

# Characteristics, Interventions, and Outcomes of Women Who Used a Birthing Pool: A Prospective Observational Study

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**ABSTRACT: Background:** Birthing pools are integrated into maternity care in the United Kingdom and are a popular care option for women in midwifery-led units and at home. The objective of this study was to describe and compare maternal characteristics, intrapartum events, interventions, and maternal and neonatal outcomes by planned place of birth for women who used a birthing pool. **Methods:** A total of 8,924 women at low risk of childbirth complications were recruited from care settings in England, Scotland, and Northern Ireland. Descriptive analysis was performed. **Results:** Overall, 7,915 (88.9%) women had a spontaneous birth (5,192, 58.3% water births), of whom 4,953 (55.5%) were nulliparas. Fewer nulliparas whose planned place of birth was the community (freestanding midwifery unit or home) had labor augmentation by artificial membrane rupture (149, 11.3% [95% CI: 9.6–13.1]), compared with an alongside midwifery unit (271, 22.7% [95% CI: 20.3–25.2]), or obstetric unit (639, 26.3% [95% CI: 24.5–28.1]). Results were similar for epidural analgesia and episiotomy. More community nulliparas had spontaneous birth (1,172, 88.9% [95% CI: 87.1–90.6]), compared with birth in an alongside midwifery unit (942, 79% [95% CI: 76.6–81.3]) and obstetric unit (1,923, 79.2% [95% CI: 77.5–80.8]); and fewer required hospital transfer (265, 20% [95% CI: 17–22.2]) compared with those in an alongside midwifery unit (370, 31% [95% CI: 28.3–33.7]). Results for multiparas and newborns were similar across care settings. Twenty babies had an umbilical cord snap, 18 (90%) of which occurred during water birth. **Conclusions:** Birthing pool use was associated with a high frequency of spontaneous birth, particularly among nulliparas. Findings revealed differences in midwifery practice between obstetric units, alongside midwifery units, and the community, which may affect outcomes, particularly for nulliparas. No evidence was found for a difference across care settings in interventions or outcomes in multiparas or in outcomes for newborns. During water birth, it is important to prevent undue traction on the cord as the baby is guided to the surface. (*BIRTH* 39:3 September 2012)

**Key words:** birthing pool, care settings, maternal, neonatal outcomes, water birth

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Birthing pools were integrated into mainstream maternity care in the United Kingdom in 1992 after a recommendation that all maternity services provide women with the option to labor or deliver in water (1), and their use is supported by national practice guidelines (2–4). By 2007, 95 percent of maternity services in the United Kingdom had a birthing pool (5). In response to professional and maternal concerns about the routine overuse of labor interventions and a decline in the spontaneous birth rate from 76.7 percent in 1990/1991 to 67.7 percent in 2009/2010, a national drive to normalize birth has occurred (6). Birthing pools are promoted as a care option that increases the likelihood that a woman will achieve a spontaneous birth with fewer interventions (7), and are chosen by women primarily as a means of non-pharmacologic pain relief and to facilitate normal birth.

Randomized controlled trials on birthing pool use during the first stage of labor have shown a significant reduction in the use of epidural analgesia, and no adverse maternal or neonatal effects (8). Observational studies have also shown that women who used a birthing pool were significantly less likely to require labor augmentation or epidural analgesia, or to sustain a perineal tear, and more likely to have a spontaneous birth (9–13).

However, individual case reports of respiratory difficulties, umbilical cord snap, and infections for babies born into water have been published (14–19). Moreover, critics of water birth have expressed concerns about birthing pool use, namely that it may slow labor progress, mask pain for women who had a previous cesarean section, or increase perineal tears, postpartum hemorrhage, and maternal infection (20–22). Methodological limitations of these studies, however, preclude reaching definitive conclusions. Furthermore, results are not presented by maternal parity, trials involve small numbers of women having a water birth, and all studies were undertaken in the hospital environment, although birthing pool use in the United Kingdom is common practice in midwifery-led units and home birth.

The purpose of this study was to collect prospective observational data on a large sample of women who used a birthing pool during labor and were cared for by midwives employed by the National Health Service. The study aims were, first, to describe maternal characteristics, intrapartum events, interventions, and maternal and neonatal outcomes in women who choose to use a birthing pool during labor; and second, to compare maternal characteristics, intrapartum events, interventions, and maternal and neonatal outcomes across hospital, midwifery-led units, and home settings by planned place of birth.

## Methods

All heads of midwifery registered with the Royal College of Midwives were invited by letter to participate if they had a birthing pool. In addition, managers and practice development midwives from centers with a birthing pool were identified from a list of delegates who attended the first international water birth conference (23). Additional centers were recruited using a snowball sampling technique. Care settings comprised the following: obstetric units staffed by midwives, obstetricians, anesthetists, and pediatricians; alongside midwifery units staffed by midwives and situated inside the hospital building; freestanding midwifery units staffed by midwives and located away from the hospital; and midwife-attended home births.

