Incidence, indications, risk factors, and outcomes of emergency peripartum hysterectomy worldwide: a systematic review and meta-analysis

Kallianidis, A.F.; Rijntjes, D.; Brobbel, C.; Dekkers, O.M.; Bloemenkamp, K.W.M.; Akker, T. van den

Systematic Review

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Incidence, Indications, Risk Factors, and Outcomes of Emergency Peripartum Hysterectomy Worldwide

A Systematic Review and Meta-analysis

Athanasios F. Kallianidis, MD, MSc, Douwe Rijntjes, BSc, Carolien Brobbel, MD, MSc, Olaf M. Dekkers, MD, PhD, Kitty W. M. Bloemenkamp, MD PhD, and Thomas van den Akker, MD, PhD

OBJECTIVE: To describe the incidence, indications, risk factors, outcomes, and management of emergency peripartum hysterectomy globally and to compare outcomes among different income settings.

DATA SOURCES: PubMed, MEDLINE, EMBASE, ClinicalTrials.gov, Cochrane Library, Web of Science, and Emcare databases up to December 10, 2021.

METHODS OF STUDY SELECTION: Update of a systematic review and meta-analysis (2016). Studies were eligible if they reported the incidence of *emergency peripartum hysterectomy,* defined as surgical removal of the uterus for severe obstetric complications up to 6 weeks postpartum. Title and abstract screening and full-text review were performed using Endnote data-management software. Of 8,775 articles screened, 26 were included that were published after 2015, making the total number of included studies 154. A subanalysis was performed for the outcomes of interest per income setting.

TABULATION, INTEGRATION, AND RESULTS: The meta-analysis included 154 studies: 14,409 emergency peripartum hysterectomies were performed in 17,127,499 births in 42 countries. Overall pooled incidence of hysterectomy was 1.1 per 1,000 births (95% CI 1.0–1.3). The highest incidence was observed in lower middle–income settings (3/1,000 births, 95% CI 2.5–3.5), and the lowest incidence was observed in high-income settings (0.7/1,000 births, 95% CI 0.5–0.8). The most common indications were placental pathology (38.0%, 95% CI 33.9–42.4), uterine atony (27.0%, 95% CI 24.6–29.5), and uterine rupture (21.2%, 95% CI 17.8–25.0). In lower middle–income countries, uterine rupture (44.5%, 95% CI 36.6–52.7) was the most common indication; placental pathology (48.4%, 95% CI 43.5–53.4) was most frequent in high-income settings. To prevent hysterectomy, uterotonic medication was used in 2,706 women (17%): 53.2% received oxytocin, 44.6% prostaglandins, and 17.3% ergometrine. Surgical measures to prevent hysterectomy were taken in 80.5% of women, the most common being compressive techniques performed in 62.6% (95% CI 38.3–81.9). The most common complications were febrile (29.7%, 95% CI 25.4–34.3) and hematologic (27.5%, 95% CI 20.4–35.9). The overall maternal case fatality rate was 3.2 per 100 emergency peripartum hysterectomies (95% CI 2.5–4.2) and was higher in lower middle–income settings (11.2/100 emergency peripartum hysterectomies 95% CI 8.9–14.1) and lower in high-income settings (1.0/100 emergency peripartum hysterectomies 95% CI 0.6–1.6).

CONCLUSION: Substantial differences across income settings exist in the incidence of emergency peripartum hysterectomy. Women in lower-income settings have a higher risk of undergoing emergency peripartum hysterectomy and suffer more procedure-related morbidity

From the Department of Obstetrics and Gynecology and the Department of Clinical Epidemiology, Leiden University Medical Center, Leiden, the Division Woman and Baby, Department of Obstetrics, Birth Center Wilhelmina's Children Hospital, University Medical Center Utrecht, Utrecht, and the Athena Institute, VU, Amsterdam, the Netherlands; and Mbuma Mission Hospital, Mbuma, Zimbabwe.

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Corresponding author: Athanasios F. Kallianidis MD, MSc, Department of Obstetrics and Gynecology, Leiden University Medical Center, Leiden, the Netherlands; email: a.f.kallianidis@lumc.nl.

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and mortality. The frequency of emergency peripartum hysterectomy is likely to increase in light of increasing cesarean delivery rates.

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Emergency peripartum hysterectomy is the surgical removal of the uterus due to severe complications during pregnancy, birth, or postpartum. When all conservative measures have failed to control massive obstetric hemorrhage or life-threatening sepsis, emergency peripartum hysterectomy is used as an intervention of last resort. Although emergency peripartum hysterectomy can be a life-saving operation, it is uncommon in modern obstetrics.[1] However, because rates of cesarean delivery and, consequently, placenta accreta spectrum in pregnancies after a previous cesarean delivery are increasing, the global incidence of emergency peripartum hysterectomy is likely to rise as a result.[1–3] The risks and benefits of the procedure must be weighed, but undue delays in performance of hysterectomy may contribute to increased morbidity and mortality.

