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Factors affecting third-stage management and postpartum hemorrhage in planned midwife-led home and birth center births in the United States

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Abstract

Background: Postpartum hemorrhage (PPH) is a potential childbirth complication. Little is known about how third-stage labor is managed by midwives in the United States, including use of uterotonic medication during community birth. Access to uterotonic medication may vary based on credentials of the midwife or state regulations governing midwifery.

Methods: Using data from the Midwives of North America 2.0 database (2004–2009), we describe the PPH incidence for women giving birth in the community, their demographic and clinical characteristics, and methods used by midwives to address PPH. We also examined PPH rates by midwifery credentials and by the presence of regulations for legal midwifery practice.

Results: Of the 17 836 vaginal births, 15.9% had blood loss of over 500 mL and 3.3% had 1000 mL or greater blood loss. Midwives used pharmaceuticals to prevent or treat postpartum bleeding in 6.3% and 13.9% of births, respectively, and the rate of hospital transfer after birth was 1.4% (n = 247). In adjusted analyses, PPH was less likely when births occurred at home vs a birth center, if the midwife had a CNM/CM credential vs a CPM/LM/LDM credential, or if the woman was multiparous without a history of PPH or prior cesarean birth. PPH was more likely in states with barriers to midwifery practice compared with regulated states (OR: 1.26; 95% CI, 1.16–1.38).

Conclusions: Women giving birth in the community experienced low overall incidence of PPH-related hospital transfer. However, the occurrence of PPH itself would likely be reduced with improved legal access to uterotonic medication.

Keywords

community birth; oxytocin; postpartum hemorrhage; third stage labor

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1 | INTRODUCTION

The number of pregnant women seeking community birth (in home or birth centers) in the United States has increased over the last decade, from 0.87% of births in 2004 to 1.61% in 2017.[1] The safety of community birth for women and newborns remains an important research question, especially in regions of the United States where community birth is not well-integrated into existing health care structures.[2] This lack of integration has been implicated in poorer outcomes, as it may delay or prevent collaborative transfers from home or birth center to hospital when the need for a higher level of care arises. Postpartum hemorrhage (PPH) is an example of a complication that can be treated initially by midwives in the home or birth center. Women having PPH sometimes require a transfer of care if bleeding does not respond to uterotonic medications or, in some states, when midwives do not have access to life-saving antihemorrhagics because of a lack of state regulation.

Postpartum hemorrhage is a growing problem in the United States.[3,4] It is also a primary contributor to maternal death worldwide[5] and has the potential to affect pregnant individuals and practitioners across all birth settings. PPH occurs more frequently when certain risk factors are present, including following long labors, with macrosomic newborns, in induced or augmented labors, following surgical and assisted vaginal births, with abnormal placentation, and when magnesium sulfate is administered.[6,7] Data indicating rising maternal morbidity and mortality in the United States are primarily derived from hospital births[8] where women of higher obstetric risk and complex co-morbidities are cared for using higher levels of birth-related interventions (oxytocin for induction)—which may contribute to increased rates of PPH.[6] Increased awareness of rising PPH-related morbidity has led to state and national initiatives for PPH risk assessment, prevention, and treatment using bundles of care.[9] However, little is known about how practitioners attending women in the community setting in the United States approach third-stage labor management, use of preventive strategies for PPH, treatment, and rates of hospital transfer for prolonged third-stage labor and/or PPH.[10] In addition, the methods midwives use for third-stage management may be influenced by training, form of licensure, certification, and/or state-level regulations that either prohibit or support their practice, and access to and use of uterotonic medications.

Evidence indicates that community birth is safest when there is careful patient selection, a clear plan for transfer to a higher level of care if needed, and when community midwives are well-trained to respond to complications like PPH that require immediate action.[11] In 2017, researchers reported an incidence of PPH (>1000 mL blood loss) of 3.8% among community births in the United States (2004–2009 and 2012–2014).[12] Yet, no large studies have examined *how* community midwives manage physiologic blood loss or PPH through prophylactic measures or via treatment strategies. Thus, the primary purpose of this study is to describe, in the context of planned community birth, the incidence of PPH, pregnancy and birth variables associated with PPH, and the actions taken by community midwives to prevent and treat blood loss, including the transfer of women to hospitals because of third-stage labor complications. Our secondary aim was to evaluate the impact of state-level regulation and the licensure/certification status of community midwives on the prevention/treatment of PPH and on PPH outcomes.

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2 | METHODS

We obtained permissions from the Midwives Alliance of North America (MANA) Research Division and the research ethics board at Oregon Health and Science University for this study. MANA Stats 2.0 data were collected during the years 2004–2009 by midwives attending clients in the community setting. The variables for the 2.0 version of MANA contain detailed information about pregnancy, labor, birth, and postpartum care including variables specific to the third stage of labor, not collected in later versions of MANA Stats (3.0 and 4.0). During data collection for MANA 2.0, midwives "logged" new clients in the online data collection system after their first prenatal visit. Data were then entered throughout pregnancy, birth, and the postpartum period; a series of automatic data validity checks, followed by manual data review, helped with accuracy. Only those midwifery practices whose prior year records were entirely completed by early May were included in the research data set for that year. This ensured that outcomes for all clients, even those whose pregnancies ended with severe adverse outcomes, were known.[13]

2.1 | Participants and outcome variables

To generate the sample of women, we limited our analyses to those intending a home or birth center birth and who completed a vaginal birth in the community setting. Our intent was to examine the conduct and outcomes of community births; therefore, women with higher risk conditions or who ended up having hospital care were excluded. Therefore, women who experienced intrapartum transfer (some of whom eventually had cesareans) and those who planned hospital births were excluded (n = 2010). We also excluded antepartum transfers of care, multiple gestations, intrauterine fetal demises, and one maternal death (n = 4023); preterm births (n = 375); breech births (n = 239); and newborns with suspected birth defects (n = 31). We excluded missing cases of estimated blood loss when transfusion data were also missing (n = 393), and thus retained 88 cases with missing blood loss data, because the blood transfusion variable was completed.