Data were collected for consecutive women in labor who chose to use a birthing pool at any point during labor, and for any length of time. To be eligible for birthing pool use in the United Kingdom, it is recommended that women have a “low risk” obstetric profile. This profile is defined as an uncomplicated pregnancy, singleton fetus with cephalic presentation, and labor at 37 weeks or more gestation, and no preexisting disease that may affect a woman’s labor risk (24). Birthing pool dimensions were ascertained to ensure that they were sufficiently large to enable a woman to adopt a range of different positions; this size requirement excluded the use of ordinary bath tubs. Portable birthing pools were used for home births.

Midwives prospectively recorded data on a standardized form while caring for the woman during labor and birth. Midwifery managers nominated a midwife from each unit who was responsible for co-coordinating data collection, collating and checking the data forms for completeness, and entering data onto an Excel database. Midwives were trained by the principal investigator to record data on the proforma and database. This process was piloted in each center to clarify the understanding of terms and definitions, and gauge data quality, particularly that all events were recorded. Each unit was asked to send data at least every 6 months so that the primary investigator could check the datasets and track missing data.

Data for maternal and neonatal complications were collected up to the seventh postnatal day. We selected maternal and neonatal outcomes that are internationally acknowledged safety indicators. Data were collected on the following items:

- Maternal characteristics: parity, age, gestation, spontaneous or induced labor onset, previous cesarean section.
- Intrapartum events and interventions: analgesia (pharmacological/nonpharmacological), augmentation by artificial rupture of the membranes and/or intravenous

infusion of oxytocin, reasons for leaving the birthing pool before delivery, time spent in the birthing pool.

- Maternal outcomes: type of delivery, active or physiological third stage, labor length, perineal trauma, hospital transfer (when and reason), postpartum hemorrhage graded as minor (500–1,000 mL) and major (>1,000 mL), manual removal of placenta, infection, pyrexia, readmission, death.
- Neonatal outcomes: Apgar scores (at 1, 5, and 10 min), birthweight, resuscitation, respiratory difficulty requiring treatment, cord snap, shoulder dystocia, infection, readmission, neonatal intensive care unit admission, death.

### Data Analysis

Using the SPSS data analysis program (25), data were analyzed for the sample as a whole, and by planned place of birth, stratified by parity. Frequencies were calculated; the number, percentage, and 95 percent confidence interval were calculated for categorical data. Appropriate measures of central tendency (mean, median) and dispersion (SD, range) were calculated for continuous data after assessing the distribution of the data. Missing data were excluded from the analysis. A sensitivity analysis using all maternal variables was performed to test the influence of pooling freestanding midwifery unit and home, using a chi-squared test for categorical data and the independent *t* test for continuous data with significance set at 0.05.

The goal was to have a cohort large enough to be able to observe rare events by care setting and maternal parity. A target sample of 1,000 per subset is large enough to observe at least two rare events occurring with an incidence of 5 in 1,000, with a probability of 95 percent. Rare outcomes to be observed were major postpartum hemorrhage, extensive perineal trauma, neonatal intensive care unit admission, and perinatal mortality.

Research ethics approval to conduct the study was sought and obtained from Oxford Brookes University. We followed the advice given by the research ethics committee at the time that individual consent from women was not required.

### Results

We recruited 8,924 women across 26 National Health Service Hospital Trusts in England, Scotland, and Northern Ireland, consisting of 15 obstetric units, 5 alongside midwifery units, 9 freestanding midwifery units, and 155 women's homes, during the period between 2000 and 2008. No center from Wales responded to the invitation to participate. Participants

were recruited across diverse rural and urban regional areas (Table 1). The largest proportion of women who planned to have a home birth lived in the London region (116, 74.8%), 19 (12.2%) were in the South East, and, with the exception of one woman in Scotland, the remaining 19 (12.2%) were scattered over the other English regions.

Sample size in participating centers ranged from 50 to 764 women (median 240). Recruitment periods ranged from 8 to 72 months (median 27). All but one study center took part for a minimum of 1 year and participated for as long as they were able. Birthing pool operational problems and staff shortages meant that in three obstetric units data were collected from two

**Table 1. Geographical Distribution of Participating Centers by Care Setting and Births per Year**

<i>Geographical Region</i>	<i>Care Setting</i>	<i>Number of Births per Year*</i>
England		
South East	Obstetric unit × 3 <sup>†</sup> Alongside midwifery unit × 2 <sup>‡</sup> Freestanding midwifery unit × 1 <sup>‡</sup>	1, 2, 3 B, D A
South West	Obstetric unit × 5 Alongside midwifery unit × 1 Freestanding midwifery unit × 3	3, 4 × 2 C B, B C
London	Obstetric unit × 1 Alongside midwifery unit × 1	2 D
East Midlands	Obstetric unit × 1	2
West Midlands	Obstetric unit × 1	3
East of England	Obstetric unit × 2	2, 3
East Yorkshire	Obstetric unit × 1 Freestanding midwifery unit × 1	3 C
North West	Obstetric unit × 1 Freestanding midwifery unit × 1	2 B
Northern Ireland		
Antrim	Alongside midwifery unit × 1	A
Scotland		
Central	Freestanding midwifery unit × 3	A, B, B
Strathclyde	Obstetric unit × 1	2