We previously identified differences in incidence, indications, risk factors, and outcomes of emergency peripartum hysterectomy between high-income and low-income countries.[1] The incidence of emergency peripartum hysterectomy tends to be higher in low- and lower middle–income countries. The main indications for emergency peripartum hysterectomy are massive obstetric hemorrhage due to placental pathology, uterine atony, or uterine rupture, followed by puerperal sepsis.[4,5]

Since the previous version of this review, new studies about emergency peripartum hysterectomy have been published, including several population-based studies, which were infrequent at the time of the previous review. Therefore, we performed an update of our previous systematic review and meta-analysis. The aim of this study was, first, to estimate the overall incidence of emergency peripartum hysterectomy and compare the incidence across different income settings and, second, to describe indications, risk factors, outcomes, and management of emergency peripartum hysterectomy and compare these among income settings.

SOURCES

This is an update of the systematic review and meta-analysis previously published by van den Akker et al.[1] A systematic search of PubMed, MEDLINE, EMBASE, ClinicalTrials.gov, Cochrane Library, Web of Science, and Emcare was performed up to December 10, 2021 (for search strategy, see Appendix 1, available online at http://links.lww.com/AOG/C968).

STUDY SELECTION

Study selection was performed independently by two of the authors (D.R. and A.F.K.). Studies published before 2015 were previously selected and included.[1] First, articles were assessed based on title and abstract. Selected studies were further assessed for eligibility based on the full text.

We used the same inclusion criteria as before; in brief, studies were included if they reported the incidence, management, or outcomes of emergency peripartum hysterectomy up to 6 weeks postpartum in a hospital, region, or country. *Emergency peripartum hysterectomy* was defined as partial or total surgical removal of the uterus for severe obstetric complications. Case–control, cohort, and cross-sectional study designs were eligible.

Excluded study designs were case reports, case series (sample size less than 10), comments, and personal communications. Other exclusion criteria were studies not reported in English and those published in journals with an impact factor less than 1. Studies were also excluded if they did not indicate the absolute number of births and emergency peripartum hysterectomies. Where possible, hysterectomies for malignancies or other nonobstetric indications were excluded from the calculation of incidence, indications, and outcomes. So-called "elective" or "planned" hysterectomies were not excluded, because most often these were performed for placenta accreta spectrum pathology.

Data extraction was performed by two authors (D.R. and A.F.K.). Data on incidence, indications, complications, maternal characteristics, and preventive measures were extracted and combined with data from the previous systematic review.[1] If studies reported on the same study population, only the most recent study was included.

The main outcome was overall pooled incidence. Incidence was calculated per income setting as well as for all countries separately. The income setting of a country was based on the gross national income per capita. Countries were classified as low-income ($1,045 or less), lower middle–income ($1,046–4,095), upper middle–income ($4,096–12,695), or high-income ($12,696 or more).[6]

Secondary outcomes were indications, risk factors, outcomes, and management characteristics of emergency peripartum hysterectomy. Indications for emergency peripartum hysterectomy were subdivided into placental pathology (placenta accreta spectrum,

placenta previa, combined placental pathology, or placental abruption), uterine atony, uterine rupture, unspecified hemorrhage, infection, cervical tear or laceration, leiomyomas with major obstetric hemorrhage, disseminated intravascular coagulation, hematoma, abnormal location of pregnancy, other, and unknown. Outcomes included transfusion of any type, intensive care unit admission, complications, and maternal morbidity and mortality. Characteristics of emergency peripartum hysterectomy described were hysterectomy type (total or subtotal), preventive measures used before emergency peripartum hysterectomy (medical or surgical), duration of surgery, blood loss, and additional procedures performed. Indications, outcomes, and management characteristics were stratified based on income setting, and the highest and lowest proportions were described. Maternal characteristics were antenatal care registration, age, and parity.

Risk-of-bias assessment was performed for all included articles. The COSMOS-E (Conducting Systematic Reviews and Meta-Analyses of Observational Studies of Etiology) methodology was followed to create study-specific guidelines for describing the risk of bias of included articles.[7] These guidelines assisted in describing selection, information, and confounding biases (Appendix 2, available online at http://links.lww.com/AOG/C968). Sources of selection bias considered were extent of the catchment area, length of postpartum inclusion period, definition of emergency peripartum hysterectomy, definition of study time period, and gestational age limits. For case–control studies, the selection process and comparability by design were also taken into account. Potential causes of information bias were duration of the follow-up period and the source of data extraction. Possible confounders included age and parity, because they are commonly accepted to influence a woman's risk of emergency peripartum hysterectomy.

Overall weighted pooled incidence was calculated using a random-effects analysis with 95% CI. Proportions of indications, outcomes, maternal, and procedure characteristics were pooled using a random-effects analysis. Continuous variables were examined with pooled mean difference and 95% CI (inverse variance weighting). We used R software for statistical computing.

