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ORIGINAL RESEARCH

Peripartum Hysterectomy as a Marker of Hemorrhage-Related Severe Maternal Morbidity: A Five-Year Multicenter Retrospective Study from Six Romanian Tertiary Maternity Units

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ABSTRACT

Background: Postpartum hemorrhage (PPH) remains the leading cause of maternal death worldwide. When bleeding and the resulting hemodynamic instability become refractory to medical and conservative surgical measures, peripartum hysterectomy (PH) is performed as a last-resort, life-saving intervention and is recognized as a maternal near-miss criterion. Severe PPH has also been linked to long-term cardiovascular risk. Romanian data on PH are limited to single-center reports. **Objective:** To estimate the prevalence of PH in Romanian tertiary maternity units and to describe its indications, the management preceding hysterectomy, and short-term maternal and neonatal outcomes. **Methods**: Retrospective multicenter study in six level III university maternity units (Brașov, Bucharest, Cluj-Napoca, Craiova, Iași, and Târgu Mureș) between 1 January 2019 and 31 December 2023. All hysterectomies performed during pregnancy or within 42 days postpartum were identified. Prevalence was expressed per 10,000 births; individual-level data were analyzed descriptively. **Results:** A total of 231 PH were performed among 88,932 births, corresponding to 26.0 per 10,000 births (95% CI 22.7–29.6), with center-specific rates ranging from 14 to 46 per 10,000. Individual-level data were available for 108 women: 93 (86.1%) underwent hysterectomy after caesarean delivery and 42 (38.9%) had a previous caesarean section. Placenta accreta spectrum disorders (~50%) and uterine atony (~30%) accounted for about 80% of indications. In 49 women (45.4%), hysterectomy was performed without previous conservative measures. Blood transfusion was required in 79% of cases; no maternal deaths occurred, whereas neonatal mortality was 12%. **Conclusions:** PH prevalence in Romanian tertiary units is approximately five times the pooled European population-based estimate and is driven mainly by caesarean-associated PAS disorders and uterine atony. The high proportion of primary hysterectomy suggests rapid hemodynamic deterioration and/or limited access to conservative options. A national obstetric surveillance system and structured long-term cardiovascular follow-up of survivors are warranted.

Keywords: postpartum hemorrhage, peripartum hysterectomy, severe maternal morbidity, maternal near-miss, placenta accreta spectrum, caesarean section, cardiovascular risk

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INTRODUCTION

Postpartum hemorrhage (PPH), conventionally defined as a blood loss of at least 500 ml after vaginal birth or at least 1,000 ml after caesarean delivery, is the leading cause of maternal death worldwide and accounts for approximately one quarter of all maternal deaths.[1,2] Although PPH-related mortality has decreased substantially in high-income countries, the incidence of PPH continues to rise in many settings, and most PPH-related deaths are still considered preventable.[3]

Because maternal deaths are rare in Europe, severe maternal morbidity has become a more sensitive indicator of the quality of obstetric care. The World Health Organization (WHO) Maternal Morbidity Working Group defined maternal morbidity as any health condition attributed to and/or complicating pregnancy and childbirth that has a negative impact on the woman's well-being and/or functioning, and described a continuum extending from morbidity through potentially life-threatening conditions to maternal near-miss and death.[4] Hysterectomy for infection or hemorrhage is one of the management-based WHO near-miss criteria, precisely because it is usually undertaken when bleeding and the associated hemodynamic instability can no longer be controlled by other means.[5,6] Peripartum hysterectomy (PH) is therefore a robust, easily ascertainable marker of the most severe end of the PPH spectrum.

The reported frequency of PH varies widely between countries and income settings.[7] In a population-based analysis of nine European countries within the International Network of Obstetric Survey Systems (INOSS), the pooled prevalence was 5.2 per 10,000 births, ranging from 2.6 in Denmark to 10.7 in Italy; uterine atony and abnormally invasive placenta were the leading indications, and caesarean birth was associated with a nine-fold higher risk of hysterectomy compared with vaginal birth.[8] Rising caesarean rates increase the population at risk of placenta accreta spectrum (PAS) disorders in subsequent pregnancies, a major driver of PH.[9]