\*Numbers in this table represent available data for the number of births during participant recruitment time periods; <sup>†</sup>births per year for obstetric units have been coded: 1 = <3,000, 2 = 3,000–5,000, 3 = >5,000; <sup>‡</sup>births per year for alongside and freestanding midwifery units have also been coded: A = <200, B = 200–400, C = >400–500, D = >500.

consecutive series of women with a break between them. The median interruption time was 14 months (range 11–32). Before pooling the data from the 29 study centers, we looked at the proportion of women receiving epidural analgesia, episiotomy, or spontaneous vaginal birth by study center to see if these rates changed over time. These features were used as we thought that any changes in practice would be reflected in one or more of these outcomes. We also conducted a sensitivity analysis by care setting, removing one study center at a time from the pooled analysis to see if any one center disproportionately affected results.

#### *Maternal Characteristics, Intrapartum Events, Interventions, and Outcomes*

Of the 8,924 women, 4,953 (55.5%) were nulliparas and 3,970 (44.4%) were multiparas. Their mean age was 29 years (SD 5.61), and mean gestational age was 39.8 weeks (SD 1.06). The most popular analgesia was inhalational (50% nitrous oxide, 50% oxygen), which was used by 6,465 (72.4%) women. Other analgesics used included injected opioids (962, 10.7%) and epidural (825, 9.2%) and spinal anesthetic (333, 3.7%). Few women used nonpharmacological analgesia (344, 3.8%). Overall, 1,888 (21.1%) women had their labor augmented: 1,632 (18.3%) by artificial membrane rupture and 256 (2.8%) by intravenous infusion of oxytocics.

Most women (7,915, 88.9%) had a spontaneous birth, including 5,192 (58.3%) who had a water birth. A large proportion of women (7,137, 79.9%) achieved a “normal birth,” defined as a spontaneous labor onset, no epidural analgesia, and a spontaneous birth with no episiotomy (7). Twenty-four (0.26%) women had a breech presentation that was undiagnosed before labor, of whom 4 (0.07%) had a water birth and 11 (0.40%) a spontaneous breech birth on land.

The mean cervical dilatation at pool entry for nulliparas and multiparas was 5 cm (SD 2). A total of 3,732 (41.8%) women left the birthing pool before delivery, mostly for additional analgesia (887, 23.7%) or slow progress in the first (581, 15.5%) or second (292, 7.8%) stage of labor.

Just over one-fifth of women (1,872) had a physiological third stage, defined as delivery of the placenta without an oxytocic injection (26). Of the 5,192 women who had a water birth, 1,613 (86.1%) had a physiological third stage and the placenta was delivered underwater for 864 of 1,546 (55.8%) (data were unavailable for 67 women). Almost one-third of women (2,754) had an intact perineum, 803 (9%) had an episiotomy, 185 (2%) had a third-degree tear, and 1 had a fourth-degree tear. Fewer than 2 percent (137) of women had a retained placenta, and 80 (0.9%) had a

major postpartum hemorrhage. Of the 4,794 (53.7%) women who planned to give birth outside an obstetric unit, 745 (15.5%) were transferred—most during labor (653, 87.6%) and 87 (11.6%) postpartum.

Overall, serious neonatal outcomes were uncommon: 2 stillbirths and 2 neonatal deaths; 143 (1.6%) babies were admitted to a neonatal intensive care unit with an average length stay of 2.5 days (SD 0.8); 110 (1.2%) babies required resuscitation, and 66 (0.73%) developed a respiratory difficulty. Of the 20 (0.22%) umbilical cord snaps, 18 (90%) occurred during a water birth. Three babies with cord snap were admitted to a neonatal intensive care unit, and 1 baby required a blood transfusion. All were discharged home without additional problems. Thirty-five (0.39%) babies had pyrexia, as defined by the unit, or suspected infection, none of which resulted in a positive culture. Seventeen (0.19%) babies were readmitted to the hospital for breastfeeding support, or phototherapy for jaundice.

#### *Differences Among Care Settings*

We intended to analyze data by three care settings: obstetric unit, midwifery unit, and home. However, we made two post hoc decisions: first, to divide midwifery units into two groups (“alongside” and “freestanding” midwifery units) because of organizational differences between them; and second, to merge home and freestanding midwifery units to create one community setting. The decision was made for the following reasons:

1. The care model for home and a freestanding midwifery unit is similar (greater likelihood of continuity of care, midwife-led care with an emphasis on optimizing the physiology of childbirth, and located away from the hospital).
2. A sensitivity analysis showed no differences between freestanding midwifery units alone and when merged with home for key variables.
3. The number of women who planned to give birth at home was small (145, 1.6%), and merging the freestanding midwifery unit and home enabled a more meaningful comparison across care settings.

The final care settings for comparisons were obstetric unit, alongside midwifery unit, and community.