Postpartum hemorrhage was determined using the historical definition of over 500 mL following vaginal birth and using the updated ReVITALize definition of 1000 mL or more.[14] The blood loss variable in MANA Stats did not differentiate between estimated and quantitative blood loss; therefore, it is presumed to be estimated by visualization. A composite variable for a PPH-related transfer was generated for women who were transferred to a hospital during the 3rd or 4th stage of labor when postpartum bleeding or abnormal placental delivery (retained placenta, prolonged third stage, or retained fragments) was marked as a reason for triaging to a higher level of care. Additional outcomes for this study were the use of pharmaceutical/herbal methods for preventing PPH, length of the third stage of labor, hospital transfer because of bleeding/placental delivery problems, dilation and curettage, blood transfusion, and late postpartum anemia.

Duration of the third stage of labor was entered directly by midwives (eg, not calculated from dates/times), with options for entering in either hours or minutes; all were converted to minutes during data cleaning. There were 60 cases in which the third stage was reported as longer than 6 hours. Record numbers for these cases were given to MANA Division of Research staff, who examined all data fields for those cases. For all 60 of these cases, there

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was no indication of substantial morbidity as one would expect given a prolonged third stage of labor (eg, no transfusions, hospitalizations, nor maternal postpartum complications). Thus, we assumed that, for those 60 cases, midwives had mistakenly entered the durations as hours instead of minutes. Analyses were run with durations corrected accordingly and with these 60 cases dropped. There were no significant differences in findings when cases were dropped or converted (data not shown). Findings presented here are based on hour-to-minute conversions.

2.2 | Descriptive and predictor variables

We examined differences in PPH outcomes by parity, primiparity (first birth), multiparity (at least one prior birth), and grand multiparity (five or more previous births). We reported the pregnancy characteristics of the participants including age, race/ethnicity, gestational age at birth, body mass index at the start of pregnancy, history of prior cesarean birth, history of prior PPH, pregnancy bleeding in the first, second, or third trimesters, or pregnancy complications (anemia, gestational diabetes, abnormal amniotic fluid volume, intrauterine growth restriction, and hypertensive disorders/preeclampsia). In addition, we detailed the characteristics of the labor and birth including labor onset and progression (any methods to help start or accelerate labor), duration of ruptured membranes, duration of each stage of labor, perineal trauma/repair, location of birth (home or birth center), and newborn sex.

Midwives Alliance of North America Stats 2.0 asked midwives to record actions taken for PPH prevention separately from those intended to treat blood loss. Variables assessing preventive strategies for postpartum bleeding included use of uterotonic medications (oxytocin and methergine), herbal preparations, or an undefined “Other Preventive Action” with an opportunity for free text. Strategies for treating blood loss including pharmaceuticals, herbal therapies (shepherd’s purse [*Capsella bursa-pastoris*], Angelica, motherwort [*Leonurus cardiaca*]), intravenous fluids, fundal massage, nipple stimulation, and bimanual compression. Precise timing of the administration of the medications or herbs or interventions was not recorded in the data set.

State-level regulatory status and midwifery licensure/certification status were also examined. Barriers to midwives’ integration, which may have affected their ability to carry or use uterotonic medications, were evaluated for all 50 states and the District of Columbia. We determined the states that were either not regulating midwives or were barring midwives from carrying/administering pharmaceuticals like oxytocin (used for PPH prophylaxis or treatment, not for labor stimulation) in 2004–2009.[15] These states were labeled as “barrier states.” States where community midwifery was regulated and medications were accessible during the data collection period were labeled as “regulated states.” We determined that 31 states lacked formal regulation and/or had barriers that prevented community midwives from legally carrying uterotonic pharmaceuticals during the data collection period. Two states enacted regulations during the study period, Utah (2005) and Wisconsin (2006). Births occurring in these states in the years before adoption of regulation (including the year of adoption) were coded as occurring in a “barrier state,” and births occurring after regulations were considered regulated states. Finally, each midwife could self-report their credentials (certification type and/or licensure) as either: (a) certified professional midwives (CPM),

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licensed midwives (LM), and licensed direct-entry midwives (LDM); (b) certified nurse-midwives (CNM) and certified midwives (CM); (c) dual-credentialed midwives (midwife having both CNM/CM and CPM/LM/LDM); or (d) no stated midwifery certification/licensure listed.

