceeding 160-110 mmHg, multi-organ involvement with paraclinical evidence of target organ damage, seizures, or new-onset neurological symptoms [2,3]. Gestational hypertension is characterized by elevated blood pressure without proteinuria or target organ damage, occurring after 20 weeks of gestation. Hypertension that begins before 20 weeks of gestation is considered chronic hypertension [3].

Hypertensive disorders of pregnancy require quality prenatal care, early recognition, appropriate treatment, and timely delivery [7].

Several strategies have been used to prevent preeclampsia and its complications, including initiating aspirin and calcium at the end of the first trimester in at-risk patients [2,8], close monitoring of the disease, magnesium sulfate to prevent eclamptic seizures, and strict blood pressure control to prevent strokes [2]. Poor quality care appears to be the biggest contributor to the small reduction in mortality from this cause [9].

Therefore, the objectives of this study were: to describe the characteristics of the affected population and the delays that contributed to maternal mortality, secondary to hypertensive disorders of pregnancy.

## 2 Materials and methods

This retrospective, observational study was conducted using epidemiological surveillance of sentinel cases of early maternal deaths among residents of Antioquia, Colombia, during pregnancy, childbirth, and the 42 days following delivery, occurring between 2012 and 2020. Cases were collected from the Population Registry, which contains mandatory reports from health facilities submitted to the public health surveillance system, and from the death certificates of all women of childbearing age. Clinical information was obtained from mortality analysis databases and epidemiological surveillance reports from the research committee of the Nacer group at the University of Antioquia, which is responsible for monitoring and analyzing cases for the Regional Health and Social Protection Secretariat of Antioquia, from whom authorization to conduct the research was obtained.

No interventions or modifications were made to the patients' biological, physiological, psychological, or social variables. The confidentiality of the databases was guaranteed. Variables collected included: age, access to prenatal care, area of residence, level of education, place and time of death relative to delivery, mode of delivery, gestational age at delivery, and recognized risk factors for preeclampsia. Maternal age, parity, and prenatal care are reported as means. The remaining variables are presented numerically. The "three delays" model proposed by Maine in 1994 was used to describe the factors contributing to maternal mortality [10,11]. (Table 1) Information from medical records and interviews with family members was used.

Table 1. Three-delay model

| |
|---|
| Delay 1: Delay in the decision to seek care due to failure to recognize pregnancy risk factors or the patient's lack of perception of the severity of the illness, family or community factors, economic status, perception of distance to the health center, potential cost, and previous experiences with the health system. |
| Delay 2: Accessibility challenges due to distance, distribution of health centers near the housing area, condition of communication routes, availability and cost-effective means of transport. |
| Delay 3: Delay in receiving appropriate care and treatment at a health facility. This refers to the service offered at the health facility. It may be due to insufficient equipment, a hostile environment, or inadequately trained staff. |

Source: Thaddeus S, Maine D. Too To Walk: Maternal mortality. Soc Sci Med. 1994;38(8):1091-110 [10].

For the analysis and assessment of delays, international recommendations and guidelines were standardized by consensus among the evaluators after reviewing medical records, based on the best available scientific evidence. "Delayed detection" of preeclampsia was defined as the description in the medical record of elevated blood pressure readings and

warning signs or symptoms, or a delay in clinical suspicion by the time the patient experienced a complication. "Inadequate clinical monitoring" was defined as incomplete paraclinical studies, inadequate vital sign monitoring, lack of monitoring or detection of signs and symptoms of magnesium sulfate toxicity, inadequate treatment of complications secondary to preeclampsia, and failure to identify the severity of the preeclampsia.

"Inadequate treatment" was defined as the failure to prescribe initial treatment lines at the appropriate time or dosage, or the prescription of medications not indicated for the treatment of hypertensive emergency or eclampsia, respectively. "Lack of magnesium sulfate prophylaxis" was defined as the failure to order an initial intravenous bolus of 4 to 6 g per hour when blood pressure readings were borderline critical or signs or symptoms of cortical irritation were present; the failure to administer a maintenance dose of 1 to 2 g per hour after the initial bolus when indicated; the failure to continue prophylaxis within the first 24 hours postpartum; or the failure to administer an additional magnesium sulfate bolus to eclamptic patients. The adequacy of fluid administration and whether or not the patient was admitted to an intensive care unit when indicated were assessed. Regarding "inappropriate referral decisions", it was evaluated whether, after stabilization, the staff continued treatment at the initial care center. A lack of resources was considered to exist when medical centers at a certain level of care did not have the required treatment available. Administrative difficulties were considered to include issues related to treatment authorizations, referral decisions, and transportation by healthcare providers.