#### *Maternal Characteristics, Intrapartum Events, Interventions, and Outcomes, by Maternal Parity and Care Setting*

An obstetric unit was the most common planned place of birth, particularly for nulliparas (Table 2). Maternal

age and gestation were similar across care settings. Differences were found in interventions and outcomes among settings, and by parity (Tables 2-4). For example, more obstetric unit nulliparas had their labor induced by prostaglandin E<sub>2</sub> or artificial membrane rupture than nulliparas who gave birth in other settings. Artificial membrane rupture was performed least often in community women. The frequencies for obstetric unit and alongside midwifery unit were similar. Almost twice as many obstetric unit and alongside midwifery unit nulliparas had epidural analgesia compared with those in the community. Approximately 50 percent fewer community nulliparas left the birthing pool before delivery for more analgesia than those in an alongside midwifery unit or obstetric unit. Nulliparas who planned to give birth in the community spent more time in the birthing pool than those in either the obstetric unit or alongside midwifery unit (Table 3).

Irrespective of parity, more community women had physiological management of the third stage of labor (Table 3).

More community nulliparas had a spontaneous birth, and a significant proportion of these women met the criteria for "normal birth" (community 1,089, 82.6%; alongside midwifery unit 809, 67.9%; obstetric unit 1,577, 65.0%). Differences were less pronounced for multiparas across the care settings (Table 4). Community nulliparas had one-half as many episiotomies or extensive perineal tears as those in the obstetric unit or alongside midwifery unit (Table 4). Little difference was found in the frequency of minor or major postpartum hemorrhage by setting or parity. Hospital transfers were fewer from community women than from the alongside midwifery unit (Table 5). Most intrapartum

transfers were for additional analgesia or slow progress in the first or second stage of labor. One woman in the study was readmitted to the hospital within the first postpartum week for heavy lochia but negative microbiological culture.

### Neonatal Outcomes

Neonatal outcomes were similar across care settings (Table 6). One stillbirth occurred after alongside midwifery unit transfer to the hospital, and another stillbirth in the community (freestanding midwifery unit). One obstetric unit neonatal death occurred 4 days after a spontaneous birth on land. No post mortem was performed. The other neonatal death (freestanding midwifery unit) occurred 2 hours after an operative vaginal delivery in the hospital.

### Discussion

This study reports on 8,924 women in labor at low risk of complications who used a birthing pool in different care settings in England, Scotland, and Northern Ireland between 2000 and 2008. Age and gestation were similar to the national average for "low-risk" pregnancies (27, 28). Overall, 90 percent of women had a spontaneous birth, and three-fourths of the multiparas and almost one-half of the nulliparas had a water birth. Neonatal mortality and morbidity were rare. However, differences were found in labor events, interventions, and maternal outcomes across care settings, and by parity. Irrespective of parity, a significantly higher proportion

**Table 2. Maternal Characteristics by Planned Place of Birth**

Maternal Characteristics	Hospital N = 4,130 (46.2)		Alongside Midwifery Units N = 2,100 (23.5)		Community N = 2,694 (30.1)	
	Nulliparas	Multiparas	Nulliparas	Multiparas	Nulliparas	Multiparas
Binary: No. (%) [95% CI]						
Continuous: Mean (SD)						
Parity – number (n = 8,923)*	2,433 (59) [57, 60]	1,697 (41) [39, 43]	1,195 (57) [55, 59]	905 (43) [41, 45]	1,325 (49) [47, 51]	1,368 (51) [49, 53]
Age (yr) mean (SD) (n = 8,817)	28 (5.54) (n = 2,373)	31.3 (5.11) (n = 1,664)	28 (5.50) (n = 1,195)	31.5 (5.13) (n = 905)	27.5 (5.47) (n = 1,315)	31.2 (5.06) (n = 1,364)
Gestation (completed wk) mean (SD) (n = 7,300)	39.7 (1.07) (n = 1,495)	39.8 (1.06) (n = 1,093)	39.8 (1.09) (n = 1,195)	39.8 (1.10) (n = 905)	39.8 (1.05) (n = 1,258)	39.8 (1.01) (n = 1,354)
Induced labor onset (n = 8,924)	93 (3.8) [3.1, 4.7]	77 (4.5) [3.6, 5.6]	17 (1.4) [0.8, 2.3]	25 (2.8) [1.8, 4.1]	7 (0.5) [0.2, 1.1]	7 (0.5) [0.2, 1.0]
Previous cesarean section (n = 8,924)	0	14 (0.8) [0.4, 1.4] (n = 1,697)	0	6 (0.7) [0.2, 1.4] (n = 905)	0	5 (0.4) [0.1, 0.8] (n = 1,368)

\*Parity missing for one community woman.

N = sample size; n = number analyzed.

