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Definitions, Vital Statistics and Risk Factors: an Overview

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INTRODUCTION

A recent systematic review suggests that the prevalence of postpartum hemorrhage (PPH) (blood loss of 500 ml or more) and severe PPH (defined by authors as blood loss of 1000 ml or more) is 1.85% and 6%, respectively, of all deliveries, albeit with significant regional variations[1]. This chapter describes the incidence of primary PPH, the difficulties in reporting epidemiological data on primary PPH and the etiology and precipitating factors for primary PPH. Because of its broad scope, this discussion invariably includes several points mentioned in greater detail elsewhere. Regardless, these statistics should provide additional insights as many derive from secondary analyses.

DEFINING POSTPARTUM HEMORRHAGE

The traditional definition of primary PPH used in most textbooks of obstetrics is a visually estimated blood loss of 500 ml or more within the first 24 h after delivery[2]. In contrast, secondary PPH generally is defined as 'excessive bleeding' from the genital tract after 24 h and up to 6 weeks postdelivery (see Chapter 16). As such, this latter definition only contains quantification of the time period rather than the extent of blood loss. However, according to older and commonly quoted data, measured blood loss during a vaginal delivery averages 500 ml, whereas during a cesarean section the average is 1000 ml[3]. Given this reality, the 'classic' definition of primary PPH is a reflection of the almost universal tendency to underestimate delivery blood loss (see below and Chapters 9 and 11).

Because a loss of 500 ml at delivery for most women in the developed world does not result in significant morbidity, one might argue that the classic definition of primary PPH is clinically inappropriate and should be revised to identify a group of women who manifest symptoms or become 'ill' and thus are at real risk of morbidity after the hemorrhage. If the classic definition were to be changed, definitions of any event leading to severe obstetric morbidity could then be based on 'pathophysiology', 'management' or a combination of both parameters[4]. The problem with using a management-based definition of hemorrhage, such as number of units of blood transfused, is that it can only be used retrospectively and is of no value to the clinician attempting to treat this condition. Further, such a definition is likely to be highly influenced by local practitioner/hospital beliefs about when to transfuse as well as the local facilities available for transfusion. Consequently, it may be better to think of the term 'significant obstetric hemorrhage', using a definition of loss of more than 1000 ml or more than 1500 ml, rather than define primary PPH as more than 500 ml blood loss[5].

In the average non-pregnant adult, circulating blood represents a total of 7% of body weight, or approximately 5 liters. Loss of 30–40% of the circulating volume (1500–2000 ml) results in tachycardia, tachypnea, a measurable fall in systolic blood pressure and alterations in mental state[6]. Therefore, the concept of defining a 'significant primary PPH' as one resulting in a blood loss of 1500 ml or more is meritorious as this reflects the point when physiological compensatory mechanisms begin to fail. Whether this concept will find universal acceptance remains to be seen, however. Even if it does, its implementation would depend on the accuracy of the estimation, a circumstance which is more often than not lacking in clinical practice.

DIFFICULTIES OF COMPARING STUDIES

Two key factors must be considered when comparing published studies of primary PPH: first, the method used to determine blood loss, and, second, the method of managing the third stage of labor. In addition, confounding represents a potential problem in case–control studies that examine risk factors for primary PPH.

Determining blood loss: estimating versus measuring

Accurate measurement of blood loss at delivery is possible but must be planned for in advance (see also Chapter 11). The most obvious is collection of blood into receptacles and direct measurement. This can be combined with a gravimetric procedure which

depends upon converting the increase in weight of sponges and linen into milliliters of blood on a ml/g basis. Gulmezoglu and Hofmeyr proposed a method for directly measuring blood loss objectively which does not interfere with routine care[7]. They suggest 'after delivery of the baby, the amniotic fluid is allowed to drain away and amniotic fluid-soaked bed linen is covered with a dry disposable 'linen saver'. A low-profile, wedge-shaped plastic 'fracture bedpan' is slipped under the woman's buttocks for blood collection, with blood and clots decanted into a measuring cylinder. Weighing of blood-soaked swabs and linen savers occurs, with the known dry weight subtracted and calculated volume added to that from the bedpan.' They particularly recommend this method for all future trials of interventions to reduce primary PPH. Strand and colleagues suggested a novel method with a combination of a plastic sheet and a bucket below a cholera bed on which the woman rested during postpartum observation[8]. As interesting as these methods are, they are cumbersome, time-consuming and may not be widely available. In contrast, the BRASSS-V collection drape and the instructions for its use as described in Chapter 11 is cheap, can be produced locally and has been enthusiastically accepted in a variety of circumstances. As with any direct measurement of blood loss, however, contamination with amniotic fluid and urine is not uncommon.

Laboratory-based methods for measuring blood loss include photometric techniques, whereby sanitary protection is collected and blood pigment converted to acid or alkaline hematin and the concentration then compared in a colorimeter with the patient's own venous blood[9]. Alternatively, volumetric methods involve labelling the woman's plasma or erythrocytes with dyes or radioactive substances and then calculating the reduction in blood volume. Unfortunately, both techniques require expertise, are time-consuming and expensive to perform compared to simple measurement of blood loss.

Visual estimation has long been considered to be unreliable. Duthie and colleagues compared visual estimation and measured blood loss using the alkaline-hematin method during normal delivery in 37 primigravid and 25 multigravid women. These investigators found that, for both groups, the mean estimated blood loss (261 ml and 220 ml, respectively) was significantly lower than the mean measured blood loss (401 ml and 319 ml, respectively)[10]. This observation is consistent with studies of simulated scenarios that suggest trained and experienced midwives and doctors underestimate blood loss at delivery by 30–50%[11]. Importantly, estimates are particularly unreliable for very small and very large amounts of blood[12] (see Chapter 9).

Reported rates of PPH also differ widely depending on the method of measuring blood loss. Older studies that directly measured blood loss reported rates of primary PPH (>500 ml) of between 22% and 29%[13,14] compared to rates of 5–8% with visual estimation. More recently, Prasertcharoensuk and colleagues compared visual estimation with direct measurement in 228 women who had a spontaneous vaginal delivery[15]. The incidences of PPH more than 500 ml and more than 1000 ml were 5.7% and 0.44%, respectively, by visual estimation, whereas direct measurements showed incidences of 27.63% and 3.51%, respectively. These differences are five and seven times higher, respectively. The authors concluded that visual estimation underestimated the incidence of PPH by 89%. Razvi and colleagues conducted a similar prospective study and showed a similar degree of underestimation[16].