Beyond the acute event, severe PPH may have long-term consequences for maternal health. Cardiovascular disease (CVD) is the leading cause of death in women, accounting for approximately 35% of female deaths annually.[10] Pre-eclampsia and gestational diabetes are well-established risk factors for future CVD,[11,12] whereas the long-term cardiovascular risk associated with PPH is less clearly defined. A Scottish record-linkage cohort reported a higher risk of CVD after PPH, most pronounced during the first postpartum year,[13] and PPH requiring transfusion has been associated with an increased risk of later cardiovascular events.[14,15] In contrast, an English population-based cohort found no significant association over a median follow-up of four years.[16] A recent meta-analysis estimated a 1.76-fold higher risk of CVD and a 2.10-fold higher risk of thromboembolic events after PPH.[17] Proposed mechanisms include hemorrhagic shock with tissue hypoperfusion, ischemia–reperfusion injury, systemic inflammation, oxidative stress, endothelial dysfunction and the consequences of massive transfusion.[17,18] Women who require PH for hemorrhage represent the extreme end of this exposure.

Romania has one of the highest caesarean section rates in Europe, yet no national obstetric surveillance system exists, and published data on PH are limited to single-center series.[19,20] Preliminary results of the present collaboration were reported in abstract form.[21]

The aim of this study was to estimate the prevalence of PH in six Romanian tertiary maternity units and to describe its indications, the management preceding hysterectomy, and short-term maternal and neonatal outcomes, using unplanned PH as a marker of last-resort treatment of hemorrhage-related hemodynamic compromise.

MATERIALS AND METHODS

STUDY DESIGN AND SETTING

We conducted a retrospective, multicenter, observational study reported in accordance with the STROBE statement.[22] Data were collected from six level III university maternity units located in Brașov, Bucharest, Cluj-Napoca, Craiova, Iași, and Târgu Mureș, which serve as regional referral centers and were assumed to manage the majority of severe maternal morbidity cases in their regions. The study period extended from 1 January 2019 to 31 December 2023.

CASE DEFINITION AND ELIGIBILITY

A case was defined as any woman who underwent removal of the uterus during pregnancy or within the first 42 days after the end of pregnancy, regardless of gestational age or mode of delivery. The total number of births in each center during the study period was obtained from institutional registries and used as the denominator. Women younger than 18 years were excluded from the individual-level analysis because of national regulations regarding informed consent, but were counted in the aggregate case numbers used for prevalence estimation.

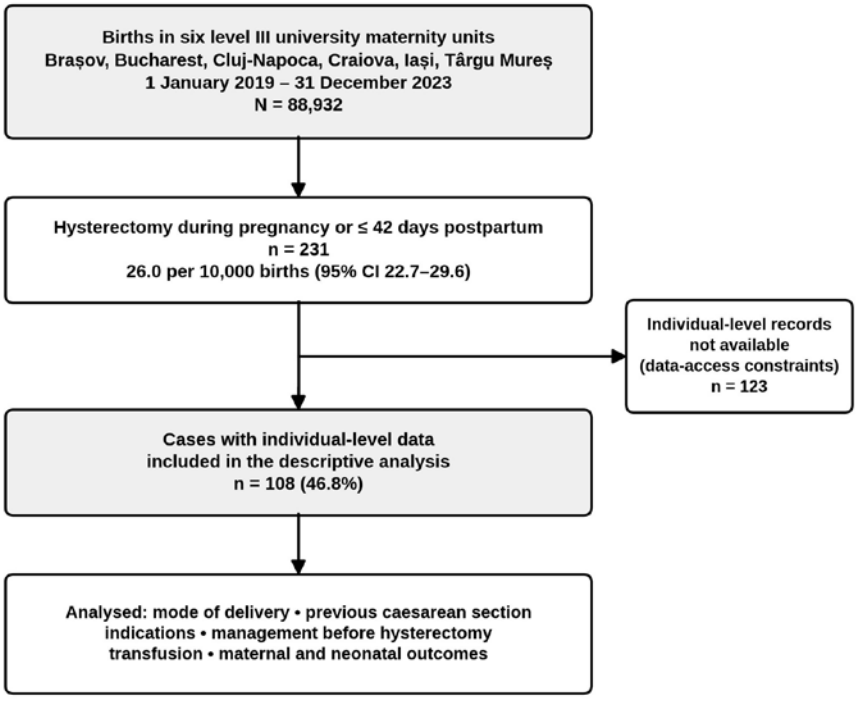

FIGURE 1. Study flow chart. Individual-level data were available for 108 of the 231 peripartum hysterectomies recorded in the six participating tertiary maternity units.