**Table 3. Intrapartum Events and Interventions by Planned Place of Birth**

<i>Intrapartum Events and Outcomes</i>	<i>Hospital</i> N = 4,130 (46.2)		<i>Alongside Midwifery Units</i> N = 2,100 (23.5)		<i>Community</i> N = 2,694 (30.1)	
	<i>Nulliparas</i>	<i>Multiparas</i>	<i>Nulliparas</i>	<i>Multiparas</i>	<i>Nulliparas</i>	<i>Multiparas</i>
<i>Binary: No. (%) [95% CI]</i>						
<i>Continuous: Mean (SD)</i>						
Parity – number ( <i>n</i> = 8,923)*	2,433 (59) [57, 60]	1,697 (41) [39, 43]	1,195 (57) [55, 59]	905 (43) [41, 45]	1,325 (49) [47, 51]	1,368 (51) [49, 53]
Augmentation						
Artificial membranes rupture ( <i>n</i> = 8,904)	639 (26.3) [24.5, 28.1] ( <i>n</i> = 2,429)	324 (19.1) [17.2, 21.0] ( <i>n</i> = 1,696)	271 (22.7) [20.3, 25.2] ( <i>n</i> = 1,195)	111 (12.3) [10.2, 14.6] ( <i>n</i> = 904)	149 (11.3) [9.6, 13.1] ( <i>n</i> = 1,317)	138 (10.1) [8.5, 11.8] ( <i>n</i> = 1,362)
Intravenous infusion oxytocin ( <i>n</i> = 8,923)	81 (3.3) [2.6, 4.1]	9 (0.5) [0.2, 1.0]	87 (7.3) [5.9, 8.9]	7 (0.8) [0.3, 1.6]	62 (4.7) [3.6, 5.6]	10 (0.7) [0.3, 1.3]
Epidural analgesia ( <i>n</i> = 8,920)	419 (17.2) [15.7, 18.8] ( <i>n</i> = 2,432)	60 (3.5) [2.7, 4.5] ( <i>n</i> = 1,697)	205 (17.2) [15.1, 19.4] ( <i>n</i> = 1,195)	25 (2.8) [1.8, 4.0] ( <i>n</i> = 905)	100 (7.6) [6.2, 9.1] ( <i>n</i> = 1,322)	16 (1.2) [0.7, 1.9] ( <i>n</i> = 1,368)
Shoulder dystocia ( <i>n</i> = 8,924)	18 (0.7) [0.4, 1.1]	21 (1.2) [0.7, 1.8]	8 (0.7) [0.2, 1.3]	5 (0.6) [0.1, 1.2]	13 (0.98) [0.5, 1.6]	19 (1.4) [0.8, 2.1]
Third stage care	( <i>n</i> = 2,431)	( <i>n</i> = 1,696)	( <i>n</i> = 1,195)	( <i>n</i> = 905)	( <i>n</i> = 1,319)	( <i>n</i> = 1,367)
Physiological <sup>†</sup>	567 (23.3) [21.6, 25.0]	618 (36.4) [34.1, 38.7]	304 (25.4) [22.9, 28.0]	346 (38.2) [35.0, 41.4]	463 (35.1) [32.5, 37.7]	655 (47.9) [45.2, 50.6]
Left pool before delivery ( <i>n</i> = 8,895)	1,388 (57.2) [55.2, 59.1] ( <i>n</i> = 2,426)	429 (25.3) [23.2, 27.5] ( <i>n</i> = 1,691)	729 (61.2) [58.3, 63.9] ( <i>n</i> = 1,191)	257 (28.3) [25.4, 31.4] ( <i>n</i> = 905)	624 (47.3) [44.6, 50.1] ( <i>n</i> = 1,317)	276 (20.2) [18.1, 22.4] ( <i>n</i> = 1,365)
Pool time (min) mean (SD) ( <i>n</i> = 8,355)	158 (108.37) ( <i>n</i> = 2,133)	100 (75.93) ( <i>n</i> = 1,558)	145 (117.60) ( <i>n</i> = 1,163)	86 (66.38) ( <i>n</i> = 885)	190 (143.12) ( <i>n</i> = 1,273)	102 (83.85) ( <i>n</i> = 1,343)

\*Parity missing for one community woman; <sup>†</sup>physiological third stage was defined as no oxytocic injection before delivery of the placenta. N = sample size; n = number analyzed.

of women who planned to give birth in the community had a normal birth—a key care quality outcome measure (7, 29). Other differences among care settings for nulliparas included fewer augmentations, epidurals, operative vaginal deliveries, cesarean sections, episiotomies, and minor postpartum hemorrhage for community than for obstetric unit and alongside midwifery unit women. Hospital transfer from the community occurred less frequently than from the alongside midwifery unit, with no apparent difference in adverse outcomes. In contrast, neonatal outcomes, interventions, and outcomes for multiparas were remarkably similar across care settings.

Frequencies for intrapartum interventions and maternal and neonatal outcomes were similar to those in other studies on women with an uncomplicated pregnancy (30–33), with the exception of augmentation and epidural analgesia, which were lower than those reported in previous studies. Other studies on birthing pool use during labor have also reported fewer intrapartum interventions and less extensive perineal trauma (third or fourth degree) (8–10, 34). More community women had physiological management of the placenta

delivery, a practice considered to predispose a woman to postpartum hemorrhage (35), yet the incidence of postpartum hemorrhage was similar across care settings. This study is the first to report on both postpartum hemorrhage and the method of third-stage management in women using a birthing pool, but recent studies on women not using a birthing pool have also shown that physiological management was not associated with an increase in the risk of postpartum hemorrhage in low-risk women (26, 36–38).