Conduct of third stage of labor

Active management of the third stage (AMTSL) involves early clamping of the umbilical cord before pulsations have stopped, controlled cord traction using the Brandt–Andrews technique and the use of prophylactic uterotonics, usually with the delivery of the fetal anterior shoulder (see also Chapter 14). In contrast, expectant or 'physiological' third stage involves late clamping of the cord after pulsations have stopped, waiting for spontaneous separation of the placenta from the uterine wall and avoidance of synthetic uterotonics. Nipple stimulation has been used to promote the release of endogenous oxytocin and reduce the length and amount of bleeding in the third stage of labor[17], but is not part of active or expectant management. A meta-analysis of five randomized, controlled trials (involving over 6000 women) indicates that active management results in a reduction in maternal blood loss at delivery and a reduction in the risks of PPH, defined as an estimated blood loss of more than 500 ml (relative risk (RR) 0.38, 95% confidence interval (CI) 0.32–0.46), and severe PPH, defined as an estimated blood loss of 1000 ml or more (RR 0.33, 95% CI 0.21–0.51) as well as prolonged third stage[18].

Clearly, the reported incidence of PPH in any population is influenced by the conduct of the third stage. As active management is less widely practiced in some areas of the developing world, this must be considered when making international comparisons of PPH rates.

CONFOUNDING FACTORS IN EPIDEMIOLOGICAL STUDIES

Confounding is a potential problem in epidemiologic studies exploring risk. A confounder is associated with the risk factor and causally related to the outcome. Thus, a researcher may attempt to relate an exposure to an outcome, but actually measures the effect of a third factor, the confounding variable[19]. As an example, parity, particularly grand multiparity, is generally considered a risk factor for primary PPH. However, grand multiparas tend to be older and therefore have higher rates of age-related medical diseases, such as diabetes mellitus, which could be the 'true' risk factors for PPH.

Methods used to control confounders include:

(1) Restriction – in the example cited in the preceding paragraph, women with diabetes mellitus could be excluded. However, restriction limits the external validity of the findings and reduces the sample size.

(2) Matching – here, if diabetes mellitus is deemed a confounder, then for every woman recruited with diabetes mellitus who has a PPH, she is matched to a control with diabetes mellitus who did not have PPH.

(3) Stratification – can be thought of as *post hoc* restriction performed at the analysis phase.

Multivariate analysis is a statistical tool for determining the relative contributions of different causes to a single event or outcome[20]. Epidemiological studies that use multivariate methods are more likely to eliminate confounders. For readers who require further information about the problems of epidemiological studies, please refer to Grimes and Schultz[21] and Mamdani and colleagues[22].

INCIDENCE OF PRIMARY POSTPARTUM HEMORRHAGE

Denominator data

Studies that attempt to quantify the incidence and impact of PPH need a denominator value over a time period to calculate rates. Common denominators used to calculate maternal mortality and morbidity rates[23] are illustrated in Table 1.

Developed countries, including the UK, have the advantage of accurate denominator data, including both livebirths and stillbirths. Consequently, the UK Confidential Enquiries into Maternal Deaths have used maternities for denominator data, because this enables establishment of a more detailed picture of maternal death rates. However, for many countries, particularly in the developing world, no process of stillbirth (or even livebirth) registration exists. Denominator data are, therefore, likely to be based on livebirths, rather than maternities. Indeed, in some countries even livebirth data collection may not be reliable. As a result, it is often extremely difficult to compare maternal mortality and morbidity from different geographic areas.

Table 1 Denominators used in calculating maternal mortality and morbidity

Denominator	*Definition*	*Advantages and disadvantages*
Livebirths	Number of pregnancies that result in a livebirth at any gestational age	Easier to collect than maternities
Maternities	Number of pregnancies that result in a livebirth at any gestational age or stillbirths occurring at or after 24 weeks of completed gestation and required to be notified by law	Includes the majority of women at risk from death from obstetric causes but requires infrastructure for notification of stillbirths
Women aged 15–44 years	Number of women of reproductive age in a given population	Lacks rigor of confining rate to women who were pregnant, but enables comparison with other causes of death

Maternal mortality

One method of attempting to quantify the magnitude of PPH is to determine its contribution to maternal deaths around the world, and in a particular country over time. Trends over time within one country are an important audit tool in examining the care of women with PPH, as can be seen from the UK Confidential Enquiries into Maternal Deaths. However, differences between countries often reflect differences in health care provision, general economic prosperity and geographic and climactic conditions that affect access to obstetric care.

Global picture

WHO estimates that obstetric hemorrhage complicates 10.5% of all livebirths in the world, with an estimated 13,795,000 women experiencing this complication in 2000[23]. Around 132,000 maternal deaths are directly attributable to hemorrhage, comprising 28% of all direct deaths. In comparison, the following numbers relate to other conditions: 79,000 deaths from sepsis, 63,000 deaths from pre-eclampsia/eclampsia, 69,000 from abortion and 42,000 from obstructed labor.

United Kingdom

A triennial report on Confidential Enquiries into Maternal Death has been published since 1985, with reports for England and Wales commencing in 1952 (see Chapter 20). Direct deaths are reported that result from obstetric complications of the pregnant state (pregnancy, labor and puerperium up to 42 days), from interventions, omissions, incorrect treatment or from a chain of events resulting from any of the above. Obstetric hemorrhage comprising placental abruption, placenta previa and PPH is one example of direct deaths[24]. In the 2006–2008 triennium, there were 107 direct maternal deaths. Nine (8%) of these were attributed to obstetric hemorrhage with five (4.7%) principally attributed to PPH. Since the UK-wide triennium report began in 1985, 106 deaths from obstetric hemorrhage have been recorded, of which half (55 women) were caused by PPH, resulting in a death rate for PPH of 3.1 per million maternities. Calculated death rates for PPH for each triennium are shown in Table 2 as is a decline during the most recent three reports.