RESULTS

In total, 154 studies were included (Fig. 1); 128 had been included in the previous meta-analysis.[1] This update includes 26 additional studies and presents data for an additional 7,741 women in 22 nations[8–33] (Appendix 3, available online at http://links.lww.com/AOG/C968). Eight of the new studies were from

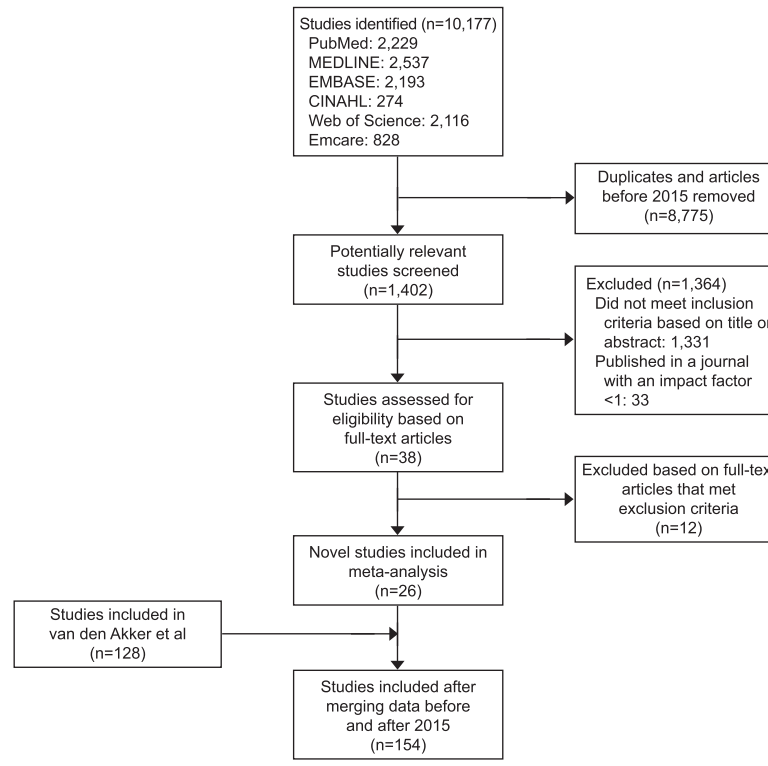

Fig. 1. Flowchart showing selection of studies included in the meta-analysis.

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countries from which we previously did not have data: Belgium, France, Germany, Romania, Slovakia, Sweden, Iceland, and Papua New Guinea. All studies combined included a total of 15,599 women who underwent emergency peripartum hysterectomy–193 (1.2%) from low-income settings, 2,403 (15.4%) from lower middle–income settings, 1,975 (12.7%) from upper middle–income settings, and 11,028 (70.7%) from high-income settings.

Overall, risk of bias was considered low in 25 studies (16.2%), moderate in 66 studies (42.8%), and high in 63 studies (40.5%) (Appendix 2, http://links.lww.com/AOG/C968). Risk of selection bias was considered high in 55 of the studies (35.7%). Risk of information bias was low in 106 studies (68.8%), moderate in 35 studies (22.7%), and high in 13 studies (8.4%). Fifteen of 24 case–control studies did not account for confounding by age or parity. Risk of confounding bias was thus assessed as high in these 15 studies, moderate in two studies, and low in seven studies.

Seventeen of the included studies were population-based.[17–19,22,23,27,34–45] The other 137 were hospital-based, of which six were multicenter studies. Two population-based studies reported data from more than one country.[18,19] Information on these countries was subdivided and analyzed separately.

In 89 studies, case definitions of emergency peripartum hysterectomy were described. Definitions varied widely among studies. In 13 studies, women undergoing hysterectomy up to 6 weeks postpartum were included,[11,17,30,31,41,44–51] 54 studies included women up to 24 hours postpartum,[9,12,14–16,25,28,29,33,34,38,39,52–94] and 22 studies included women within another time range (but within 6 weeks).[18,19,21,27,32,35,36,40,42,89,95–106] In 31 studies, only emergency peripartum hysterectomies beyond 24 weeks of gestation were included.[11,12,31–33,40,47,50,53,58,71–73,76–78,83,86,90,97,98,100,107–117] Another 20 studies excluded women based on limits other than 24 weeks of gestation.[9,18,19,23,24,27,34,41,46,48,51,57,59,64,67,69,85,87,118,119] Nine studies included peripartum hysterectomies regardless of gestational age.[37,44,45,91,102,117,120–123] All other studies (n=91) lacked specific exclusion criteria for gestational age. There were no new case–control studies since 2015. Information on indications, complications, and preventive measures for hysterectomy was extracted from medical records in 130 studies.

The incidence of emergency peripartum hysterectomy was reported in 147 studies; seven studies were not included because they reported only cesarean[64,70,106] or postpartum hysterectomies[87] or did not report an incidence at all.[42,89,124] Altogether, 14,409 emergency peripartum hysterectomies were performed over 17,127,499 births in 42 countries. The overall weighted incidence was 1.1 cases per 1,000 births (95% CI 1.0–1.3).

The reported incidence differed considerably across income settings (Table 1). The highest incidence was observed in lower middle–income settings (3.0, 95% CI 2.5–3.5), and the lowest incidence was observed in high-income settings (0.7, 95% CI 0.5–0.8). Incidence varied from 0.2 per 1,000 births in Denmark,[35] Ireland,[103] Norway,[78] and Turkey[67] to 10.1 per 1,000 births in India.[123] Figures 2 and 3 show incidence of emergency peripartum hysterectomy worldwide and in Europe, respectively.

Maternal age ranged from 11[96] to 54[22,47] years, with an overall mean age of 32.1 years (95% CI 31.9–32.8). The overall mean gestational age was 36 5/7 weeks (95% CI 35 3/7–37 1/7 weeks). Parity was reported in 105 studies, representing 7,555 women: 6,324 (83.7%) women were multiparous.