2.3 | Statistical analyses

We performed descriptive analyses for frequencies and data distribution followed by cross-tabs (χ^2) for differences in PPH outcomes by demographic, pregnancy, and labor/birth characteristics. We also reported frequencies of PPH outcomes by barrier state status and midwifery credential/licensure. Multivariable regression models were used to estimate odds of PPH and hospital transfer by barrier state status. In the first model, we sought to estimate the likelihood for PPH of over 500 mL by using the barrier state as the exposure and controlling for the location of birth (home or birth center), the midwives' credentials, and client history (parity/history of PPH or prior cesarean). We included the use of pharmaceuticals for PPH prevention in a second adjusted model. Analyses were generated using Stata 15.1 (College Station, TX). Statistical significance was set at $P < .05$.

3 | RESULTS

The analytic sample (Table 1) consisted of 17 836 births spanning years 2004–2009, comprised of mostly women identified by their midwife as White (90.6%). About 2/3 (66.1%) of the participants had given birth 1–4 times previously, with 12.1% being grand multiparous. The mean age of the women was 29.9 years (SD 5.3), and 20.1% were 35 years of age or older. Most women had a normal body mass index at the start of pregnancy (66.8%), and there was a low frequency of antenatal complications overall (Table 1). History of PPH was documented in 9.8% (n = 1301) of the multiparous women. Among multiparous women, 6.7% (n = 941) were planning to labor in the community setting after a prior cesarean birth. Of these, 668 had also had a previous vaginal birth. Most midwives reported having the CPM, LM, or LDM credential (78.0%).

Most women gave birth at or after 40 weeks of gestation (57.6%, n = 10 269) (Table 1). Although the majority of births had spontaneous onset of labor, 12.7% (n = 2274) used some method to help start labor and another 7.9% of labors involved methods to accelerate labor progress (n = 1418). The dominant strategies for encouraging labor included one or more of the following: castor oil (n = 827), membrane sweeping (n = 976), and blue/black cohosh administration (n = 461). Artificial rupture of membranes was the dominant approach for labor augmentation (n = 826) followed by nipple stimulation (n = 319) and blue/black cohosh use (n = 297). Most births occurred in the home setting (82.4%, n = 14 689) compared with a birth center (17.5%, n = 3119). The lengths of labor and frequencies of intrapartum events including perineal lacerations are also listed in Table 2.

3.1 | Postpartum hemorrhage and third stage

The median length of third stage was 15 minutes (interquartile range [IQR]: 10–24 minutes). Median blood loss was 300 mL (IQR: 237–473 mL). The overall rate of blood loss greater than 500 mL was 15.9% (n = 2823) with 3.3% (n = 586) having 1000 mL or higher blood

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lost. A small number of women needed a manual removal of the placenta (1.3%, n = 239). Hospital transfer occurred after 247 births (1.4%). Among those transferred, 57 women received a blood transfusion and 60 had a dilation and curettage procedure.

Midwives listed measures taken to prevent PPH, including administering oxytocin or methergine (6.3%, n = 1114), herbal preparations (7.3%, n = 1296), or "other" strategies (5.2%, 927) such as treating lacerations, breastfeeding, homeopathy, expressing uterine clots, and bladder management. Overall, 83.3% (n = 14 852) of births did not include a PPH prevention-focused intervention. A small number of women received both pharmaceuticals and herbs for bleeding prevention (n = 120, 0.6%).

Management of bleeding was most often addressed using fundal massage (31.0% of births, n = 5527). Use of pharmaceuticals occurred in 13.9% of births (n = 2490) with (external or internal) bimanual compression in 2.3% of births (n = 414) and intravenous fluid administration in 2.2% of births (n = 384). Herbal preparations for treating bleeding were used at 5.9% of births (n = 1049).

3.2 | Variables associated with PPH over 500 mL

Postpartum hemorrhage rates (over 500 mL) varied by several demographic, pregnancy, and labor characteristics (Table 2). Rates of PPH increased with advancing gestation. Nearly 20% of women giving birth at 42 weeks experienced a PPH (n = 238) Women having their first babies had a higher rate of PPH (21.5%, n = 830) relative to multiparous women (14.3%, n = 1679) and grand multiparous women (14.2%, n = 303). Multiparous women with a history of PPH in a prior birth had a 28.7% rate of PPH (n = 373). A history of first trimester bleeding, but not second or third trimester bleeding, was associated with higher PPH rates (19.0%, n = 297) relative to women who did not have vaginal bleeding during pregnancy. Hypertensive disorders and a history of prior cesarean birth were also associated with a higher incidence of PPH, at 23.9% and 19.0%, respectively.

Women who used some method of labor encouragement had higher rates of PPH (20.4% vs 15.3% without). Similarly, women who used methods to speed their labor progress had higher PPH rates (19.8%) compared with other spontaneously laboring women without augmentation (14.8%). Women who had a water birth had lower rates of PPH compared with land births (13.5% vs 19.8%). Longer duration of latent first-stage (19.7% for 18 hours or more vs 15.4% for <18 hours), active first-stage (25.0% for >12 hours vs 14.3% for <6 hours), and second-stage labor (23.6% for >1 hour vs 12.5% for <30 minutes) was associated with higher rates of PPH. Women with 3rd/4th-degree lacerations (24.7%) and multiple locations of perineal trauma (23.2%) both had nearly double the rate of PPH, compared with having no genital tract trauma (12.5%).

Births that involved prophylactic pharmaceutical or herb use had higher PPH rates than those without any prophylactic intervention (37.5% pharmaceutical, n = 413; 28.5% herbal, n = 368 and no preventive method 13.2%, n = 1957). The timing of the prophylactic is not recorded in the data set, which limits interpretation of this association.