VARIABLES AND OUTCOMES

The primary outcome was the prevalence of PH, expressed per 10,000 births to allow comparison with published data. Secondary outcomes were: (i) indications for hysterectomy, categorized as PAS disorders (placenta accreta, increta, or percreta, with or without placenta previa), uterine atony, uterine rupture, placental abruption, unspecified uterine hemorrhage, infection, cervical laceration, leiomyomas with major obstetric hemorrhage, and disseminated intravascular coagulation; (ii) the management preceding hysterectomy, including uterotonic and other medical treatment, mechanical measures, and conservative surgical procedures (uterine compression sutures, vascular ligation, instrumental uterine revision); (iii) procedural characteristics (total or subtotal hysterectomy, operative duration, estimated blood loss); and (iv)outcomes, including transfusion of any blood product, admission to the intensive care unit, postoperative complications, maternal death, and neonatal death. Maternal and obstetric characteristics collected included gestational age at the end of pregnancy, antenatal care, previous caesarean section, mode of delivery, elective or emergency nature of caesarean delivery, obstetric indication for caesarean section, and type of uterine incision.

STATISTICAL ANALYSIS

The pooled prevalence of PH was calculated as the number of cases divided by the number of births, with an exact Poisson 95% confidence interval (CI); center-specific rates were used to describe between-center variability. Categorical variables are reported as absolute frequencies and percentages with Wilson 95% CIs, and continuous variables as mean ± s.d. or median (interquartile range), according to distribution (Shapiro–Wilk test). The study protocol also provides for a comparison group of women delivering in the same centers without undergoing hysterectomy; comparative analyses (χ^2 or Fisher's exact test for categorical variables, Student's t test or the Mann–Whitney U test for continuous variables) and multivariable regression will be reported separately once individual-level control data are complete. Analyses and figures were produced in GraphPad Prism v.8.0 (GraphPad Software). A two-sided p value of <0.05 was considered statistically significant.

RESULTS

PREVALENCE OF PERIPARTUM HYSTERECTOMY

Between 1 January 2019 and 31 December 2023, 231 PH were performed among 88,932 births in the six participating

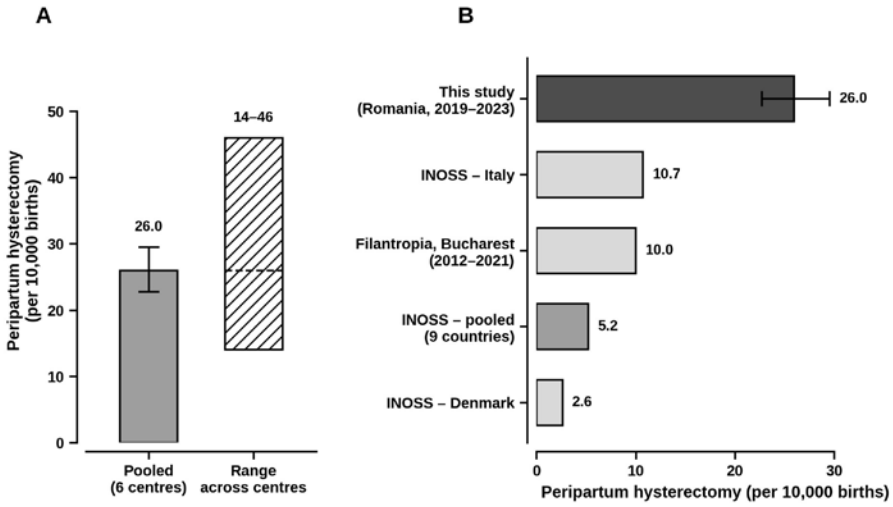

FIGURE 2. Prevalence of peripartum hysterectomy. **A.** Pooled prevalence across the six centres (bar, with exact Poisson 95% CI) and range of centre-specific prevalence (floating bar; dashed line, pooled value). **B.** Comparison with published estimates from Filantropia Clinical Hospital, Bucharest (36 cases/36,099 births, 2012–2021)[19] and from INOSS (pooled estimate and countries with the lowest and highest prevalence).[8] Note that INOSS restricted cases to hysterectomies for hemorrhage performed from 22 weeks of gestation up to 48 h postpartum, so the comparison is indicative only.

centers (Figure 1), corresponding to a pooled prevalence of 26.0 per 10,000 births (95% CI 22.7–29.6). Prevalence differed considerably between centers, ranging from 14 to 46 per 10,000 births (Figure 2A); when between-center heterogeneity was taken into account, the 95% CI widened to 14.4–38.4 per 10,000 births.