Prior uterine surgery was described in 101 studies, representing 6,841 women. A total of 3,319 (49.8%, 95% CI 45.1–54.6) women had previously undergone cesarean delivery. The total number of cesarean deliveries was provided for 1,362 women; 671 (51.0%, 95% CI 44.4–57.7) of these women had had two or more cesarean deliveries. Other uterine surgery (eg, myomectomy, curettage, hysteroscopic septum resection, cornual resection) had previously been performed in 556 women (0.4%, 95% CI 0.1–1.2). In 44 studies, registration status was mentioned: 877 of 2,251 women (37.4%, 95% CI 28.5–47.4) had been registered for

Table 1. Incidence Per Income Setting*

Income Setting	No. of Studies	No. of Emergency Peripartum Hysterectomies	No. of Women	Incidence (95% CI)
Low	2	193	93,355	1.5 (0.6–4.0)
Lower middle	43	2.257	849,772	3.0 (2.5–3.5)
Upper middle	34	1.924	2,573,707	0.9 (0.7–1.1)
High	75	10,035	13,610,665	0.7 (0.5–0.8)
Total	154	14,409	17,127,499	1.1 (1.0–1.3)

* Weighted incidence per 1,000 births using random-effects model.

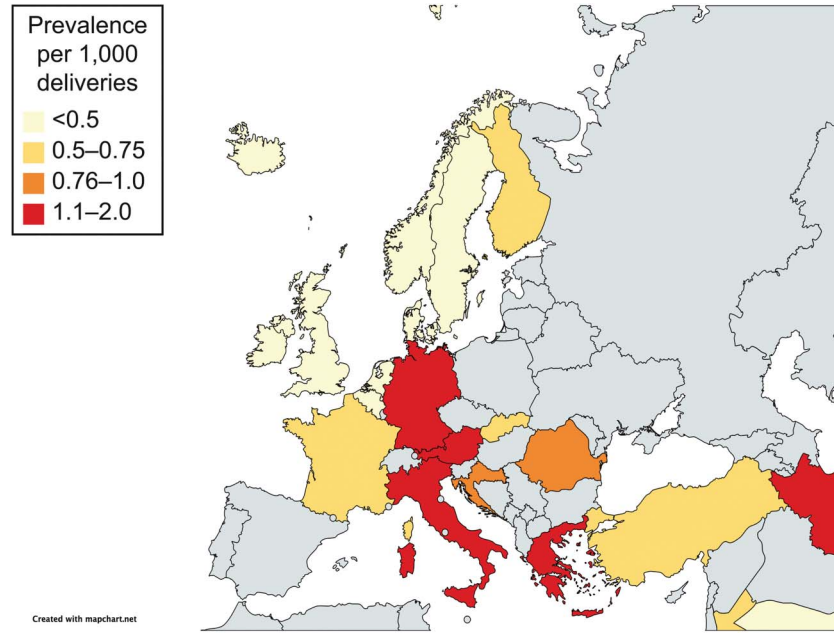

Fig. 2. Map of Europe showing the incidence of emergency peripartum hysterectomy per country. Image created with mapchart.net ©.

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antenatal care. The lowest proportion of women registered in the first trimester was in lower middle–income settings (490/1,461, 29.4%, 95% CI 22.31–37.6), followed by 76 of 165 (46.1%) women in low-income settings, based on one study only.

Indications for emergency peripartum hysterectomy were described in 157 studies for 9,258 women (Table 2). The most common indications were placental pathology (38.0%, 95% CI 33.9–42.4), uterine atony (27.0%, 95% CI 24.6–29.5), and uterine rupture