Additionally, for the analysis of the cases, the rating methodology proposed by the Scottish group was used to rate the care for each case according to the categories shown in Table 2 [12].

Table 2. Rating of care according to the extreme maternal morbidity assessment model

| |
|---|
| Appropriate care: properly attended to, in accordance with care standards and guidelines |
| Incidental suboptimal event: there was a situation that did not comply with protocols but was not directly related to the complication. Something can be learned from the case, but it does not affect the outcome. |
| Minor suboptimal: the management of the complication did not adhere to protocols, but it did not influence the outcome. It did not affect the patient's progress, but it could have. |
| Suboptimal treatment: different care might have led to a more favorable outcome. The treatment significantly contributed to the patient's mortality. |

Source: Scottish Program for Clinical Effectiveness in Reproductive Health, Adamson L, Penney G. Scottish confidential audit of severe maternal morbidity: 4th annual report 2006. Edinburgh: Scottish Program for Clinical Effectiveness in Reproductive Health; 2007 [12].

A database was created using Microsoft Access 2007 (Microsoft, Redmond, WA, USA) and the data were analyzed using Microsoft Excel and SPSS version 22.

## 3 Results

During the study period, 671,906 births and 266 maternal deaths were recorded in Antioquia, Colombia, for a maternal mortality ratio of 39.58 per 100,000 live births [13]. Cases in which the research committee determined that hypertensive disorders of pregnancy had directly contributed to maternal mortality were included; 38 deaths (14.29%) were identified as being due to this cause. Table 3 shows the sociodemographic and clinical characteristics of the deceased. The causes of death associated with hypertensive disorders of pregnancy are shown in Figure 1.

Table 3. Sociodemographic and clinical characteristics of the population

| Characteristic | |
|---|---|
| Median age (years) | 26.94 |
| Prenatal control | 31 |
| Median number of prenatal checkups | 5 (1-9) |
| Parity average | 2.1 births |
| Relevant medical history | Value n/38 |
| Chronic hypertension | 1 |
| Previous preeclampsia | 2 |
| Overweight | 3 |
| Obesity | 5 |
| Diabetes | 1 |
| Area of residence | Value n/38 |
| Rural | 15 |
| Urban | 22 |
| No data | 1 |
| Educational level | Value n/38 |
| Primary | 9 |
| Secondary | 16 |
| Superior | 4 |
| No data | 8 |
| Place of death | Value n/38 |
| Home | 3 |
| Transfer | 1 |
| Level 1 Hospital | 3 |
| Level 2 Hospital | 2 |
| Level 3 Hospital | 29 |
| Time of death in relation to childbirth | Value n/38 |
| Less than 24 hours postpartum | 9 |
| 2-7 days postpartum | 17 |
| 8-42 days postpartum | 4 |
| Birth route | Value n/38 |
| Delivery | 4 |
| Caesarean section | 26 |
| Not relevant | 8 |
| Weeks of pregnancy until completion | Value n/38 |
| Less than 34 weeks | 12 |
| More than 34 weeks | 25 |
| No data | 1 |