CHARACTERISTICS OF WOMEN WITH INDIVIDUAL-LEVEL DATA

Because of data-access constraints, individual-level records were available for 108 of the 231 cases (46.8%). Gestational age at the end of pregnancy ranged from 16+0 to 42+2 weeks; two hysterectomies followed second-trimester pregnancy termination. Apart from these two cases, the distribution of hysterectomies between preterm and term births showed no distinct pattern (Table 1).

Hysterectomy followed caesarean delivery in 93 women (86.1%; 95% CI 78.3–91.4) and vaginal birth in 15 (13.9%; 95% CI 8.6–21.7) (Figure 3A). This proportion was similar for elective and emergency caesarean sections. A previous caesarean section was present in 42 women (38.9%; 95% CI 30.2–48.3), whereas 66 (61.1%) had an unscarred uterus (Figure 3B). The main obstetric indications for the index caesarean section were placenta previa, followed by previous uterine scar, maternal medical conditions, obstructed labor, and malpresentation with non-reassuring fetal status.

INDICATIONS FOR HYSTERECTOMY

PAS disorders associated with severe bleeding, acute anemia, and cardiovascular instability were the leading indication (~50% of cases), followed by hemorrhage due to uterine atony (~30%). Together, these two conditions accounted for approximately 80% of all hysterectomies, with PAS disorders being about 1.7 times more frequent than atony (Figure 3C). The remaining ~20% comprised uterine rupture, placental abruption, unspecified uterine hemorrhage, infection, cervical laceration, leiomyomas, and disseminated intravascular coagulation.

MANAGEMENT PRECEDING HYSTERECTOMY

In 49 of the 108 women (45.4%; 95% CI 36.3–54.8), hysterectomy was the first surgical measure, performed without previous conservative obstetric interventions (Figure 3D), reflecting the abrupt onset and severity of hemodynamic instability. Among the 59 women in whom conservative measures were attempted, uterine massage was used most frequently, followed by uterine compression sutures, instrumental uterine revision, and vascular ligation.

MATERNAL AND NEONATAL OUTCOMES

Blood transfusion was required in 79% of women (95% CI 70.1–85.4), and most were admitted to the intensive

TABLE 1. Obstetric characteristics, indications, management and outcomes of women undergoing peripartum hysterectomy with individual-level data (n = 108).

Characteristic	n (%)	95% CI
Gestational age at end of pregnancy, range	16+0–42+2 wk	—
Hysterectomy after second-trimester termination	2 (1.9)	—
Mode of delivery		
Caesarean section	93 (86.1)	78.3–91.4
Vaginal birth	15 (13.9)	8.6–21.7
Previous caesarean section		
Yes	42 (38.9)	30.2–48.3
No (unscarred uterus)	66 (61.1)	51.7–69.8
Main indication for hysterectomy[a]		
Placenta accreta spectrum disorders	≈50%	40.7–59.3
Uterine atony	≈30%	21.8–38.8
Other[b]	≈20%	13.9–28.9
Management before hysterectomy		
≥ 1 conservative measure[c]	59 (54.6)	45.2–63.7
Primary hysterectomy (no previous conservative measure)	49 (45.4)	36.3–54.8
Outcomes		
Blood transfusion	79%	70.1–85.4
Maternal death	0 (0)	0–3.4
Neonatal death[d]	12%	7.2–19.5

CI, confidence interval (Wilson method for proportions). [a] Proportions refer to the intraoperative complication leading to hysterectomy. [b] Uterine rupture, placental abruption, unspecified uterine hemorrhage, infection, cervical laceration, leiomyomas with major hemorrhage and disseminated intravascular coagulation. [c] In decreasing order of frequency: uterine massage, uterine compression sutures, instrumental uterine revision and vascular ligation. [d] All neonatal deaths occurred in term newborns delivered by caesarean section.