Another interesting finding was the similarity in the use of intrapartum interventions and outcomes between the obstetric unit and alongside midwifery unit and differences between the alongside midwifery unit and community. Research shows that the obstetric unit environment predisposes women with an uncomplicated pregnancy to more intrapartum interventions and a reduced likelihood of achieving a spontaneous birth (39–42). This study is the first to present results for alongside and freestanding midwifery units separately. This finding is important because there is an underlying assumption that alongside and freestanding midwifery units offer women a similar care model. They share the

same eligibility criteria, and are both defined as settings that offer women with uncomplicated pregnancy a social model of care provided by midwives who have lead professional responsibility (4, 40, 43). However, although freestanding midwifery units are staffed by distinct teams who typically care for a caseload of

women, research has shown that staffing arrangements can vary in alongside midwifery units, where midwives may function as a separate team to their colleagues on the obstetric unit or may be shared between both settings, a feature that may influence outcomes (39). Nonetheless, our finding that the alongside midwifery

**Table 4. Maternal Outcomes by Planned Place of Birth**

Maternal Outcomes	Hospital N = 4,130 (46.2)		Alongside Midwifery Units N = 2,100 (23.5)		Community N = 2,694 (30.1)	
	Nulliparas	Multiparas	Nulliparas	Multiparas	Nulliparas	Multiparas
<i>Binary: No. (%) [95% CI]</i>						
<i>Continuous: Mean (SD)</i>						
Parity – number (n = 8,923)*	2,433 (59) [57, 60]	1,697 (41) [39, 43]	1,195 (57) [55, 59]	905 (43) [41, 45]	1,325 (49) [47, 51]	1,368 (51) [49, 53]
Type of delivery (n = 8,895)	(n = 2,426)	(n = 1,691)	(n = 1,191)	(n = 905)	(n = 1,317)	(n = 1,365)
Spontaneous birth	1,923(79.2) [77.5,80.8]	1,644 (97.2) [96.3,97.9]	942 (79) [76.6,81.3]	883 (97.5) [96.3,98.4]	1,172 (88.9) [87.1,90.6]	1,351 (98.9) [98.2,99.4]
Water birth	1,038(53.9) [51.7,56.2]	1,262(76.7) [74.6,78.7]	462 (49) [45.8,52.2]	648 (73.3) [70.3,76.2]	693 (59.1) [56.2,61.9]	1,089 (80.6) 78.3,82.6]
Land birth	885 (46) [43.7,48.2]	382 (23.2) [21.2,25.3]	480 (50.9) [47.7,54.1]	235 (26.6) [23.7,29.6]	479 (40.8) [38,43.7]	262 (19.3) [17.3,21.6]
Operative delivery	331 (13.6) [12.3,15.0]	29 (1.7) [1.1,2.4]	176 (14.7) [12.8,16.9]	10 (1.1) [0.5,2.0]	101 (7.6) [6.2,9.2]	9 (0.6) [0.3,1.2]
Vaginal						
Emergency cesarean section	172 (7.1) [6.1, 8.2]	17 (1.0) [0.5, 1.6]	73 (6.1) [4.8, 7.6]	11 (.92) [0.6, 2.2]	42 (3.1) [2.3, 4.3]	5 (.36) [0.1, 0.8]
Perineal trauma (n = 8,913)	(n = 2,430)	(n = 1,697)	(n = 1,195)	(n = 905)	(n = 1,321)	(n = 1,365)
1 degree	302 (12.4) [11,13.8]	367 (21.6) [19.6,23.6]	135 (11.2) [9.5,13.2]	199 (21.9) [19.3,24.8]	226 (17.1) [15.1,19.2]	310 (22.7) [20.5,25]
2 degree	814 (33.4) [31.6,35.4]	478 (28.1) [26,30.3]	385 (32.0) [29.5,34.9]	242 (26.6) [23.8,29.7]	424 (32.1) [29.5,34.6]	274 (20) [17.9,22.2]
3 degree	74 (3.1) [2.3,3.8]	20 (1.2) [0.7,1.8]	50 (4.3) [3.1,5.4]	9 (.99) [0.4, 1.8]	26 (1.9) [1.2,2.8]	6 (.43) [0.1,0.9]
4 degree	1 (0.04)	0	0	0	0	0
Episiotomy	404 (16.6) [15.1,18.1]	45 (2.6) [1.9,3.5]	210 (17.5) [15.4,19.8]	13 (1.4) [0.7,2.4]	116 (8.7) [7.3,10.4]	15 (1.1) [0.6,1.8]
Vaginal wall tear (only)	66 (2.7) [2.1,3.4]	41 (2.4) [1.7,3.2]	58 (4.8) [3.7,6.2]	30 (3.3) [2.2,4.6]	55 (4.1) [3.1,5.3]	48 (3.5) [2.6,4.6]
Labial tear (only)	185 (7.6) [6.5,8.7]	87 (5.1) [4.1,6.2]	85 (7.1) [5.7,8.7]	40 (4.4) [3.1,5.9]	122 (9.2) [7.7,10.9]	82 (6.0) [4.8,7.4]
Labial and vaginal (only)	41 (1.7) [1.2,2.2]	9 (.35) [0.2,1]	24 (2.0) [1.2,2.9]	7 (.77) [0.3,1.5]	28 (2.1) [1.4,3]	6 (.43) [0.1,0.9]
Intact perineum	543 (22.3) [20.7,24]	650 (38.3) [35.9,40.6]	248 (20.7) [18.4,23.1]	365 (40.3) [37.1,43.6]	324 (24.5) [22.2,26.9]	624 (45.7) [43,48.4]
Postpartum hemorrhage	(n = 2,394)	(n = 1,694)	(n = 1,195)	(n = 905)	(n = 1,274)	(n = 1,347)
500–1,000 mL	365 (15.2) [13.8,16.7]	107 (6.3) [5.2,7.5]	175 (14.6) [12.6,16.7]	64 (7.0) [5.4,8.9]	130 (10.2) [8.5,11.9]	89 (6.6) [5.3,8]
>1,000 mL	31 (1.2) [0.8,1.8]	5 (0.2) [0.0,0.6]	15 (1.2) [0.7,2]	5 (0.5) [0.1,1.2]	10 (0.7) [0.3,1.4]	14 (1.0) [0.5,1.7]
Manual removal of placenta (n = 8,923)	50 (2.1) [1.5,2.7]	16 (.9) [0.5,1.5]	17 (1.4) [0.8,2.2]	14 (1.5) [0.8,2.5]	25 (1.9) [1.2,2.7]	15 (1.1) [0.6,1.8]
Labor length (min) Mean (SD) (n = 8,637)	574 (309.60) (n = 2,298)	322 (200.87) (n = 1,667)	562 (280.85) (n = 1,149)	309 (183.15) (n = 897)	596 (317.18) (n = 1,279)	329 (183.15) (n = 1,346)