At first glance there appears to be a marked increase in PPH in the 2000–2002 triennial report compared to the one that immediately preceded it. However, two patients who died had no contact at all with health services and another two refused blood products that

Table 2 Maternal mortality from PPH in UK (extrapolated from CMACE[25])

Triennium	*Postpartum hemorrhage (n)*	*Total maternities (n)*	*Rate per million maternities*
1985–87	6	2,268,766	2.6
1988–90	11	2,360,309	4.6
1991–93	8	2,315,204	3.4
1994–96	5	2,197,640	2.2
1997–99	1	2,123,614	0.4
2000–02	10	1,997,472	5.0
2003–05	9	2,114,004	4.3
2006–08	5	2,291,493	2.2

would probably have saved their lives. Excluding these four deaths results in a rate per million maternities comparable to the reports published between 1985 and 1996. Of the eight women who sought care in the 2000–2002 cohort and ultimately died from PPH, elements of substandard care were present in seven (88%) including:

(1) Organizational problems – including inappropriate booking at hospitals with inadequate blood transfusion and intensive care facilities;

(2) Poor quality of resuscitation – including inadequate transfusion of blood and blood products;

(3) Equipment failure, e.g. malfunctioning of specimen transport system;

(4) Inadequate staffing of recovery areas;

(5) Failure to recognize or treat antenatal medical conditions, e.g. inherited bleeding disorders;

(6) Failure of senior staff to attend;

(7) Concerns about the quality of surgical treatment given. The recognition of these diverse elements provides a blue-print to health care authorities to institute remedial action (see Chapter 40).

The 2003–2005 report recommended the use of Maternity Obstetric Early Warning Scoring (MEOWS) charts to help recognize the deteriorating patient. In the 2006–2008 report, there is a non-statistical reduction in death from major obstetric hemorrhage making it the 6th most common cause of direct maternal deaths[25]. Where suboptimal care was identified, the report concludes there were issues with 'lack of early senior multidisciplinary involvement, lack of close postoperative monitoring and the failure to act on symptoms and signs that a woman is seriously unwell, including readings from MEOWS charts; such factors remain important contributors to maternal death from hemorrhage.'

United States of America

The Center for Disease Control (CDC) conducted a pregnancy-related mortality survey in the USA between 1991 and 1999[26]. Hemorrhage in pregnancy was responsible for 17% of maternal deaths, although this figure includes hemorrhage from first-trimester pregnancy complications. Of the 2519 maternal deaths that were associated with livebirth and the 275 maternal deaths associated with stillbirth, 2.7% and 21.1%, respectively, were considered to be a direct result of obstetric hemorrhage. Unfortunately, no separate data were provided about PPH. Comparison with the 1987–1990 data shows a reduction in the percentage of maternal deaths from pregnancy-related hemorrhage from 28.7% to 17%[27]. The trend may no longer be present at the time of this writing.

France

A confidential enquiry into maternal deaths in five of the 22 administrative areas of France found that five deaths from 39 obstetric causes were due to PPH[28], implicating PPH in 13% of the obstetric deaths. No denominator data were collected, and therefore it is not possible to estimate rates.

Africa

Bouvier-Colle and colleagues performed a population-based survey of pregnant women from seven West African areas from 1994 to 1996[29]. Overall, 55 women died from direct or indirect obstetric causes among 17,694 livebirths. Hemorrhage accounted for 17 deaths (31%), with delivery hemorrhage (third stage) and postdelivery hemorrhage (retention of placenta) accounting for six and four deaths, respectively. This equates to a maternal mortality rate of 565 per 1,000,000 livebirths, a rate approximately 200-fold higher compared to the UK.

Another study in South Africa, involving one tertiary center, reported a maternal mortality rate of 1710 per 1,000,000 livebirths during the period 1986–1992, with 25% of deaths attributed to obstetric hemorrhage[30]. Within this setting, hemorrhage was the leading cause of death.

Maternal morbidity

Because maternal death in the developed world is a rare event, clinicians have attempted to quantify significant morbidity, which is often labelled as a maternal adverse event or a near miss (see Chapter 60). Studies have generally included massive obstetric hemorrhage as one indicator of severe maternal morbidity. As with mortality, comparisons between studies are often difficult because of variations in definition of 'massive obstetric hemorrhage'. Both antenatal and intrapartum bleeding are sometimes included within the definition of 'obstetric hemorrhage'.

Scotland

The Scottish Programme for Clinical Effectiveness in Reproductive Health (SPCERH) conducted a prospective investigation into 14 severe maternal morbidity categories for all maternity units in Scotland in 2003[4]. Within this audit, major obstetric hemorrhage

was defined as estimated blood loss of 2500 ml or more, or transfusion of 5 units or more of blood or the need for fresh frozen plasma or cryoprecipitate. Of the 375 events, 176 (46%) were reported to be related to obstetric hemorrhage. Because some patients experienced more than one morbid event, major obstetric hemorrhage occurred in 65% of 'near-miss patients' (176/270). Using a denominator of 50,157 livebirths, the authors calculated a rate of major obstetric hemorrhage of 3.5/1000 births (CI 3.0–4.1). Of the 176 cases notified to the investigators, full disclosure of data was obtained in 152 cases; 70% of the cases were due to primary PPH, 26% to intrapartum hemorrhage and 17% to antepartum hemorrhage with some women falling into more than one category.

England

In the South East Thames region, 19 maternity units participated in a 1-year study between 1997 and 1998 to determine the incidence of severe obstetric morbidity[31]. Severe obstetric hemorrhage was defined as estimated blood loss of 1500 ml or more or a peripartum fall in hemoglobin concentration of 40 g/l or more or the need for an acute transfusion of 4 or more units of blood. A total of 588 cases of severe obstetric morbidity were observed among 48,856 women delivered over the year, giving an incidence of 12/1000 deliveries. Hemorrhage was the leading cause of obstetric morbidity at 6.7 (CI 6.0–7.5) occurrences per 1000 deliveries, representing nearly two-thirds of cases. However, this study did not include thromboembolic disease, which is the leading cause of direct maternal deaths in the UK.

United States and Canada

One large US study demonstrated that PPH has increased 26% (from 2.3% to 2.9%) between 1994 and 2006, with the increase mainly attributed to an increase in uterine atony[32]. Wen and colleagues in Canada conducted a retrospective cohort study of severe maternal morbidity involving 2,548,824 women who gave birth in over a 10-year period from 1991, using information on hospital discharges compiled by the Canadian Institute for Health Information[33]. Their criteria for severe maternal morbidity included PPH requiring hysterectomy or transfusion. Their overall rate of all severe maternal morbidity was 4.38 per 1000 deliveries. Overall rates for severe PPH in the 10-year time frame are illustrated in Table 3 along with time analysis for rates at the beginning and end of the study.