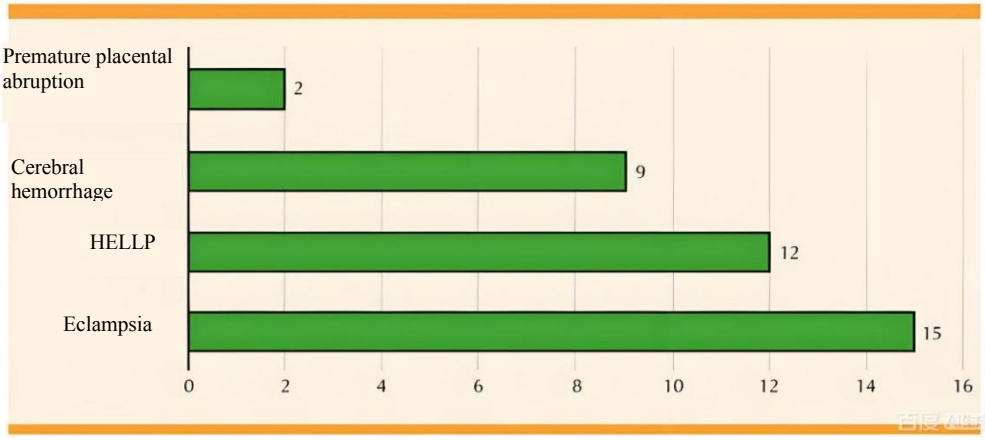


Figure 1. Causes of death due to hypertensive disorders of pregnancy (n = 38).

Regarding the delays described by Maine [11], Table 4 shows the identified factors that contributed to maternal mortality from hypertensive disorders. It is evident that all three delays occurred, with the third being a common factor in more than half of the cases. Of the 15 patients who died from eclampsia, 5 received medications that were not recommended: one patient received diazepam and 30 mg nifedipine, another patient received only midazolam, two patients received midazolam and diazepam, and another received diazepam and phenytoin. Suboptimal treatment was identified in 37 of the 38 cases.

Table 4. Contributing factors to maternal mortality due to hypertensive disorders of pregnancy

| Factors contributing to maternal mortality | Value n/38 |
|---|---|
| Delay 1 | |
| Lack of recognition of the risk by the patient | 7 |
| Cultural practices | 5 |
| Delay in the consultation due to economic reasons | 2 |
| Delay 2 | |
| Delay in arriving at the initial appointment | 8 |
| Delay 3 | |
| Without diagnosis | |
| No detection of preeclampsia | 10 |
| Delay in suspicion | 26 |
| Deficiency in questioning and physical examination | 16 |
| Incorrect clinical and paraclinical interpretation | 16 |
| Inadequate vital signs monitoring | 21 |
| Inadequate monitoring of magnesium sulfate and failure to detect its toxicity | 5 |
| Incomplete paraclinical studies | 16 |
| Inadequate treatment of complications secondary to preeclampsia | 26 |
| No classification of the severity of preeclampsia | 13 |
| Without administration of antihypertensive medication | 19 |
| Inadequate administration of the antihypertensive | 17 |
| Inadequate magnesium sulfate dosage | 13 |
| Medications not recommended for treating eclampsia | 5 |
| Inappropriate fluid administration | 14 |
| Without admission to ICU when he was admitted | 4 |
| Without timely referral of the patient to another level of care | 15 |
| Remission under inadequate conditions | 13 |
| Without timely termination of pregnancy | 15 |
| Inappropriate selection of birth route | 6 |
| Inadequate resources for the complexity | 36 |
| Administrative difficulties | 6 |
| Suboptimal care | 37 |

## 4 Discussion

Maternal mortality is one of the most important indicators of a population's health because it reflects equity and timely access to services, while also framing the progress achieved by a society in the socioeconomic and educational spheres [14]. In developing countries, maternal and perinatal morbidity and mortality rates secondary to preeclampsia have

increased [4,15], becoming the leading cause of direct maternal mortality in Colombia, according to reports from the National Institute of Health in recent years [5,16].

The literature shows that patients with preeclampsia have a 3 to 25 times greater risk of complications: eclampsia, cerebral hemorrhage, HELLP syndrome, premature placental detachment, thrombocytopenia, disseminated intravascular coagulation and pulmonary edema [7 14], which are considered complications of preeclampsia and may explain the annual death of approximately 50,000 women worldwide [14,15], which is consistent with the findings of the study published here.

Factors associated with maternal morbidity and mortality in developing countries include: lack of prenatal care, delays in diagnosis and treatment, lack of adequate care, lack of access to health services, lack of transportation to tertiary care centers, lack of properly trained personnel, lack of resources, medicines, laboratories and equipment [1,14,17]. In Antioquia, 37 of the 38 patients who died from hypertensive disorders had deficiencies in the quality of care or did not receive the necessary care to stabilize their condition, a finding consistent with studies carried out in Norway[18] and the Netherlands from 1993 to 2002 [19], in which, respectively, 87 and 90% of the women who died from hypertensive disorders of pregnancy received deficient care.