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Importantly, the rates of PPH using the 1000 mL definition were much lower overall (3.3%, 586 women). However, women with higher gestational age at delivery, those younger than 35, and a history of prior cesarean birth or prior PPH experienced proportionally more PPH over 1000 mL. Primiparous women and women who gave birth to macrosomic babies also were more likely to have PPH over 1000 mL (Table 2).

3.3 | Differences by midwifery credentials

Differences in clients, outcomes, and strategies used to manage the third stage were compared across midwifery credentials (Table 3). We compared between CPM (LM/LDM) to CNM/CM (including dual-certified CPM/CNM) and birth attendants without a listed credential (Table 4). Rates of PPH and length of third stage greater than 60 minutes differed by midwifery credential. There was a higher incidence of PPH among CPM-attended births (17.3%) and births where the attendant had no credential (17.6%) than among CNM/CM-attended births (8.8%). Although preventive pharmaceuticals were used in a minority of births across all midwife groups (6.3% overall), they were used more often by CNM/CMs (7.5%) and those with no credential (7.7%) compared with the CPM group (5.9%). However, prophylactic herbal preparations were used more commonly by CPMs (7.9%) than by CNM/CMs (4.9%). In addition, CNMs reported “other” preventive measures for PPH more often than the other groups (9.4% 276% vs 4.4%). In terms of treatment strategies for bleeding, use of pharmaceuticals (13.7%−16.9%), herbal therapies (1.6%−8.9%), fundal massage (24.2%−34.0%), nipple stimulation (7.1%−11.8%), and bimanual compression (1.2%−2.5%) differed the most significantly among groups. Transfer to the hospital for PPH or placental delivery complications occurred more often in the CPM and noncredentialed attendant groups (1.5% vs 0.9% CNM/CM)—though the overall frequency of this event was low at 1.4% (n = 247). Maternal blood transfusion and dilatation and curettage rates did not differ among midwife groups.

3.4 | Differences by state regulatory status

About 1/3 (34.9%) of births occurred in states having barriers to midwifery practice and about 2/3 (65.1%) in regulated states (for designation for each state, see Table S1). The state where the birth occurred was missing for 127 births. There were multiple differences in the characteristics of the clients, locations of birth, and PPH outcomes, in addition to the midwifery management of the third stage, when comparing births that occurred in barrier or regulated states (Table 4). Women seeking care in barrier states were more likely to have characteristics associated with higher rates of PPH including more primiparous women and more multiparous women with histories of prior cesarean birth or prior PPH. However, more births occurred at home in barrier states vs freestanding birth centers (85.8% vs 80.9%). The length of the third stage of labor was longer in barrier states as well, with more women for whom the third stage of labor lasted more than 30 minutes (20.0% vs 16.2% in regulated states). More PPH (over 500 mL) occurred in barrier states (16.9% vs 15.5%), but did not differ at the higher volumes (1000 mL or higher). More herbal therapies (8.9% vs 6.4%) and fewer pharmaceuticals (3.4% vs 7.6%) were administered to clients for bleeding prevention in barrier states than in regulated states. Similarly, bleeding treatment strategies differed by state regulation. In states that were regulated, midwives used more pharmaceuticals for

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treatment of bleeding (15.5% vs 10.8%), intravenous fluids (2.4% vs 1.6%), fundal massage (33.4% vs 26.6%), and nipple stimulation (11.7% vs 10.4%).

Based on the first adjusted regression model (without preventive pharmaceuticals, Table 5), women were 17% more likely to have a PPH if they gave birth in a barrier state (aOR 1.17 [95% CI 1.07–1.28]). Women giving birth in birth centers also had higher odds than women having home births. Primiparous women had higher odds of PPH than multiparous women without a history of PPH or cesarean. Women attended by midwives who had a CNM credential had 55% lower odds for PPH (0.45 [0.39–0.52]). In the second model that included the use of pharmaceutical prevention, the associations were similar, though births occurring in a barrier state had a further increase in odds for PPH (1.26 [1.16–1.38]).

Odds for PPH 1000 mL or higher (Table 5) were not significantly associated with state status (1.11 [0.93–1.35]) controlling for type of midwife, birth location, parity/history, and preventive pharmaceutical. Women birthing in a barrier state were not more likely to transfer to the hospital either (1.19 [0.89–1.58]) nor were they more likely to have a blood transfusion. However, women in the barrier states were 50% more likely to develop postpartum anemia (1.50 [1.11–2.03]) in adjusted analyses relative to women in regulated states. In this model, the midwifery credential was not associated with postpartum anemia.

4 | DISCUSSION

The purpose of this study was to describe third-stage management practices and PPH outcomes among births attended by midwives in home and birth center settings using data from MANA Stats 2004–2009 within the context of midwifery regulation in the state where the birth occurred and the credentials of the care practitioner. Our findings suggest that many women cared for in the community during labor experienced moderate rates of blood loss over 500 mL but <1000 mL. Rates of >1000 mL PPH were low (3.3%) and similar to those reported in a low-risk group of 4000 women from Japan (4%) who gave birth vaginally attended by midwives[16] but higher than other studies of low-risk midwifery care from Australia, New Zealand (0.58%−1.3%),[17,18] and in a recent meta-analysis by birth setting (1.2%).[19] In addition, we found low rates of transfers for third-stage problems and very low rates of blood transfusion overall. These findings indicate that midwifery care for births occurring in the community setting did not have high rates of morbidity, despite a higher frequency of PPH when defined as over 500 mL.