\*Parity missing for one community woman.

N = sample size; n = number analyzed.

**Table 5. Maternal Transfer with Reason for Transfer by Planned Place of Birth**

<i>Reasons for Maternal Transfer</i>	<i>Alongside Midwifery Units</i> N = 2,100		<i>Community</i> N = 2,694	
	<i>Nulliparas</i>	<i>Multiparas</i>	<i>Nulliparas</i>	<i>Multiparas</i>
<i>No. (%) [95% CI]</i>				
Parity <i>n</i> = 8,923*	<i>N</i> = 1,195	<i>N</i> = 905	<i>N</i> = 1,325	<i>N</i> = 1,368
Transferred to hospital: <i>N</i> = 745 (15.5)	370 (31) [28.3, 33.7]	53 (5.9) [4.4, 7.6]	265 (20) [17, 22.2]	57 (4.2) [3.2, 5.4]
Reasons for transfer: <i>n</i> = 740 (99.3)	( <i>n</i> = 1,192)	( <i>n</i> = 905)	( <i>n</i> = 1,323)	( <i>n</i> = 1,368)
During labor				
More analgesia	65 (5.4) [4.2, 6.9]	9 (1.0) [0.4, 1.9]	18 (1.3) [0.8, .005]	2 (0.2) [0.0, 0.5]
Slow first stage of labor	101 (8.5) [6.9, 10.2]	13 (1.4) [0.8, 2.4]	96 (7.2) [5.9, 8.8]	13 (1.0) [0.5, 1.6]
Slow second stage of labor	105 (8.8) [7.3, 10.6]	5 (.55) [0.2, 1.3]	74 (5.5) [4.4, 7.0]	9 (.65) [0.3, 1.2]
Retained placenta	9 (0.8) [0.3, 1.4]	8 (0.8) [0.4, 1.7]	17 (1.3) [0.7, 2.0]	15 (1.1) [0.6, 1.8]
Miscellaneous <sup>†</sup>	3 (0.3) [0.0, 0.7]	3 (0.3) [0.3, 1.0]	8 (0.6) [0.2, 1.1]	0
Fetal concern	47 (3.9) [2.9, 5.2]	7 (0.8) [0.0, 1.6]	23 (1.7) [1.1, 2.6]	3 (0.2) [0.0, 0.6]
Postnatal				
Postpartum hemorrhage	7 (0.6) [0.2, 1.2]	3 (0.3) [0.0, 1.0]	3 (0.2) [0.0, 0.7]	9 (0.7) [0.3, 1.2]
For suturing	26 (2.2) [1.4, 3.2]	5 (0.6) [0.2, 1.3]	18 (1.3) [0.8, 2.1]	4 (0.3) [0.1, 0.7]
Neonatal	4 (0.3) [0.1, 0.8]	0	5 (0.4) [0.2, 1.0]	2 (0.1) [0.2, 0.9]

\*Parity missing for one community woman; <sup>†</sup>miscellaneous included elevated blood pressure, pyrexia, prolonged rupture of membranes, malpresentation, group B streptococcal infection.

N = sample size; n = number analyzed.

unit and community showed differences is surprising, and warrants additional exploration.