care unit. No maternal deaths occurred (0/108; 95% CI 0–3.4%). Neonatal mortality among infants of women who underwent hysterectomy was 12% (95% CI 7.2–19.5%); all neonatal deaths occurred in term newborns delivered by caesarean section (Figure 4). The distribution of cases did not suggest a relationship between the occurrence of hysterectomy and gestational age at birth, inadequate antenatal care, the elective or emergency nature of caesarean section, or the type of uterine incision; however, these observations require confirmation against the control group.

DISCUSSION

PRINCIPAL FINDINGS

In this five-year multicenter study from six Romanian tertiary maternity units, PH occurred in 26.0 per 10,000 births, with almost three-fold variation between centers. Nearly nine in ten hysterectomies followed caesarean delivery, PAS disorders and uterine atony accounted for about 80% of indications, and in almost half of the women hysterectomy was performed without prior conservative measures. Although no maternal deaths occurred, four in five women required transfusion, and one in eight infants died.

COMPARISON WITH OTHER STUDIES

The prevalence observed here is about five times the pooled INOSS estimate and more than twice the highest national rate reported in that analysis (Italy, 10.7 per 10,000).[8] It is also higher than the 0.99 per 1,000 births (~9.9 per 10,000) reported from a Bucharest tertiary unit between 2012 and 2021.[19] Part of this difference is methodological: our case definition was broader (any gestational age, up to 42 days postpartum, any indication) and, more importantly, tertiary referral centers concentrate high-risk pregnancies, particularly antenatally suspected PAS, which inflates facility-based rates relative to population-based estimates. Nevertheless, the magnitude of the difference and the predominance of caesarean-associated indications are consistent with the very high caesarean section rate in Romania, reported by the authors at approximately 59%.