Important findings from this study include the differences in third-stage preventive strategies for PPH by midwife credentials and by state regulatory status. The role of regulation of community birth practitioners and their ability to carry pharmaceuticals have not been reported relative to PPH outcomes. Our findings highlight that midwives in the community used different management techniques based on their credentials, but that management also varied based on access to critical medications. Although this study was underpowered to detect significant maternal morbidity (blood transfusion, dilatation, and curettage) as these were infrequent events, we did find that women who gave birth in barrier states were disproportionately affected by anemia several weeks after birth. However, for context, the rate of postpartum anemia was lower in this study (1.1%) than the prevalence reported in

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other general obstetric literature (8%−16%).[20] Although many other unmeasured variables (nutrition and access to supplements) affect anemia, lack of integration of midwives in some states may lead to barriers in treating PPH, which can have important lasting postpartum consequences. Preventive pharmaceutical use, intravenous fluids, and fundal massage were also lower in the barrier states, indicating that state regulatory status may influence many strategies for mitigating PPH.

Another important consideration is that of client screening. CPMs and birth attendants with no reported credential were more likely to care for multiparous women with a history of PPH in a prior birth and women with a prior cesarean than were CNM/CM or dual-credentialed midwives. This difference is likely a function of individual practices' guidelines, liability insurance mandates, consulting physician agreements, or state-based regulations informing eligibility for community birth. In addition, a prior study on outcomes of vaginal birth after cesarean (VBAC) at home found that laboring after a prior cesarean was more common in states where hospitals prohibited VBACs.[21] These states are also more likely to be unregulated and/or to restrict access to antihemorrhagic medications. Women who labor and have a vaginal birth after cesarean may have higher rates of PPH than women without a prior uterine incision in hospital-based births.[8,22] However, we could only find one study of community births after prior cesarean reporting PPH outcomes; this study from Germany did not find a higher rate of PPH nor transfer because of PPH for women undergoing vaginal birth after cesarean compared with women with a prior vaginal birth.[23] Furthermore, one study of women with repeated PPH indicated that PPH may repeat in subsequent births despite having a different etiology than that of the prior PPH.[24] Maternal history is important context for midwives to consider when discussing history of risk factors that may influence choice of birth setting.

Despite preventive pharmaceuticals being used in a minority of births, CNM/CM-attended births did use these tools more frequently than CPM-attended births. This may be partly due to birth centers' protocols, where CNMs were more likely to attend births, baseline health differences in the clients using CNM vs CPM care, and differences in the methods used to assess client risk factors. Currently, the World Health Organization recommends active management of the third stage of labor using prophylactic oxytocin[5] (or other uterotonic medications) after all births, regardless of risk for PPH. In the United States, professional consensus statements addressing maternal care related to PPH indicate that physiologic management may be supported in low-risk women after a process of shared decision making.[25] This statement is supported by research showing that the usage of active management of third-stage prophylactic oxytocin for unmedicated, physiologic birth may not be as effective in reducing PPH[26] compared with reductions seen in PPH following nonphysiologic birth (induced or augmented labors) in some randomized controlled trials (RCT).[27] Consistent with this literature, we found that PPH was more common among women who induced or augmented their labors, using methods available to community birth practitioners (AROM, herbs, etc). In these cases, women with poor uterine contractility that affected all stages of labor are likely over-represented.

Additional studies have found prophylactic oxytocin/active management is associated with higher PPH rates[17,18,28,29]; however, most of the births in these studies were not community

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births. Indeed, our regression modeling also shows that preventive pharmaceutical use was associated with higher odds for PPH when controlling for state, midwife credentials, parity, hemorrhage/cesarean history, and birth setting—however, we must interpret these findings with caution given that the timing of the administered medication was not recorded and it may not represent "active management" as currently defined. Some of the highest frequencies of PPH were seen in women having genital tract trauma and prolonged third-stage labor; these are well-documented as risk factors by other studies.[24,30] Further study of second-stage and third-stage management practices in the community setting in the United States is needed.

4.1 | Strengths and limitations

The strengths of this analysis are the detailed nature of the data collection including pertinent PPH history for multiparous women, separation of actions taken for prevention, and/or treatment of PPH, which is unique for studying third-stage management in large clinical data sets. Another advantage in our analysis is the inclusion of midwifery licensure/credentials and the state-level data, which help to provide important context to birth outcomes in the community setting. However, limitations include a lack of data on the specific timing of interventions—for example, we cannot know if techniques listed as preventive for PPH (pharmaceuticals or herbs) were administered before or after placental delivery or if bleeding was noted at the time of administration or not. This limits the interpretation of any "preventive" measure in these data. Another limitation is that blood loss estimations are criticized as being fairly inaccurate in the literature, particularly when accumulative blood loss is higher than average.[31,32] As such, the potential for both overestimation and underestimation by visualization limits the interpretation of all PPH research where gravimetric measurement or postpartum hematocrit is not measured.