Within this study, rates for PPH requiring transfusion halved (RR 0.5, CI 0.44–0.55), but hysterectomy rates for PPH almost doubled (RR 1.76, CI 1.48–2.08). Because the definition of PPH was based on management rather than pathophysiology, it is difficult to tease out whether the temporal change reflects a true reduction in the incidence of PPH or simply a change in clinical management.

Australia

Roberts and colleagues demonstrated an increase in maternal morbidity outcome indicator from 11.5 per 1000 to 13.8 per 1000 in women delivering in New South Wales between 1999 and 2004, with this increase being attributed to PPH[34].

Africa

Filippi and colleagues conducted prospective and retrospective data extraction on near-miss obstetric events in nine referral hospitals in three countries (Benin, Cote d'Ivoire and Morocco)[35]. Obstetric hemorrhage was defined as hemorrhage leading to clinical shock, emergency hysterectomy and blood transfusion. The incidence of near-miss cases varied widely between hospitals. Most of the women were already in a critical condition on arrival, with two-thirds being referred from another facility. The study identified a total of 507 cases of late pregnancy obstetric hemorrhage (i.e. previa, abruption and other non-classified hemorrhage and PPH) from 33,478 deliveries, representing a near-miss late obstetric hemorrhage rate of 15.1/1000 deliveries. In total there were 266 cases of PPH, representing a near-miss PPH rate of 7.9/1000 deliveries.

Prual and colleagues examined severe maternal morbidity from direct obstetric causes in West Africa between 1994 and 1996[36]. A severe obstetric event was defined as 'prepartum', 'peripartum' or 'PPH leading to blood transfusion, or hospitalization for more than 4 days or to hysterectomy'. A total of 1307 severe maternal morbidity events were identified, with obstetric hemorrhage representing the largest group involving 601 cases, 342 of which were PPH. The near miss obstetric hemorrhage rate was 30.5 (CI 28.1–33.0)/1000 live births and the near-miss PPH rate was 17.4 (CI 15.6–19.3)/1000 live births.

The Pretoria region of South Africa has used the same definition of 'near miss' for over 5 years, allowing comparison of temporal changes[37]. Rates per 1000 births for near misses plus maternal deaths over 5 years

Table 3 Postpartum hemorrhage (PPH) rates in Canada 1991–2000. Adapted from Wen[33]

	Number of cases (1991–2000)	*Rate per 1000 deliveries (95% CI)*	*Rate per 1000 deliveries (1991–1993)*	*Rate per 1000 deliveries (1998–2000)*	*Relative risk (95% CI)**
PPH requiring transfusion	2317	0.91 (0.87–0.95)	1.27	0.63	0.5 (0.44–0.55)
PPH requiring hysterectomy	892	0.35 (0.33–0.37)	0.26	0.46	1.76 (1.48–2.08)

*The 1991–1993 period was the reference period

from severe PPH are shown in Table 4. These rates are not dissimilar to those in Canada or the UK.

ETIOLOGY AND PRECIPITATING FACTORS

Causes of primary postpartum hemorrhage

In recent years, individual authors and academic groups have used the four Ts pneumonic to provide a simplistic categorization of the causes of PPH. This is shown in Table 5[38].

Uterine atony

Uterine atony, the most common cause of PPH, is reported in 70% of cases[38]. It can occur after normal vaginal delivery, instrumental vaginal delivery and abdominal delivery. A large cohort study found an incidence of uterine atony after primary cesarean section of 1416/23,390 (6%)[39]. Multiple linear regression analysis demonstrates the following factors as being independently associated with risk of uterine atony: multiple gestation (odds ratio (OR) 2.40, 95% CI 1.95–2.93), Hispanic race (OR 2.21, 95% CI 1.90–2.57), induced or augmented labor for more than 18 h (OR 2.23, 95% CI 1.92–2.60), infant birth weight more than 4500 g (OR 2.05, 95% CI 1.53–2.69) and clinically diagnosed chorioamnionitis (OR 1.80, 95% CI 1.55–2.09).

Surprisingly, it is more difficult to find comparable studies of risk factors for uterine atony in women achieving vaginal delivery. A single center, case–control study from Pakistan reporting on women who had either assisted or non-assisted vaginal delivery found only two factors had a strong association with uterine atony: gestational diabetes mellitus (OR 7.6, 95% CI 6.9–9.0) and prolonged second stage of labor in multiparas (OR 4.0, 95% CI 3.1–5.0)[40]. They found no association with high parity, age, pre-eclampsia, augmentation of labor, antenatal anemia and a history of poor maternal or perinatal outcomes.

Trauma

Trauma is reported as the primary cause of PPH in 20% of cases[38] (see also Chapter 23). Genital tract trauma at delivery is associated with an odds ratio of 1.7 (95% CI 1.4–2.1) for PPH (measured blood loss more than 1000 ml)[41]. Similar results were found in a Dutch study with a reported OR of 1.82 (CI 1.01–3.28) for PPH (≥1000 ml) with perineal trauma of first degree tears or more[42]. Trauma to the broad ligament, uterine rupture, cervical and vaginal tears and perineal tears are all associated with increased blood loss at normal vaginal delivery.

Inversion of the uterus is a rare cause of PPH (see Chapter 23). The incidence of inversion varies from 1 in 1584 deliveries in Pakistan[43] to around 1 in 25,000 deliveries in the USA, UK and Norway[44]. Blood loss at delivery with a uterine inversion is usually at least 1000 ml[45], with 65% of uterine inversions being complicated by PPH and 47.5% requiring blood transfusion in a large series of 40 cases[46].

Table 4 Rates per 1000 births for near misses plus maternal deaths from severe postpartum hemorrhage in Pretoria. Adapted from Pattinson *et al.*[37]

	1997–99	*2000*	*2001*	*2002*
Rate/1000 births	0.96	1.37	2.38	2.28

Table 5 The four Ts of PPH (from ALSO[38])

Tone – uterine atony
Trauma – of any part of the genital tract, inverted uterus
Tissue – retained placenta, invasive placenta
Thrombin – coagulopathy

Tissue

Retained placenta accounts for approximately 10% of all cases of PPH[38]. Effective uterine contraction to aid hemostasis requires complete expulsion of the placenta. Most retained placentas can be removed manually, but rarely the conditions of placenta percreta, increta and accreta may be responsible for placental retention (see Chapters 28 and 59). Retained placenta occurs after 0.5–3% of deliveries[47]. Several case–control and cohort studies show that retained placenta is associated with increased blood loss and increased need for blood transfusion. Stones and colleagues reported that retained placenta had a RR of 5.15 (99% CI 3.36–7.87) for blood loss of 1000 ml or more within the first 24 h of delivery[48]. Bais and colleagues found an incidence of 1.8% for retained placenta in Holland[42]. Using multiple regression, these authors determined that retained placenta was associated with an OR of 7.83 (95% CI 3.78–16.22) and 11.73 (95% CI 5.67–24.1) for PPH of 500 ml or more and PPH of 1000 ml or more, respectively. In addition, retained placenta was found to have an OR of 21.7 (95% CI 8.9–53.2) for red cell transfusion in this Dutch cohort.