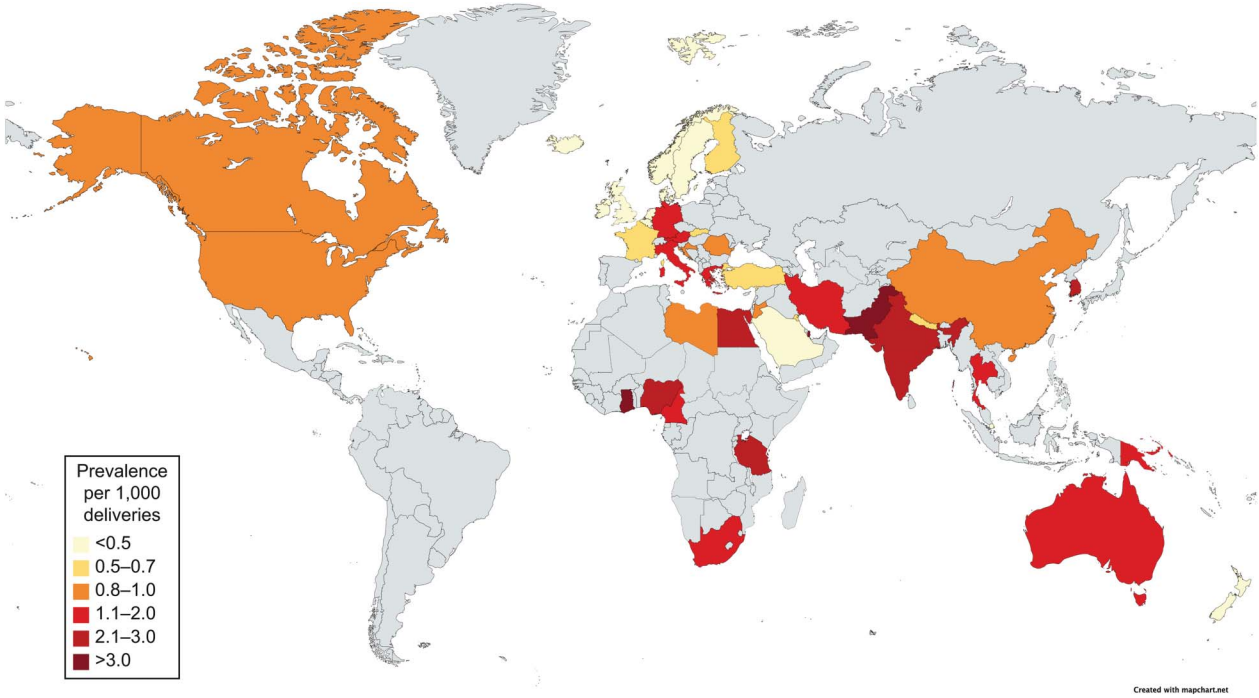

Fig. 3. World map showing the incidence of emergency peripartum hysterectomy per country. Image created with mapchart.net ©.

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Table 2. Indications for Emergency Peripartum Hysterectomy

Indication	No. of Studies	No. of Women (n/N)	Proportion (95% CI)*
Placental pathology	157	3,791/9,213	38.0 (33.9–42.4)
Placenta accreta spectrum	130	2,293/8,115	23.9 (20.5–27.7)
Placenta previa	71	809/4,822	13.9 (11.8–17.1)
Combined or unspecified placental pathology	32	416/1,606	26.1 (20.5–32.5)
Placental abruption	42	147/2,913	5.2 (4.0–6.9)
Uterine atony	143	2,638/8,157	27.0 (24.6–29.5)
Uterine rupture†	140	2,019/8,421	21.2 (17.8–25.0)
Unspecified hemorrhage	48	397/2,549	13.3 (9.8–17.9)
Infection‡	41	170/3,083	4.4 (3.9–6.0)
Cervical tear or laceration	25	99/2,250	4.0 (2.7–5.9)
DIC	15	104/1,551	4.0 (1.8–8.8)
Hematoma§	18	41/1,117	4.3 (3.2–5.8)
Abnormal location of pregnancy‖	8	14/465	3.0 (1.8–5.0)
Leiomyomas with major obstetric hemorrhage	30	65/2,970	2.3 (1.6–3.1)
Other¶	22	55/1,590	3.8 (2.7–5.4)
Unknown	14	149/2,313	3.7 (2.0–6.8)

DIC, disseminated intravascular coagulation.
* Proportions calculated using random-effects model and exceed 100% because more than one indication was possible.
† Includes both uterine rupture and extension of uterine incision.
‡ Includes endometritis, pelviperitonitis, chorioamnionitis, gangrenous uterus, puerperal sepsis, pelvic abscess, and hemorrhage due to these infections.
§ Includes broad ligament, retroperitoneal, and unspecified hematoma.
‖ Includes abdominal, cervical, molar, and ruptured cornual pregnancy.
¶ Includes avulsion of uterine artery, uterine inversion, septic abortion, medical termination of pregnancy perforation, malignancy with hemorrhage, sterilization, arteriovenous malformation, uterine anomaly, and retained tissue.

(21.2%, 95% CI 17.8–25.0). The distribution of these indications varied considerably across income settings. The most common indication in lower middle–income settings was uterine rupture (44.5%, 95% CI 36.5–52.7); in high-income countries it was placental pathology (48.4%, 95% CI 43.5–53.4) (Table 3).

Measures that were taken to prevent hysterectomy were described for 3,401 women in 46 studies (including one multinational study[18]). Uterotonic medication was given to 2,706 women: oxytocin in 1,439 (53.2%), prostaglandins in 1,207 (44.6%), and ergometrine in 467 (17.3%). Five hundred seventy-five women (21.2%) received uterotonics without further specification. Surgical measures to prevent emergency peripartum hysterectomy were described in 2,740 women (80.5%) (Table 4). Compressive surgical measures were the most commonly performed interventions before emergency peripartum hysterectomy (62.6%, 95% CI 38.3–81.9) and included bimanual compression in 235 women (98.9%, 95% CI 6.6–100.0), vaginal or uterine packing in 266 (20.5%, 95% CI 14.3–28.5), uterine balloon tamponade in 382 (16.3%, 95% CI 11.9–22.0), and uterine compression sutures in 383 (14.3%, 95% CI 9.3–21.4).

The type of hysterectomy was known for 6,240 women; total abdominal hysterectomy was performed in 3,128 (50.1%) and subtotal hysterectomy in 3,112 (49.8%). Type of hysterectomy varied among income settings; total abdominal hysterectomy was performed in 175 of 193 (90.6%) of the surgeries in low-income countries, 783 of 2,154 (36.3%) in lower middle–

Table 3. Indications Per Income Setting*

	Placental Pathology		Uterine Atony		Uterine Rupture	
Income Setting	Proportion (95% CI)	No. of Studies	Proportion (95% CI)	No. of Studies	Proportion (95% CI)	No. of Studies
Low	25 (—)	1	36 (—)	1	25 (—)	1
Lower middle	20.7 (15.8–26.8)	44	20.9 (17.6–24.7)	38	44.5 (36.6–52.7)	44
Upper middle	41.8 (33.3–50.9)	35	31.0 (25.0–37.6)	33	13.8 (9.8–19.2)	34
High	48.4 (43.4–53.4)	77	28.9 (25.7–32.3)	71	9.3 (7.0–12.1)	77

* Proportion of indications per 100 emergency peripartum hysterectomies, calculated using random-effects model.