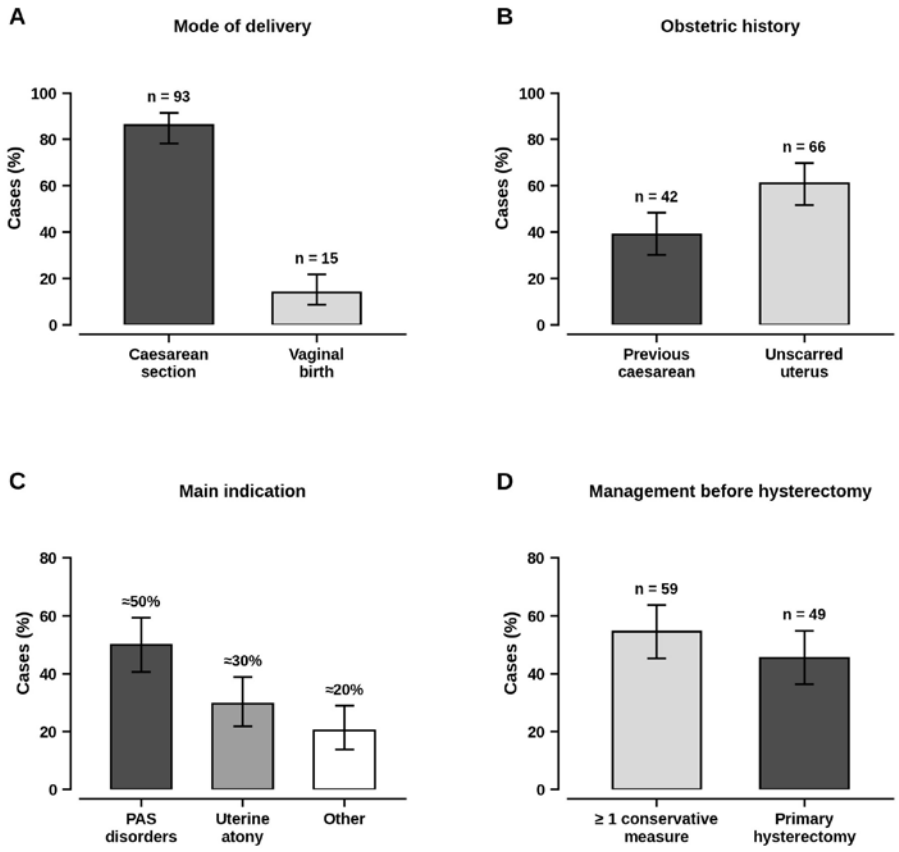

FIGURE 3. Obstetric characteristics and indications in women undergoing peripartum hysterectomy with individual-level data (n = 108). (A) Mode of delivery. (B) Previous caesarean section. (C) Main indication for hysterectomy; approximate percentages as recorded in the pooled dataset. (D) Use of conservative measures before hysterectomy. Bars represent percentages; error bars, Wilson 95% confidence intervals. PAS, placenta accreta spectrum.

The balance of indications also differs from that of other European countries. In INOSS, uterine atony (35.3%) and abnormally invasive placenta (34.8%) contributed almost equally,[8] whereas in our series PAS disorders predominated. Placenta previa and a previous uterine scar were the leading indications for the index caesarean section, reinforcing the causal chain linking repeat caesarean delivery, abnormal placentation, and PH.[9] The proportion of women with a previous caesarean section (38.9%) should be interpreted with caution: without the corresponding proportion among all women giving birth in the participating centers, relative risks cannot be calculated. INOSS estimated relative risks of 9.1 for hysterectomy after caesarean versus vaginal birth and 10.6 for birth after a previous caesarean section.[8] Similarly, the 6:1 ratio of cases after caesarean versus vaginal birth in our series is a ratio of counts and not a ratio of rates; applying the national caesarean rate of ~59% as a crude approximation would correspond to a relative risk of roughly 4, but center-specific denominators are needed for a valid estimate. Caesarean delivery was also associated with fourfold higher odds of hysterectomy among women with PPH in the international WOMAN trial cohort.[23]

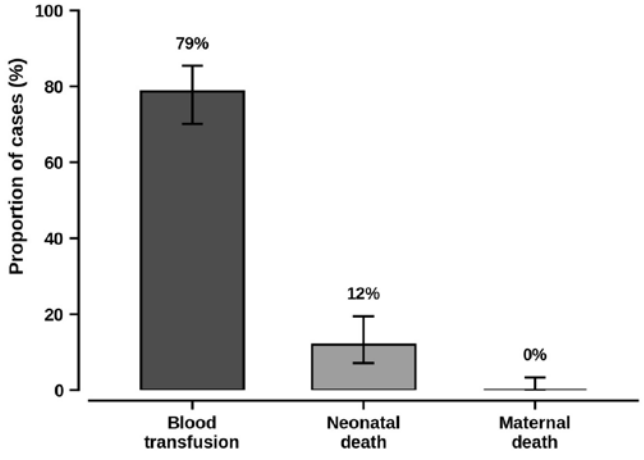

FIGURE 4. Short-term maternal and neonatal outcomes in women undergoing peripartum hysterectomy (n = 108). Bars represent percentages; error bars, Wilson 95% confidence intervals.

HEMODYNAMIC INSTABILITY AND PRIMARY HYSTERECTOMY

The finding that 45% of women underwent hysterectomy without prior conservative measures deserves attention. In some cases, this reflects the catastrophic nature of bleeding from PAS disorders, in which rapid hemodynamic collapse leaves no time for stepwise management; in others it may reflect limited availability of interventional radiology, intrauterine balloon tamponade, or a multidisciplinary team, particularly outside working hours. Management before PH differs markedly across European countries, and systematic use of uterotonics, tamponade, and conservative surgery is associated with lower hysterectomy rates.[24] Early detection of PPH through objective blood-loss measurement combined with a first-response treatment bundle,[25] early administration of tranexamic acid,[26] and the use of simple hemodynamic indicators such as the shock index to anticipate deterioration[27] are evidence-based strategies that could reduce progression to hysterectomy. The very high transfusion rate (79%) further illustrates the severity of hemorrhage in this cohort and is consistent with data showing that transfusion requirement and intensive care admission are strongly associated with severe maternal outcomes in PPH.[6]

The absence of maternal deaths is reassuring and probably reflects the concentration of these cases in tertiary centers with blood-bank and intensive-care capabilities; it is nonetheless compatible, given the sample size, with a true case-fatality rate of up to 3.4%. Worldwide, case-fatality after emergency PH remains considerably higher in lower-income settings.[7] The neonatal mortality of 12%, all in term infants delivered by caesarean section, underscores that PH is a marker of severe compromise for both mother and child.