Tandberg and colleagues reported an incidence of retained placenta of 0.6% in a large Norwegian cohort of 24,750 deliveries and showed that hemoglobin fell by a mean of 3.4 g/dl in the retained placental group compared to no fall in the controls[49]. In addition, blood transfusion was required in 10% of the retained placental group but only 0.5% of the control group. A similar incidence of retained placenta was found in a Saudi Arabian case–control study which demonstrated increased blood loss in women with a retained placenta (mean 437 ml) compared with controls (mean 263 ml)[50]. A large study from Aberdeen of over 36,000 women reported PPH in 21.3% of women with retained placenta compared to 3.5% in vaginal deliveries without retained placenta[51]. Both studies confirmed that women with a history of retained placenta have an increased risk of recurrence in subsequent pregnancies[50,51]. In the study by Adelusi and colleagues, 6.1% of the patients with retained placenta had a prior history of retained placenta, compared

to none in their control group of normal vaginal deliveries[50].

Placental accreta is a rare and serious complication, occurring in about 0.001–0.05% of all deliveries[52,53] (see also Chapters 29 and 30). Makhseed and colleagues found an increasing risk for accreta with increasing numbers of cesarean sections OR 4.11 (95% CI 0.83–19.34) after one previous cesarean section and an OR of 30.25 (95% CI 9.9–92.4) after two previous cesarean sections, compared with no previous cesarean section. Kastner and colleagues found that placenta accreta was implicated in 49% of their 48 cases of emergency hysterectomy[54]. Zaki and co-workers found an incidence of 0.05% of placenta accreta in a population of 23,000 women[53]. They found that rates of PPH and emergency hysterectomy were higher in the accreta group compared to the placenta previa group undergoing cesarean section. PPH occurred in 91.7% of the accreta group compared to 18.4% of the previa group (OR 48.9, 95% CI 5.93–403)[27], whereas 50% of accreta cases required emergency hysterectomy compared to 2% in the previa group (OR 48, 95% CI 7.93–290)[52]. Within the accreta group, 75% of patients had a previous history of cesarean section, compared to 27.5% in the previa group (OR 7.9, 95% CI 1.98–31)[38].

Thrombin

Disorders of the clotting cascade and platelet dysfunction are the cause of PPH in 1% of cases[38]. Known associations with coagulation failure include placental abruption, pre-eclampsia, septicemia and intrauterine sepsis, retained dead fetus, amniotic fluid embolus, incompatible blood transfusion, abortion with hypertonic saline and existing coagulation abnormalities[5,55,56] (see Chapter 25).

ANTENATAL RISK FACTORS FOR PRIMARY POSTPARTUM HEMORRHAGE

Age

Increasing maternal age appears to be an independent risk factor for PPH. In Japan, Ohkuchi and colleagues studied 10,053 consecutive women who delivered a singleton infant[57]. Excessive blood loss (≥90th centile) was defined separately for vaginal and cesarean deliveries (615 ml and 1531 ml, respectively). On multivariate analysis, age of 35 years or older was an independent risk factor for PPH in vaginal deliveries (OR 1.5, 95% CI 1.2–1.9) and cesarean deliveries (OR 1.8, 95% CI 1.2–2.7). In Nigeria, Tsu reported that advanced maternal age (≥35 years) was associated with an adjusted RR of 3.0 (95% CI 1.3–7.3) for PPH (defined as visual estimation of ≥600 ml)[58]. Ijaiya and co-workers in Nigeria found that the risk of PPH in women over 35 years was two-fold higher compared to women less than 25 years, although no consideration of confounding was made in this study[59]. Rates of obstetric hysterectomy have also been reported to increase with age; Okogbenin and colleagues in Nigeria reported an increase from 0.1% at 20 years to 0.7% at 40 years or older[60]. However, others have found no relationship between delaying childbirth and PPH[61].

Ethnicity

Several studies have examined whether ethnicity is a factor for PPH. Magann and co-workers, using a definition of PPH as measured blood loss of more than 1000 ml and/or need for transfusion[41], found Asian race to be a risk factor (OR 1.8, 95% CI 1.4–2.2)). Other studies have observed similar findings in Asians[62] (OR 1.73, 95% CI 1.20–2.49) and the Hispanic races (OR 1.66, 95% CI 1.02–2.69)[62] and for low postnatal hematocrit value of less than 26%, (OR 3.99, 95% CI 0.59–9.26)[63].

Body mass index

Women who are obese have higher rates of intrapartum and postpartum complications. Usha and colleagues performed a population-based observational study of 60,167 deliveries in South Glamorgan, UK; women with a body mass index (BMI) more than 30 had an OR of 1.5 (95% CI 1.2–1.8) for blood loss more than 500 ml, compared to women with a BMI of 20–30[64]. Stones and colleagues reported a RR for major obstetric hemorrhage of 1.64 (95% CI 1.24–2.17) when the BMI was over 27[48].

Parity

Although grand multiparity has traditionally been considered a risk factor for PPH, Stones and colleagues and Selo-Ojeme did not demonstrate any relation between grand multiparity and major obstetric hemorrhage[48,65]. This observation was confirmed in a large Australian study which used multivariate regression analysis and found no association between grand multiparity (five or more previous births) and PPH (>500 ml)[66]. Tsu reported an association with low parity (0–1 previous birth) with an adjusted RR without intrapartum factors of 1.7 (95% CI 1.1–2.7) and an adjusted RR with intrapartum factors of 1.5 (95% CI 0.95–2.5) but not with grand multiparity (defined as five or more births)[58]. Ohkuchi also found primiparity to be associated with excessive blood loss at vaginal delivery (OR 1.6, 95% CI 1.4–1.9)[57]. Studies from Pakistan[67] and Nigeria[59] reported an association between grand multiparity and PPH, but failed to account for other confounding factors such as maternal age.