In the study published here, some women did not seek medical attention when they experienced risk signs or symptoms, and those who consulted at an early stage of the disease did not receive adequate treatment, either due to omissions or errors in identification and management, a situation also observed by Verona in Peru [20]. Inadequate practices in diagnosis, treatment, and referral of patients to a higher level of care are believed to contribute directly to more than one-third of all maternal deaths worldwide [21,22]. Maternal mortality associated with eclampsia, the most common cause of death in our series, is more pronounced in women who experience seizures outside the hospital and those who lack prenatal care [21]. Actions at the primary care level should focus on the early identification, stabilization, and timely referral of women with complications [22].

Everything indicates that up to 60% of cases of preeclampsia that occur in the postpartum period are not previously diagnosed, but contribute substantially to maternal morbidity and mortality [23]. In addition, the highest blood pressure readings usually occur 3 to 6 days after delivery, when patients are already at home [24], a finding found in the study published here, since 17 patients in the cohort died between the second and seventh postpartum day.

The literature mentions that lifestyle modification, weight loss, and bariatric surgery are effective measures for reducing risk [25]. In the cohort studied, 3 of the deceased were overweight and 5 were obese, which indirectly highlights the impact this variable can have on mortality. Despite the implementation of primary prevention measures, such as the prescription of aspirin and calcium from the end of the first trimester in at-risk populations [26], cases of severe preeclampsia and the morbidity and mortality associated with its complications continue to occur.

Secondary prevention measures for patients with hypertension (with or without proteinuria) aim to detect associated disorders, prescribe antihypertensive medications at the appropriate time, and initiate magnesium sulfate once severe symptoms or signs are identified, and terminate the pregnancy if necessary. Tertiary prevention aims to prevent the recurrence of eclamptic seizures once they have occurred, in order to reduce the impact and sequelae of the disease [1]. Eclamptic seizures occur in 2% of women with severe preeclampsia who do not receive magnesium sulfate and in less than 0.6% who do [27].

Magnesium sulfate is superior to phenytoin [28], diazepam [29] and nimodipine [30] for the prevention of eclampsia, and is the drug of choice for preventing eclamptic seizures and reducing the risk of maternal death, without substantial harmful effects on the mother or fetus [31]. Therefore, the administration of magnesium sulfate is the most important action to prevent death from eclampsia, and its availability and the competence of health personnel in its use should be

universal [27]. In the cohort analyzed, a significant number of patients did not receive or were inappropriately prescribed magnesium sulfate for the prevention or initial treatment of eclampsia. This situation was also evidenced in a study carried out by Karolinski and colleagues, regarding the impact of the intervention on maternal mortality and severe morbidity in 24 public hospitals (20 Argentinian and 4 Uruguayan), where the indication of magnesium sulfate was reported in only 33% of patients with preeclampsia to prevent eclampsia and in 58.3% of patients with eclampsia to treat the disease [32 ], similar results to those reported in the previous study by Zuleta in Antioquia, Colombia [9].

Although different societies have developed guidelines for the timely treatment of patients with hypertension in pregnancy [33], clear care protocols and training of healthcare personnel at all levels are needed to facilitate early detection and intensive treatment of hypertensive disorders in order to reduce and prevent adverse maternal and perinatal outcomes.

The study published here has several strengths: it goes beyond simply describing characteristics and non-modifiable risk factors, analyzing the components of medical care that directly contribute to maternal mortality; it reduces variability in the judgments made by the research committee because the findings related to medical history were compared with recognized, evidence-based clinical practice guidelines; and it includes all maternal deaths due to hypertensive disorders of pregnancy in a department of Colombia over a nine-year period.

## 5 Conclusion

Hypertensive disorders of pregnancy are a major cause of maternal death in Antioquia, Colombia. Prenatal care is a crucial opportunity for detection, prevention, and risk stratification. All obstetric care centers must be prepared to manage emergencies associated with hypertensive disorders of pregnancy. Outcomes improve with the implementation of standardized, organized emergency protocols and the participation of multidisciplinary teams that ensure quality care and a positive impact on preventable maternal morbidity and mortality.

## Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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