Table 4. Mechanical Measures to Prevent Emergency Peripartum Hysterectomy

Measure	No. of Studies	No. of Patients (n/N)	Proportion (95% CI)*
Fundal massage	6	210/319	83.8 (33.7–98.1)
Compression[†]	36	1,274/2,700	62.6 (38.3–81.9)
Bimanual compression	7	235/686	98.9 (6.6–100)
Vaginal or uterine packing	21	266/1,195	20.5 (14.3–28.5)
Uterine balloon tamponade	20	382/1,870	16.3 (11.9–22.0)
Uterine compression sutures[‡]	26	383/2,367	14.3 (9.3–21.4)
Artery ligation[§]	38	603/2,407	22.4 (16.4–29.8)
Oversewing of placental bed[‖]	17	190/985	19.1 (13.4–26.5)
Manual removal of placenta[¶]	8	68/493	10.8 (6.1–18.4)
Uterine artery embolization	14	136/1,569	7.9 (5.5–11.2)
Curettage	10	116/583	2.2 (8.0–48.1)
Other[#]	9	143/787	15.9 (10.7–23.0)

* Weighted proportions per 100 emergency peripartum hysterectomies using random-effects model.
† Including eight cases in which compression was unspecified.
‡ Includes B-Lynch procedure and other or unspecified procedures.
§ Includes ligation of the uterine, ovarian, internal iliac, and hypogastric arteries.
‖ Includes suturing of bleeding points and cervical lacerations.
¶ Includes examination under anesthesia.
# Includes placenta left in utero, intra-abdominal packing, internal iliac artery balloon placement, hot saline packs, lower segment belt, securing of uterine angles, and unspecified measures.

income countries, 752 of 1,463 (51.4%) in upper middle–income countries, and 1,418 of 2,492 (56.9%) in high-income countries.

Additional surgery performed during or after hysterectomy was detailed for 5,248 women. Repeat laparotomy was required in 434 patients (8.9%, 95% CI 6.9–11.6) (Table 5). Relaparotomy was performed most often in high-income countries (265/2,813, 10.9%, 95% CI 8.2–14.9), followed by upper middle–income (139/1,492, 9.7%, 95% CI 6.2–16.1), lower middle–income (28/750, 7.4%, 95% CI 3.5–11.1), and low-income (2/193, 1.0%, 95% CI 0.2–4.2).

Weighted mean operating time was 137 minutes (95% CI 132–153). The weighted mean volume of blood loss during surgery was 3.9 L (95% CI 3.3–4.2).

Most women undergoing hysterectomy (4,930/5,420, 91.4%) received transfusion of red blood cells, with a weighted mean of 8 units per person (95% CI 7.1–8.9). Two studies mentioned salvage of blood cells, accounting for 12 of 143 women included (8.4%).[23,38] Fresh frozen plasma was administered to 847 of 1,431 women (59.1%). Other transfusions given to treat coagulopathy were platelets in 213 of 407 women (52.3%), tranexamic acid in 154 of 486 (31.7%), fibrinogen in 135 of 707 (19.1%), cryoprecipitate in 30 of 204 (14.7%), recombinant factor VIIa in 90 of 1,125 (8.0%), and prothrombin complex in 3 of 126 (2.4%).

The proportion of women receiving transfusion of packed red blood cells differed among income settings: 79 of 165 in low-income settings (47.8%), 1,248 of 1,285 (97.1%) in lower middle–income settings, 783 of 816 (95.6%) in upper middle–income settings, and 2,816 of 3,154 (89.2%) in high-income settings. The mean number of units of red blood cells given per person increased with income setting; 2.4 in low-income settings, 4.4 in lower middle–income settings, 7.3 in upper middle–income settings, and 9.7 in high-income settings.

Table 5. Procedures in Addition to Hysterectomy

Procedure	No. of Studies	No. of Patients (n/N)	Proportion (95% CI)*
Salpingo-oophorectomy	33	234/2,244	10.1 (8.2–12.5)
Relaparotomy	63	434/4,014	9.0 (6.9–11.6)
Bladder or ureteral repair	23	115/1,156	8.6 (6.1–12.0)
Artery ligation or embolization	7	35/406	8.2 (3.9–16.5)
Other[†]	5	20/308	6.8 (2.8–15.4)

* Weighted proportions per 100 emergency peripartum hysterectomies using random-effects model.
† Includes abdominal packing, bowel repair, appendectomy, uterine curettage, and unspecified procedures.

The duration of hospital stay ranged from 6 hours[11] to 240 days[125]; the pooled average time of admission was 9.2 days (95% CI 8.4–10.1). A total of 1,588 of 3,438 (46.2%) women were admitted into the intensive care unit, with a mean stay of 2.4 days (95% CI 2.0–3.2).