Other medical conditions

Several medical conditions are associated with PPH. Women with type 2 diabetes mellitus have an increased incidence of PPH of more than 500 ml (34%) compared to the non-diabetic population

(6%)[68,69]. Epilepsy is also associated with PPH with odds ratio of 1.2 (95% CI 1.1–1.4)[70] . A large Norwegian cohort study demonstrated an association between PPH (both mild >500 ml and severe >1500 ml) and pre-eclampsia[71]. Connective tissue disorders such as Marfans and Ehlers-Danlos syndrome have also been associated with PPH[69,72]. Blood loss at delivery is also increased with inherited coagulopathies[56]. The most common inherited hemorrhagic disorder is von Willebrand's disease, with a reported prevalence of between 1 and 3%. Most patients (70%) have type 1 disease characterized by low plasma levels of factor VIII, von Willebrand factor antigen and von Willebrand factor activity. Less common inherited bleeding disorders include carriage of hemophilia A (factor VIII deficiency) or hemophilia B (factor IX deficiency) and factor XI deficiency. In their review, Economaides and colleagues suggest that the risks of primary PPH in patients with von Willebrand's disease, factor XI deficiency and carriers of hemophilia are 22%, 16%, and 18.5%, respectively, compared with 5% in the general obstetric population[56]. James also reviewed the numerous case series and the more limited case–control studies of women with bleeding disorders and came to similar conclusions[73] (see Chapter 25).

Prolonged pregnancy

A large Danish cohort study compared a post-term group (gestational age ≥42 weeks or more) of 77,956 singleton deliveries and a term group of 34,140 singleton spontaneous deliveries[74]. The adjusted odds ratio for PPH was 1.37 (95% CI 1.28–1.46), suggesting an association between prolonged pregnancy and PPH. A large American study of 119,254 women reported increased incidence of PPH at 41 weeks of gestation with OR 1.21 (95% CI 1.1–1.32)[75].

Fetal macrosomia

Fetal macrosomia is associated with PPH. Jolly and colleagues examined 350,311 completed singleton pregnancies in London[76]. Linear regression analysis suggested that a birth weight of more than 4 kg was better at predicting maternal morbidity than birth weight of more than the 90th centile. PPH was increased in women with fetal macrosomia (OR 2.01, 95% CI 1.93–2.10). In a large cohort of 146,526 mother–infant pairs in California, Stotland and co-workers also demonstrated an adjusted OR for PPH of 1.69 (95% CI 1.58–1.82) in infants of 4000–4499 g compared to 2.15 (95% CI 1.86–2.48) and 2.03 (95% CI 1.33–3.09) with weights of 4500–4999 g and 5000 g or more, respectively[77]. In Nigeria, a case–control study of 351 infants weighing more than 4 kg with 6563 term infant controls found an incidence of PPH of 8.3% and 2.1%, respectively[78]. Bais and colleagues, in their Dutch study, also demonstrated an increase in risk for PPH (≥500 ml) and severe PPH (≥1000 ml) with infants with weights of 4 kg or more (OR 2.11, 95% CI 1.62–2.76 and 2.55, 95% CI 1.5–4.18)[42].

Multiple pregnancies

Twins and higher-order pregnancies are at increased risk for PPH. Walker and co-workers conducted a retrospective cohort study involving 165,188 singleton pregnancies and 44,674 multiple pregnancies in Canada[79]. Multiple pregnancies were associated with an increased risk for PPH (RR 1.88, 95% CI 1.81–1.95), hysterectomy (RR 2.29, 95% CI 1.66–3.16) and blood transfusion (RR 1.67, 95% CI 1.13–2.46). Several additional studies estimated the RR of PPH associated with multiple pregnancies to be between 3.0 and 4.5[48,62,80]. Bais and colleagues, in a Dutch population-based cohort study of 3464 women, used multiple regression analysis and found that the OR for PPH of 500 ml or more for multiple pregnancy was 2.6 (95% CI 1.06–6.39)[42]. Albrecht and co-workers conducted a retrospective review of 57 triplet deliveries and found an incidence of 12.3% for PPH requiring transfusion[81], and a case series of 71 quadruplet pregnancies conducted by Collins and colleagues estimated that the frequency of PPH and transfusion to be 21% (95% CI 11–31%) and 13% 95% CI 5–21%), respectively[82]. Magann and colleagues demonstrated an OR for PPH of 2.2 (95% CI 1.5–3.2) in multiple pregnancies[41], and Stones and colleagues showed a relative risk of 4.46 (95% CI 3.01–6.61) for obstetric hemorrhage with multiple pregnancies[48].

Fibroids

The suggestion that leiomyomas can cause PPH is mainly based on case reports[83], but one cohort study of 10,000 women in Japan found that women with leiomyomas had an OR of 1.9 (95% CI 1.2–3.1) and 3.6 (95% CI 2.0–6.3) for excessive blood loss at vaginal and cesarean delivery, respectively[57].

Antepartum hemorrhage

Antepartum hemorrhage is associated with a risk of PPH with an OR of 1.8 (95% CI 1.3–2.3)[41]. Stones and co-workers found a RR for major obstetric hemorrhage (>1000 ml) of 12.6 (95% CI 7.61–20.9), 13.1 (95% CI 7.47–23) and 11.3 (95% CI 3.36–38.1) for proven abruption, previa with bleeding, and previa with no bleeding, respectively[48]. Ohkuchi and colleagues, in their 10,000 women, demonstrated that a low-lying placenta was associated with odds ratios of 4.4 (95% CI 2.2–8.6) and 3.3 (95% CI 1.4–7.9) for excess blood loss at the time of vaginal and cesarean delivery, respectively[57]. This study also reported that placenta previa was associated with an OR of 6.3 (95% CI 4.0–9.9) for excessive blood loss at cesarean delivery.

Previous history of PPH

Magann and colleagues found previous PPH to be associated with an increased risk for subsequent PPH (OR 2.2, 95% CI 1.7–2.9)[41]. Similar findings have been reported by Ford and colleagues[84].

Previous cesarean delivery

A Japanese study demonstrated an odds ratio of 3.1 (95% CI 2.1–4.4) for excessive blood loss at vaginal delivery in women with a previous cesarean section[57].