4.2 | Conclusions

This research contributes to the growing knowledge of outcomes for women seeking birth in the community. It raises important findings about the role of midwifery access and use of pharmaceuticals for prevention and treatment of PPH and indicates that midwives should have access to uterotonics. This study also highlights important considerations for risk factors for PPH within a community birth population. Future research can further examine care processes that may help modify PPH rates for women having physiologic births, as the overall incidence of severe morbidity from PPH was low.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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TABLE 1

Incidence of PPH by pregnancy and demographic characteristics, United States community births, 2004–2009

Variable	N (%)	PPH over 500 mL, n (%)	PPH 1000 mL or greater n (%)
	17 836	2823 (15.9)	586 (3.3)
Race/ethnic background			
White women	16 010 (90.6)	2507 (15.7)	513 (3.2)
Women of color	1668 (9.4)	290 (17.5)	67 (4.1)
Gestational age (wk)			
37	757 (4.3)	95 (12.6)***	21 (2.8)***
38	2115 (11.9)	276 (13.1)	54 (2.6)
39	4683 (26.3)	663 (14.2)	125 (2.7)
40	5828 (32.7)	955 (16.5)	195 (3.4)
41	3234 (18.1)	596 (18.5)	138 (4.3)
42 wk or later	1207 (6.8)	238 (19.9)	53 (4.4)
Advanced maternal age (>=35)	3577 (20.1)	520 (14.6)*	97 (2.7)*
Less than 35 years	14 192 (79.9)	2303 (16.2)	489 (3.5)
Parity			
Primiparous	3874 (21.8)	830 (21.5)***	201 (5.2)***
Para 1–4	11 743 (66.1)	1679 (14.3)	331 (2.8)
Para 5 or more	2142 (12.0)	303 (14.2)	53 (2.5)
Prepregnancy body mass index			
Underweight	855 (4.9)	141 (16.6)*	24 (2.8)
Normal weight	11 716 (66.8)	1781 (15.3)	369 (3.2)
Overweight	3290 (18.8)	542 (16.6)	115 (3.5)
Obese	1681 (9.6)	295 (17.6)	68 (4.1)
Trial of labor after cesarean (vs no)	941 (6.7)	179 (19.0)**	48 (5.1)***
History of PPH (vs no)	1301 (7.6)	373 (28.7)***	89 (6.9)
Pregnancy bleeding			
First trimester	1569 (8.8)	297 (19.0)***	73 (4.7)***
Second trimester	439 (2.5)	73 (16.7)	19 (4.4)

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Variable	N (%)	PPH over 500 mL, n (%)	PPH 1000 mL or greater n (%)
Third trimester	278 (1.6)	48 (17.5)	12 (4.4)
Pregnancy complications (vs no)			
Anemia	159 (0.9)	34 (21.5)	9 (5.7)
Gestational diabetes	149 (0.8)	23 (15.4)	1 (0.7)
Abnormal amniotic fluid volume and/or IUGR	184 (1.0)	37 (20.3)	8 (4.4)
Hypertensive disorder or preeclampsia	290 (1.6)	69 (23.9)***	15 (5.2)
Sex of baby (Female vs male)	8830 (49.5)	1457 (16.6)*	329 (3.8)**
Newborn macrosomia (≥4000 g)	3965	810 (20.4)***	190 (4.8)***

Abbreviations: IUGR, intrauterine growth restriction; PPH, postpartum hemorrhage.

*$P < .05$,

**$P < .01$,

***$P < .001$,

chi-square test.

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TABLE 2

Incidence of PPH by labor and birth characteristics, United States community births, 2004–2009

Variable	n (%)	PPH over 500 mL, n (%)	PPH 1000 mL or greater, n (%)
Induction	2267 (12.7)	459 (20.4%)***	107 (4.8)***
No Induction	15 567 (87.3)	2363 (15.3)	478 (3.1)
Augmentation	1414 (7.93)	280 (19.8)***	59 (4.2)*
No augmentation (spontaneous labors)	14 153 (90.9)	2083 (14.8)	419 (2.9)
Water birth	6364 (35.7)	858 (13.5)***	175 (2.7)***
Land birth	11 463 (64.3)	1965 (17.2)	411 (3.6)
Artificial rupture of membranes			
Before 5 cm	210 (1.2)	32 (15.3)	6 (2.9)
5 cm or greater	1005 (5.6)	185 (18.4)*	35 (3.5)
Duration of rupture of membranes			
Less than 1 h	8658 (50.6)	1144 (13.3)***	210 (2.4)***
Up to 12 h	6693 (39.1)	1210 (18.1)	261 (3.9)
≥12 h	1764 (10.3)	364 (20.7)	90 (5.1)
Duration of (Latent) first stage			
<18 h	15 450 (87.9)	2366 (15.4)***	494 (3.2)
≥18 h	2132 (12.1)	418 (19.7)	80 (3.8)
Duration of (active) first stage			
0–6 h	12 852 (72.3)	1831 (14.3)***	367 (2.9)***
6.1–12 h	3869 (21.8)	719 (18.7)	160 (4.2)
>12 h	1064 (5.9)	266 (25.0)	58 (4.5)
Duration of second stage			
Up to 30 min	10 655 (60.1)	1331 (12.5)***	251 (2.4)***
31–60 min	3127 (17.6)	552 (17.7)	122 (3.9)
>1 h and <5 h	3712 (20.9)	876 (23.6)	202 (5.4)
5+ hours	233 (1.3)	61 (27.4)	11 (4.9)
Perineal trauma			
None	8753 (49.4)	1091 (12.5)***	210 (2.4)***