Information on complications was given in all but 24 studies,[19,21,22,25,26,28,34,41,42,57] representing[63,66,68,69,82,89,93,104,111,126–129] a total of 7,469 women (Table 6). The most common complications described were febrile morbidity in 1,175 women (29.7%, 95% CI 25.4–34.3), hematologic in 1,787 women (27.5%, 95% CI 20.4–35.9), and infection in 713 women (12.7%, 95% CI 10.0–15.9).

Maternal case fatality rates were given in all but seven studies.[19,22,46,79,96,113,128] Overall, maternal death occurred in 453 of 9,814 hysterectomies, resulting in a case fatality rate of 3.2% (95% CI 2.5–4.2). Maternal case fatality rates differed among income settings; low- and lower middle–income countries had mean case fatality rates of 9.3% (95% CI 5.9–14.3) and 11.2% (95% CI 9.0–14.0), respectively, whereas, in upper middle– and high-income countries, case fatality rates were 3.9% (95% CI 2.8–5.7) and 1.0% (95% CI 0.5–1.6), respectively. The highest maternal case fatality rate was reported in Nigeria: 13 of 22 women (59.1%) undergoing hysterectomy died.

Data on perinatal death were provided in 94 studies. The overall perinatal case fatality rate was 19% (14.4–24.9). The perinatal case fatality rate was 14.3% (95% CI 4–32.7) in low-income settings, 54.7% (95% CI 46.7–62.6) in lower middle–income settings, 18% (95% CI 13.9–24.8) in upper middle–income settings, and 5.6% (95% CI 4.1–7.5) in high-income settings.

No new case–control studies were included. Appendix 4 (available online at http://links.lww.com/AOG/C968) describes risk factors.

DISCUSSION

Marked differences in incidence, indications, management, and outcomes of emergency peripartum hysterectomy that were previously identified remain among countries with different income levels. Of the 26 newly included studies, a substantial proportion were population-based studies, which contributed to the validity of the present review. Overall, the incidence of emergent peripartum hysterectomy was 1.1 per 1,000 births, with the highest incidence

Table 6. Complications After Emergency Peripartum Hysterectomy

Complication	No. of Studies	No. of Patients (n/N)	Proportion (95% CI)[1]
Febrile morbidity	81	1,175/4,252	29.7 (25.4–34.3)
Hematologic[2]	115	1,787/4,058	27.5 (20.4–35.9)
Infection[3]	77	647/4,372	12.7 (10.0–15.9)
Wound[4]	88	643/4,643	11.8 (9.8–14.3)
Genitourinary[5]	109	713/6,531	9.9 (8.5–11.5)
Pulmonary[6]	38	179/2,229	6.1 (4.1–8.9)
Psychological disturbance	16	60/990	5.9 (3.7–9.3)
Gastrointestinal[7]	55	170/2,827	5.5 (4.2–7.2)
Renal[8]	45	181/3,428	4.2 (3.0–6.4)
Cardiovascular[9]	31	69/2,504	3.2 (2.4–4.4)
Thromboembolic[10]	35	67/2,137	3.2 (2.5–4.3)
Neurologic[11]	6	8/295	3.0 (1.5–5.9)
Endocrinologic[12]	5	8/243	3.3 (1.7–6.4)
Other[13]	19	93/1,728	4.6 (2.6–7.9)

[1] Weighted proportions per 100 emergency peripartum hysterectomies using random-effects model.
[2] Includes bleeding, anemia, hypovolemic shock, hematomas, and coagulopathy.
[3] Includes septicemia; pelvic, subphrenic, or vaginal cuff abscess; thrombophlebitis; respiratory infection; urinary infection; urinary tract infection; and peritonitis.
[4] Includes dehiscence, hematoma, infection or sepsis, and incisional hernia.
[5] Includes bladder or ureteric injury, fistula, incontinence, and urine retention.
[6] Includes atelectasis, pneumothorax, pulmonary edema, pleural effusion, acute respiratory distress syndrome, and ventilation requirement.
[7] Includes paralytic ileus, jaundice, liver dysfunction, ascites, bowel injury, and intestinal obstruction.
[8] Includes acute renal failure, hydronephrosis, and oliguria.
[9] Includes cardiac arrest, myocardial infarction, heart failure, and cardiomyopathy.
[10] Includes deep vein thrombosis, pulmonary embolism, air embolism, and amniotic fluid embolism.
[11] Includes stroke, seizure, and coma.
[12] Includes Sheehan's syndrome and premature ovarian failure.
[13] Includes prolonged pain, reactive splenomegaly, multiorgan failure, compartment syndrome, bed sores, anaphylactic shock, and cortical blindness.

observed in lower middle–income settings (3.0/1,000 births). The most common indication in low-income settings was uterine rupture; in high-income settings, it was placental pathology. Half of all women undergoing emergency peripartum hysterectomy previously underwent cesarean delivery.

There was a considerable difference in incidence of emergency peripartum hysterectomy among income settings. International differences in the incidence of emergency peripartum hysterectomy may be caused by variations in maternal age and health status, cesarean delivery rates, clinical management of major obstetric hemorrhage, study setting, and definition and availability of other surgical or radiologic interventions.[1,130,131] Data suggest that the incidence also varies among high-income countries. This may be attributed to large geographic distances within countries; countries with spread out populations (eg, Canada, Australia) seem to have a higher incidence of emergency peripartum hysterectomy. Transport to health care facilities may result in longer delay, with women presenting already in shock in case of hemorrhage necessitating prompt intervention, or transport to a referral hospital with options for uterus-sparing interventions being logistically impossible.