IMPLICATIONS FOR LONG-TERM CARDIOVASCULAR HEALTH

Maternal morbidity and mortality remain critical public-health concerns even in high-income countries, where CVD has become the leading cause of pregnancy-related death.[28] In the United States, severe maternal morbidity increased from 1.5% to 2.2% of delivery hospitalizations between 2016 and 2022, largely due to the growing burden of hypertensive disorders, chronic hypertension, and obesity.[29] Pregnancy has been conceptualized as a cardiovascular "stress test", with adverse obstetric outcomes serving as early indicators of future disease.[30]

Women who survive hemorrhage severe enough to require hysterectomy constitute the group most exposed to the mechanisms thought to link PPH to later CVD: prolonged hypovolemia and hypoperfusion, massive transfusion, systemic inflammation, and endothelial injury.[17,18] The association between PPH and future CVD appears strongest when transfusion is required[14,15] and may persist for many years, especially in women with coexisting hypertensive disorders of pregnancy.[17] Current postpartum care pathways do not systematically incorporate a history of severe PPH into long-term cardiovascular risk stratification. We therefore suggest that survivors of hemorrhage-driven PH be offered structured follow-up, including blood pressure, lipid, and glucose assessment and, where appropriate, referral to cardio-obstetric services. Whether PH itself, through premature loss of the uterus or associated oophorectomy, further modifies cardiovascular risk cannot be addressed by our data and warrants prospective study.

STRENGTHS AND LIMITATIONS

To our knowledge, this is the first multicenter study of PH in Romania, covering six of the country's main university maternity units over five years and nearly 89,000 births. Several limitations must be acknowledged. First, the retrospective design relies on the completeness and accuracy of medical records, which may vary between centers. Second, only tertiary units were included; because these centers receive referrals of high-risk pregnancies, the prevalence reported here cannot be extrapolated to the national level. Third, individual-level data were available for fewer than half of the cases, which may introduce selection bias. Fourth, objective hemodynamic parameters (e.g. shock index, lactate, vasopressor use), quantified blood loss, and number of transfused units were not systematically available, therefore hemodynamic instability was inferred from the indication for and context of hysterectomy rather than measured directly. Fifth, the control group has not yet been analyzed, precluding estimation of risk factors and relative risks. Finally, no long-term follow-up was available to assess cardiovascular outcomes.

CONCLUSIONS

PH, a near-miss event performed as a last resort to prevent maternal death, occurred in 26 per 10,000 births in six Romanian tertiary maternity units, with marked between-center variation and a rate several-fold higher than population-based European estimates. Caesare-

an-associated PAS disorders and uterine atony were the dominant indications, transfusion was required in most women, and nearly half underwent hysterectomy without previous conservative measures. These findings support (i) the creation of a national obstetric surveillance system, ideally aligned with INOSS definitions; (ii) strategies to reduce non-medically indicated caesarean sections and to improve antenatal diagnosis and centralized management of PAS; (iii) wider access to conservative measures and multidisciplinary hemorrhage teams; and (iv) structured long-term cardiovascular follow-up of women who survive hemorrhage-driven PH.

CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

ETHICS APPROVAL

The study was conducted in accordance with the Declaration of Helsinki and approved by the Ethics Committee of the George Emil Palade University of Medicine, Pharmacy, Science and Technology of Târgu Mureș (approval no. 2781/02.02.2024). Data were extracted from medical records and anonymized at source before pooling.

DATA AVAILABILITY STATEMENT

The anonymized data supporting the findings of this study are available from the corresponding author upon reasonable request.

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AUTHOR CONTRIBUTIONS

L.P. conceptualized the study, contributed to the methodology, supervised the research, and administered the project. I.M.M. contributed to the methodology, data curation, formal analysis, investigation, visualization, and preparation of the original draft. R.M.M. contributed to data curation, formal analysis, investigation, and preparation of the original draft. A.C. contributed to data curation, investigation, and review and editing of the manuscript. L.P. and A.C. reviewed and edited the manuscript. All authors have read and agreed to the published version of the manuscript.

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