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Variable	n (%)	PPH over 500 mL, n (%)	PPH 1000 mL or greater, n (%)
Single/minor repair	6650 (37.4)	1172 (17.7)	235 (3.6)
3rd/4th or major (cervical/sulcus)	378 (2.1)	93 (24.7)	26 (6.9)
Multiple sites of trauma	1974 (11.1)	455 (23.2)	110 (5.6)
Length of third stage			
<15 min	8585 (48.3)	1371 (16.0)***	250 (2.9)***
15–29 min	6065 (34.1)	899 (14.9)	185 (3.1)
30–59 min	2526 (14.2)	355 (14.1)	68 (2.7)
≥60 min	607 (3.4)	181 (30.1)	78 (12.9)
Manual removal of placenta	239 (1.3)	143 (60.3)***	69 (29.1)***
Spontaneous placenta	17 583 (98.7)	2678 (15.3)	517 (2.9)
PPH prevention strategy/action			
None	14 852 (83.3)	1957 (13.2)***	456 (2.7)***
Oxytocin/methergine	1114 (6.3)	413 (37.5)***	130 (11.8)***
Herbal preparation	1296 (7.3)	368 (28.5)***	103 (7.9)***
Others	927 (5.2)	222 (24.0)***	60 (6.5)***
Postpartum anemia	193 (1.1)	157 (82.6)***	93 (48.9)***

Abbreviations: cm, centimeters; PPH, postpartum hemorrhage.

*$P < .05$,

**$P < .01$,

***$P < .001$.

chi-square test.

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TABLE 3

Client/ birth characteristics, postpartum outcomes, and management strategies by midwifery credential and licensure, United States community births, 2004–2009

	Total n (%)	CPM/LM/LDM n (%)	CNM/CM or dually credentialed (CNM/CPM) n (%)	No known midwifery credential, n (%)
Total number of community births	17 836	13 891 (78.0)	2931 (16.5)	986 (5.5)
Parity/history				
Primiparous	3874 (22.6)	2938 (21.9)	739 (26.2)	197 (20.7)***
Multiparous with no history	11 131 (64.9)	8682 (64.9)	1830 (64.9)	619 (65.1)
Multiparous with history of PPH	1211 (7.1)	1029 (7.7)	119 (4.2)	63 (6.6)
Multiparous with history of prior cesarean birth	851 (4.9)	657 (4.9)	125 (4.4)	69 (7.3)
Multiparous with history of prior cesarean birth and PPH	90 (0.5)	81 (0.6)	6 (0.2)	3 (0.3)
Location of birth				
Home	14 689 (82.5)	11 555 (83.2)	2303 (78.6)	831 (84.3)***
Freestanding birth center	3119 (17.5)	2336 (16.8)	628 (21.4)	155 (15.7)
Stage 3 length				
≥30 min	3113 (17.6)	2464 (17.8)	483 (16.5)	186 (18.9)
≥60 min	607 (3.4)	485 (3.5)	76 (2.6)	46 (4.7)**
Postpartum hemorrhage				
Blood loss (>500 mL)	2823 (15.9)	2395 (17.3)	257 (8.8)	171 (17.6)***
Blood loss (>=1000 mL)	586 (3.3)	491 (3.5)	54 (1.9)	41 (4.2)***
Preventive measures				
None recorded	14 852 (83.3)	11 667 (83.9)	2344 (79.9)	841 (85.1)***
Oxytocin/methergine	1114 (6.3)	819 (5.9)	219 (7.5)	76 (7.7)***
Herbal preparation	1296 (7.3)	1102 (7.9)	144 (4.9)	50 (5.1)***
Others	927 (5.2)	616 (4.4)	276 (9.4)	35 (3.5)***
Bleeding treatment				
Oxytocin/methergine or other pharmaceuticals	2490 (13.9)	1904 (13.7)	419 (14.3)	167 (16.9)*
Herbal preparation	1049 (5.9)	915 (6.6)	46 (1.6)	88 (8.9)***
Intravenous fluids	384 (2.2)	294 (2.1)	73 (2.5)	17 (1.7)

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	Total n (%)	CPM/LM/LDM n (%)	CNM/CM or dually credentialed (CNM/CPM) n (%)	No known midwifery credential, n (%)
Fundal massage	5527 (30.1)	4289 (30.8)	999 (34.0)	239 (24.2) ***
Nipple stimulation	1995 (11.2)	1643 (11.8)	282 (9.6)	70 (7.1) ***
Bimanual compression	414 (2.3)	346 (2.5)	56 (2.0)	12 (1.2) *
Manual removal of placenta	239 (1.3)	184 (1.3)	43 (1.5)	12 (1.2)
Transfer (PPH or placental delivery)	247 (1.4)	206 (1.5)	26 (0.9)	14 (1.5) *
Dilation and curettage	60 (0.3)	50 (0.4)	6 (0.2)	4 (0.4)
Blood transfusion	57 (0.3)	46 (0.33)	8 (0.3)	3 (0.3)
Postpartum anemia	193 (1.1)	151 (1.1)	26 (0.9)	16 (1.6)

Abbreviations: CM, certified midwife; CNM, certified nurse-midwife; CPM, certified professional midwife; LM, licensed midwife, LDM, licensed direct-entry midwife; PPH, postpartum hemorrhage.