For low-income countries, the incidence of emergency peripartum hysterectomy should be interpreted with caution because it was based on only two hospital-based studies from Tanzania (low-income during the study period) and Nepal. Low-income countries face multiple challenges, including difficulties for women to access health care facilities, limited availability of conservative management options, and low numbers of skilled birth attendants. Moreover, research output is limited compared with higher-income countries and might be published in lower-impact journals, thereby making it harder to identify. This makes the representativity of our findings for these countries limited.

Worldwide, placental pathology was the most common indication for emergency peripartum hysterectomy. This is likely a result of the increasing rates of cesarean delivery.[132] Indications varied among income settings. Uterine rupture was most common indication in lower middle–income settings, and placental pathology was most frequently observed in high-income settings. This difference may be attributable to higher rates of obstructed labor, lack of monitoring of labor progress, and reduced accessibility and availability of maternity care in lower-income settings.[133]

Previous studies have demonstrated that registration for antenatal care is a protective factor for emergency peripartum hysterectomy.[134] Although many women were registered as not having received antenatal care, the association between antenatal care and emergency peripartum hysterectomy remains unclear because of possible lack of documentation. First, it was not possible to distinguish truly unregistered women from women referred who received antenatal care outside the facility where emergency peripartum hysterectomy was performed. Also, antenatal care registration was mentioned almost exclusively for low- and lower middle–income countries, where women may have a higher chance of not accessing antenatal care.

Postoperative maternal morbidity and mortality rates were considerable. A quarter of the women had infectious or bleeding complications. This is likely due to the high volume of blood loss associated with emergency peripartum hysterectomy (average volume of blood loss 3.9 L).[135] The highest rates of blood transfusion were found in lower middle–income settings. The highest quantities of red blood cells, however, were transfused in high-income settings. This inverse relationship may be explained by fewer alternative preventive measures and a limited availability of blood transfusion in lower-income settings.[136] The ability to transfuse a woman will undoubtedly influence the decision to perform emergency peripartum hysterectomy, which may happen earlier in the course of hemorrhage in some settings as a result. The same may happen when few other conservative management options are available. Access to safe blood transfusion is likely to be an efficient and cost-effective intervention to reduce maternal mortality associated with emergency peripartum hysterectomy in lower-income settings.

There was also a remarkable difference in perinatal mortality among income settings; rates in lower-income settings were disproportionally higher compared with high-income settings. Risk of perinatal death was up to nine times higher in lower middle–income compared with high-income settings. These impressive inequities can be explained by resource limitations and delays in accessing maternity care, as well as by inadequate management compounded by a lack of skilled birth attendants.[133,137,138]

To our knowledge, this is the largest and most comprehensive review to date on incidence, indications, and outcomes of emergency peripartum hysterectomy. It provides a robust global overview of emergency peripartum hysterectomy through reporting on data from 42 countries. Our study includes a thorough assessment of the quality of included studies. Whereas the previous article used an adaptation of the

Newcastle-Ottawa scale, we assessed all 154 studies again, this time using the COSMOS-E criteria.

Nevertheless, this study has several limitations. First, women from low-income settings were underrepresented in this meta-analysis. Second, this meta-analysis includes few population-based studies. However, population-based studies have their own limitations, such as unknown data quality, data collection not usually done by the researchers, and possibly missing confounder information. Third, in the absence of individual data, multivariable analysis was not possible and multiple or sequential measures could not be described, as often occurs in practice. Fourth, risk of bias was assessed as high in 35.7% of the studies. We did not exclude studies after quality assessment, to calculate a more accurate estimate of mean values. Also, by excluding such a high number of studies, we deemed that estimations of incidence would become problematic.

These data suggest a number of considerations. First, there is a need for a universal definition for emergency peripartum hysterectomy. We suggest that future studies on emergency peripartum hysterectomy include all hysterectomies up to 6 weeks postpartum, because most infectious complications will arise later than 24 or 48 hours postpartum.[17] Also, almost none of the studies included hysterectomies in the first trimester due to abortive complications, which would also be of importance. Second, literature on emergency peripartum hysterectomy in low-income countries and in South America, Asia, and Africa is scarce. Clearly more data are needed from these regions. Third, we observed an increase in the number of population-based studies that were included compared with 7 years ago. Although population-based studies provide the most accurate representation of a country's incidence, use of routinely collected data may have some degree of inaccuracy. Forth, this review underlines the importance of reducing cesarean delivery rates, which remain the most important risk factor for placenta accreta spectrum, uterine rupture, and massive obstetric hemorrhage. Fifth, because placental pathology is the most frequent indication for emergency peripartum hysterectomy in high-income settings, we recommend that increased efforts should be undertaken to care for these complex patients.

To conclude, considerable inequity exists in incidence and associated morbidity and mortality of emergency peripartum hysterectomy across the world. This inequity can be reduced only by improving accessibility, availability, and quality of care for the vulnerable group of pregnant women globally.

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