INTRAPARTUM RISK FACTORS FOR PRIMARY POSTPARTUM HEMORRHAGE

Induction of labor

Meta-analysis of trials of induction of labor at or beyond term indicates that induction does not increase cesarean section or operative vaginal delivery rates[85]. However, this meta-analysis did not examine blood loss at delivery. Epidemiological studies suggest a link between induction of labor and PPH. Brinsden and colleagues reviewed 3674 normal deliveries and found that the incidence of PPH was increased after induction of labor[86]; among primipara, the incidence was nearly twice that of spontaneous labor, even when only normal deliveries were considered. The study of Magann and colleagues suggested an OR of 1.5 (95% CI 1.2–1.7) for PPH after induction of labor[41] and Bais and co-workers found an OR of 1.74 (95% CI 1.06–2.87) for severe PPH of more than 1000 ml after induction of labor[42].

Tylleskar and colleagues performed a prospective, randomized, controlled trial of term induction of labor with amniotomy plus oxytocin versus waiting for spontaneous labor in 84 women and found no difference in the amount of bleeding at the third stage[87]. A Cochrane review[88] of amniotomy versus vaginal prostaglandin for induction of labor reported no difference in PPH rates. Another Cochrane[89] review of amniotomy plus intravenous oxytocin included only one placebo-controlled trial, but no data on PPH were reported. This review compared amniotomy plus intravenous oxytocin against vaginal prostaglandin (two trials, 160 women) and found a higher rate of PPH in the amniotomy/oxytocin group (13.8% vs. 2.5%, respectively, RR 5.5, 95% CI 1.26–24.07)[89].

A review of intravenous oxytocin alone for cervical ripening[90] found no difference in PPH rates compared to the placebo/expectant management group (three trials, 2611 women; RR 1.24, 95% CI 0.85–1.81) or vaginal prostaglandin (PG) E2 (four trials, 2792 women; RR 1.02, 95% CI 0.75–1.4). Use of mechanical methods to induce labor[91] was not associated with any difference in PPH rates when compared to placebo (one study, 240 women, RR 0.46, 95% CI 0.09–2.31), vaginal PGE2 (one study, 60 women, RR 3.0, 95% CI 0.33–27.24), intracervical PGE2 (three studies, 3339 women, RR 0.91, 95% CI 0.40–2.11), misoprostol (one study, 248 women, RR 2.34, 95% CI 0.46–11.85) or to oxytocinon alone (one study, 60 patients, RR 1.0, 95% CI 0.22–4.56).

Meta-analysis[92] of trials of membrane sweeping for induction of labor found a reduction in PPH compared to no intervention (three trials, 278 women, RR 0.31, 95% CI 0.11–0.89). A review of oral misoprostol for induction of labor[93] did not include any trial that compared this agent with placebo. However, one trial reported in this review, involving 692 women and using PGE2 in the control arm, found no difference in PPH rate (RR 0.98, 95% CI 0.73–1.31). Other reviews of induction of labor methods have reported no difference in PPH rates between vaginal misoprostol when compared to placebo (two trials, 107 women, RR 0.91, 95% CI 0.13–6.37)[94], vaginal prostaglandins (five trials, 1002 women, RR 0.88, 95% CI 0.63–1.22), intracervical prostaglandins (two trials, 172 women, RR 1.62, 95% CI 0.22–12.19), or with oxytocin (two trials, 245 women, RR 0.51, 95% CI 0.16–1.66). Finally, a review of vaginal PGE2 for induction of labor suggested an increased risk of PPH compared to placebo[95] (eight studies, 3437 women, RR 1.44, 95% CI 1.01–2.05).

Duration of labor

First stage

Compared with the second stage of labor, limited evidence is available regarding the influence of the duration of the first stage of labor on PPH[96]. Magann and colleagues defined a prolonged first stage of labor as a latent phase of more than 20 h in nulliparous and more than 14 h in multiparous and/or an active phase of less than 1.2 cm per hour in nulliparous and less than 1.4 cm in multiparous patients[41]. These investigators found an OR of 1.6 for prolonged first stage of labor, but the 95% CI ranged from 1 to 1.6.

Second stage

Several large studies have explored the relationship between the length of the second stage and adverse maternal and neonatal outcomes. Cohen analysed obstetric data from 4403 nulliparas and found an increase in PPH rate after more than 3 h in the second stage[97]. He attributed this to the increased need for mid-forceps delivery. A large retrospective study involving 25,069 women in spontaneous labor at term with a cephalic presentation found that second-stage duration had a significant independent association with the risk of PPH[98]. A more recent retrospective cohort study of 15,759 nulliparous term, cephalic singleton births in San Francisco divided the second stage of labor into 1-h intervals[99]. PPH was defined as estimated blood loss of more than 500 ml after vaginal delivery or more than 1000 ml after cesarean delivery. The frequency of PPH increased from 7.1% when the second stage lasted 0–1 h to 30.9% when it lasted more than 4 h. The risk for PPH with a second stage of more than 3 h remained statistically significant when controlled for confounders (including operative

vaginal delivery, episiotomy, birth weight and fetal position) (OR 1.48, 95% CI 1.24–1.78). Myles and colleagues examined 6791 cephalic singleton births and found that the incidence of PPH was 2.3% in women experiencing a second stage less than 2 h compared to 6.2% in women with a longer second stage[100]. Janni and co-workers compared 952 women with a singleton cephalic pregnancy after 34 weeks' gestation with a 'normal' second stage to 248 women with a second stage more than 2 h[101]. The median difference between intrapartum and postpartum hemoglobin levels was lower in the normal group (–0.79 g/dl) compared to the prolonged second-stage group (–1.84 g/dl). Multivariate regression confirmed duration of the second stage as an independent predictor of PPH (RR 2.3, 95% CI 1.6–3.3). Magann and colleagues also found an OR of 1.6 (95% CI 1.1–2.1) for prolonged second stage[41]. Recently, a French group has published data on the duration of passive and active phases of the second stage of labor in low risk nulliparous women finding that severe PPH (≥1000 ml blood loss) was increased with active second stage exceeding 40 minutes (adjusted OR 3.5, 95% CI 1–12.3) and exceeding 50 minutes (adjusted OR 10.6; 95% CI 2.8–40.3) but a prolonged passive second stage was not associated with increased risk for severe PPH[102].