*$P < .05$,

**$P < .01$,

***$P < .001$.

χ^2 test.

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TABLE 4

Midwife credentials, client characteristics, postpartum outcomes, and management strategies by state regulatory status, United States community births, 2004–2009

	Barrier state n = 6187 n (%)	Regulated state n = 11 522 n (%)
Midwife		
CPM/LM/LDM	4558 (32.9)	9284 (67.1) ***
CNM/CM or dual	1292 (44.0)	1644 (55.9)
No known credential	594 (63.8)	337 (36.2)
Parity/history		
Primiparous	1238 (20.8)	2578 (12.2) ***
Multiparous with no history	3826 (64.4)	7259 (65.4)
Multiparous with history of PPH	475 (7.9)	731 (6.6)
Multiparous with history of prior cesarean birth	359 (6.0)	486 (4.4)
Multiparous with history of prior cesarean birth and PPH	46 (0.8)	43 (0.4)
Birth location		
Home	5299 (85.8)	9318 (80.9) ***
Freestanding birth center	878 (14.2)	2190 (19.0)
Stage 3 length		
≥30 min	1237 (20.1)	1858 (16.2) ***
≥60 min	252 (4.1)	347 (3.0) ***
Postpartum hemorrhage		
Blood loss (>500 mL)	1039 (16.9)	1771 (15.5) *
Blood loss (≥1000 mL)	198 (3.2)	382 (3.3)
Preventive measures		
Oxytocin/methergine	212 (3.4)	880 (7.6) ***
Herbal preparation	556 (8.9)	736 (6.4) ***
Others	477 (7.7)	445 (3.8) ***
Bleeding treatment		
Oxytocin/methergine or other pharmaceuticals	670 (10.8)	1791 (15.5) ***

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	Barrier state	Regulated state
	n = 6187 n (%)	n = 11 522 n (%)
Herbal preparation	500 (8.1)	546 (4.7) ***
Intravenous fluids	100 (1.6)	279 (2.4) ***
Fundal massage	1647 (26.6)	3853 (33.4) ***
Nipple stimulation	644 (10.4)	1347 (11.7) **
Bimanual compression	171 (2.8)	241 (2.1) **
Manual removal of placenta	81 (1.3)	156 (1.4)
Transfer (PPH or placental delivery)	81 (1.3)	165 (1.5)
Dilation and curettage	18 (0.3)	41 (0.4)
Blood transfusion	18 (0.3)	39 (0.3)
Postpartum anemia	77 (1.3)	114 (0.9)

Abbreviations: CM, certified midwife; CNM, certified nurse-midwife; CPM, certified professional midwife; LDM, licensed direct-entry midwife; LM, licensed midwife; PPH, postpartum hemorrhage.

*$P < .05$,

**$P < .01$,

***$P < .001$.

χ^2 test

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TABLE 5

Adjusted odds ratios for postpartum hemorrhage over 500 mL and 1000 mL or more, United States community births, 2004–2009

	Odds for PPH Greater than 500 mL		Odds for PPH 1000 mL or higher	
	Model 1	Model 2	Model 1	Model 2
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
State				
Barrier state	1.17 (1.07–1.28)***	1.26 (1.16–1.38)***	0.98 (0.82–1.19)	1.11 (0.93–1.35)
Regulated state	Reference	Reference	Reference	Reference
Birth location				
Birth center	1.27 (1.14–1.42)***	1.19 (1.07–1.34)***	1.22 (0.99–1.51)	1.11 (0.90–1.38)
Home	Reference	Reference	Reference	Reference
Midwife				
CPM/LM/LDM	Reference	Reference	Reference	Reference
CNM/CM or dual	0.45 (0.39–0.52)***	0.42 (0.36–0.48)***	0.53 (0.39–0.71)***	0.49 (0.37–0.66)***
No known credential	1.11 (0.93–1.31)	1.08 (0.91–1.29)	1.27 (0.91–1.78)	1.24 (0.89–1.75)
Parity/history				
Multiparous with no history	Reference	Reference	Reference	Reference
Multiparous with PPH history	2.73 (2.38–3.13)***	2.27 (1.97–2.62)***	3.06 (2.35–3.99)***	2.26 (1.72–2.98)***
Multiparous with prior cesarean birth	1.51 (1.25–1.82)***	1.52 (1.26–1.83)***	2.09 (1.47–2.98)***	2.11 (1.48–3.02)***
Multiparous with prior cesarean birth and PPH history	2.86 (1.81–4.52)***	2.76 (1.74–4.37)***	6.31 (3.31–12.04)***	5.95 (3.09–11.46)***
Primiparous	1.93 (1.75–2.13)***	1.85 (1.67–2.04)***	2.48 (2.04–3.02)***	2.30 (1.89–2.81)***
Preventive				
Pharmaceutical use	Not included	3.36 (2.92–3.87)	Not included	4.18 (3.35–5.23)***
No pharmaceutical used		Reference		Reference

Abbreviations: CB, cesarean birth; CI, confidence interval; CM, certified midwife; CNM, certified nurse-midwife; CPM, certified professional midwife; LDM, licensed direct-entry midwife; LM, licensed midwife; OR, odds ratio; PPH, postpartum hemorrhage.

*$P < .05$,

**$P < .01$,

***$P < .001$.