Third stage

Strong evidence indicates that, despite the use of active management, prolongation of the third stage of labor increases the risk for PPH. Combs and colleagues studied 12,979 singleton, vaginal deliveries and found that the median duration of the third stage was 6 min (interquartile range 4–10 min)[103]. The incidence of PPH and blood transfusion remaining constant until the third stage reached 30 min (3.3% of deliveries). Thereafter, it increased progressively, reaching a plateau at 75 min[103]. Dombrowski and colleagues studied the third stage in 45,852 singleton deliveries of 20 weeks' gestation or more[104]. PPH was defined as an estimated blood loss of 500 ml or more. At all gestational ages, the frequency of PPH increased with increasing duration of the third stage, reaching the peak at 40 min. Magann and colleagues performed a prospective observational study of 6588 vaginal deliveries[105]. PPH was defined as a blood loss of more than 1000 ml or hemodynamic instability requiring blood transfusion. PPH risk was significant (and increased in a dose-related fashion with time) at 10 min (OR 2.1, 95% CI 1.6–2.6), 20 min (OR 4.3, 95% CI 3.3–5.5) and at 30 min (OR 6.2, 95% CI 4.6–8.2). Using receiver operating characteristic (ROC) curves, the best predictor for PPH was a third stage of 18 min or more[105]. Similarly, a Dutch population-based cohort study of 3464 nulliparous women suggested that a third stage of 30 min or more was associated with a blood loss of 500 ml or more (OR 2.61, 95% CI 1.83–3.72) and 1000 ml or more (OR 4.90, 95% CI 2.89–8.32)[42]. Blood loss was determined by a combination of measurement and visual estimation.

Analgesia

A retrospective case–control study involving 1056 and 6261 women with and without epidural analgesia, respectively, found that use of epidural analgesia was associated with intrapartum hemorrhage of 500 ml or more[106]. Magann and colleagues also found an OR of 1.3 for PPH with epidural analgesia, but the 95% CI extended from 1 to 1.637[105]. However, if cesarean delivery is required, regional analgesia is superior to general anesthesia in reducing blood loss, according to evidence from one randomized, controlled trial involving 341 women[107].

Delivery method

The UK NICE guideline on cesarean section examined maternal morbidity in a comparison of planned cesarean section with planned vaginal birth from available randomized, controlled trials on an intention-to-treat basis[108]. For maternal obstetric hemorrhage (defined as blood loss >1000 ml), an absolute risk of 0.5% for planned cesarean section and 0.7% for vaginal birth (RR 0.8, 95% CI 0.4–4.4) was reported, suggesting there is no difference in risk. Magann and colleagues examined the incidence and risk factors for PPH in 1844 elective cesarean sections and 2933 non-elective cesarean sections[109]. Two criteria were used to define PPH: measured blood loss more than 1000 ml and/or need for blood transfusion and measured blood loss more than 1500 ml and/or need for blood transfusion. Six per cent of all cesarean deliveries were complicated by a blood loss more than 1000 ml. The PPH rates for elective cesarean section (blood loss >1000 ml – 4.84%, blood loss >1500 ml – 1.9%) were lower than for non-elective cesarean delivery (6.75% and 3.04%, respectively). During the 4-year period of this study, there were 13,868 vaginal deliveries with a PPH rate of 5.15% (blood loss >1000 ml) and 2.4% (blood loss >1500 ml)[109]. No data on operative vaginal delivery rate were reported. Although the PPH rate was higher in women undergoing non-elective cesarean delivery than after vaginal delivery, the difference in rate for elective cesarean delivery was not statistically different. Using linear regression, risk factors for PPH at elective cesarean delivery were leiomyomas, placenta previa, preterm birth and general anesthesia. For non-elective cesarean delivery, risk factors were blood disorders, retained placenta, antepartum transfusion, antepartum/intrapartum hemorrhage, placenta previa, general anesthesia and macrosomia.

Combs and colleagues performed a case–control study involving 3052 cesarean deliveries[110]. They reported a PPH incidence (based on fall in hematocrit and/or need for blood transfusion) of 6.4% for cesarean delivery, similar to Magann and colleagues. However, Combs and colleagues did not differentiate elective from non-elective deliveries.

This group also examined 9598 vaginal deliveries and found an overall incidence of PPH of 3.9%[62]. Using linear regression, they reported an adjusted OR of 1.66 (95% CI 1.06–2.60) for forceps or vacuum extraction use, suggesting that operative vaginal delivery is associated with PPH. In addition, the use of sequential instruments (forceps after unsuccessful vacuum extraction) to achieve vaginal delivery is a further risk factor (OR 1.9, 95% CI 1.1–3.2)[41] or relative risk of 1.6 (95% CI, 1.3–2.0)[111] for PPH.

Episiotomy

A Cochrane review argues for restrictive use of episiotomy because this policy is associated with fewer complications[112]. Surprisingly, this meta-analysis does not address the question of PPH incidence with episiotomy. Iatrogenic trauma by the indiscriminate use of a mid-line or mediolateral episiotomy is associated with increased blood loss and PPH in most studies, with blood loss increases of between 300 and 600 ml compared with no episiotomy[113,114]. Stones and colleagues reported a relative risk of 2.06 (95% CI 1.36–3.11) for PPH when episiotomy occurred[48]. Bais and co-workers reported similar results with an OR of 2.18 (95% CI 1.68–2.81)[42] and Combs and colleagues reported that a mediolateral episiotomy is associated with an odds ratio of 4.67 (95% CI 2.59–8.43) for PPH[62]. However, one recent randomized, controlled trial of the use of episiotomy when perineal tears appear imminent suggested no difference in PPH rates[115].

Chorioamnionitis

Several studies report an increased risk for PPH in the presence of chorioamnionitis, with ORs ranging from 1.3 (95% CI 1.1–1.7) at vaginal birth[41] to 2.69 (95% CI 1.44–5.03) at cesarean section[110].

CONCLUSIONS

PPH remains an extremely important cause of maternal mortality and morbidity throughout the world. Sadly, substandard care continues to contribute to mortality and morbidity from PPH, regardless of the country in which death takes place. Major obstetric hemorrhage complicates around 10% of live births and is responsible for 28% of direct deaths, globally. Marked differences exist between countries; in the UK there are two deaths per million maternities, whereas the figure is 200 times higher in parts of Africa. Severe obstetric hemorrhage is increasingly used as a measure of quality of health care in women. In the UK, severe obstetric hemorrhage occurs in three to seven cases per 1000 livebirths, with PPH implicated in 70% of cases. In contrast, rates as high as 30.5 per 1000 livebirths are reported in parts of Africa, with PPH rates of 17.4 per 1000.

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