The hospital transfer frequency of 15.5 percent for this study was similar to results from a recent study in Denmark for women transferred from freestanding midwifery units to hospital (44). Intrapartum transfer rates for the United Kingdom vary between 12.4 percent and 31 percent for alongside midwifery units (4), 11.8 percent (45) and 18 percent (46) for freestanding midwifery units, and 12.5 percent (47) and 20.9 percent (48) for home births. Neonatal outcomes were similar across care settings.

Of the 66 babies who developed transient respiratory difficulty, 31 (46.9%) were born in water. Infection can compromise respiratory function, but neonatal infections overall were rare and the incidence was similar to that reported in other water birth studies (12, 13). Almost all the umbilical cord snaps in this study occurred during water birth. Cord snaps associated with water birth may be related to undue traction exerted on the cord as the baby is lifted out of the water. When

preparing midwives to assist women in water birth, it is important to recommend that they ensure that no undue cord traction occurs as the baby's head is guided out of the water. We found no difference in perinatal mortality across setting.

A recent although controversial meta-analysis of 12 international studies concluded that home births were associated with a higher risk of neonatal mortality (49). These findings have been challenged, however, because the analysis was restricted for neonatal mortality to only 9 percent of the total sample (50, 51). Moreover, when results for women with a complicated pregnancy and those not cared for by midwives were excluded from the analysis, no significant difference was found in perinatal mortality (52).

This study involved a large sample of prospectively collected data with almost complete follow-up on all recruited women. It is the first study to comprehensively report intrapartum interventions and maternal and neonatal outcomes across different care settings by maternal parity in women who chose to use a birthing pool.

The main limitation of the study is the lack of a control group of women who met the eligibility criteria and chose not to use the pool. Since all women in the study used the birthing pool, this use may have influenced their care management. In addition, the study was based on a convenience sample of 29 care settings, and although this factor may limit generalizability, the study centers do reflect the range and diversity of maternity care settings in England, Scotland, and Northern Ireland. Although we report on a comprehensive data set, and made every effort to ensure completeness, we cannot guarantee that data were not collected for some women who used a birthing pool. We have no reason to believe that failure to collect data was likely to have happened in one care setting more than another. For example, whereas it is feasible that data were missing for women who planned to give birth in the community, it is equally possible that it could have occurred for women in alongside midwifery units, and possibly more likely in the obstetric unit setting where midwives often have to assume simultaneous responsibility for more than one woman during labor.

Measurements for some intrapartum events and outcomes were subjective, such as duration of labor and postpartum hemorrhage, which may have resulted in measurement error. However, there is no reason to assume that this error would vary by care setting. Covering 8 years, the duration of this study was long, but our sensitivity analyses using three key outcomes indicated no evidence of trends over time or undue influence of individual study centers to prevent pooling of the data.

## Conclusions

Birthing pool use was associated with a high frequency of spontaneous birth and *normal birth*, particularly among nulliparas. Findings reveal differences in midwifery practice among obstetric units, alongside midwifery units, and the community, which may affect outcomes, particularly for nulliparas. The use of interventions and outcomes in alongside midwifery units was similar to that in the obstetric units, but not the community. With the exception of more normal births

**Table 6. Neonatal Outcomes by Planned Place of Birth**

Neonatal Outcomes	Hospital N = 4,130 (46.2)		Alongside Midwifery Units N = 2,100 (23.5)		Community N = 2,694 (30.1)	
	Nulliparas	Multiparas	Nulliparas	Multiparas	Nulliparas	Multiparas
Parity – number n = *8,923	2,433	1,697	1,195	905	1,325	1,368
Apgar 7 or < at 5 min (n = 8,894)	31(1.2) [0.8,1.8] (n = 2,423)	18 (1.1) [0.6,1.6] (n = 1,693)	21(1.7) [1,2.6] (n = 1,195)	8 (0.9) [0.3,1.7] (n = 905)	18 (1.3) [0.8,2.1] (n = 1,316)	17 (1.2) [0.7,1.9] (n = 1,362)
Apgar 7 or < at 10 min (n = 8,915)	10 (0.4) [0.1,0.7] (n = 2,430)	4 (0.2) [0.1,0.6] (n = 1,696)	2 (0.1) [0.0,0.6] (n = 1,194)	2 (0.2) [0.0,0.7] (n = 905)	9 (0.6) [0.3,1.2] (n = 1,323)	2 (0.1) [0.0,0.5] (n = 1,367)
Birthweight (g) mean (SD) (n = 8,890)	3,472 (412.9) (n = 2,428)	3,647 (443.3) (n = 1,693)	3,459 (411.8) (n = 1,195)	3,604 (434.7) (n = 905)	3,447 (438.6) (n = 1,311)	3,633 (452.0) (n = 1,358)
Resuscitation required (n = 8,924)	37 (1.5) [1,2]	22 (1.2) [0.8,1.9]	13 (1.08) [0.5,1.8]	4 (0.4) [0.1,1.1]	21 (1.5) [0.9,2.4]	13 (0.9) [0.5,1.6]
Respiratory problem requiring support (n = 8,924)	20 (0.8) [0.5,1.2]	7 (0.4) [0.1,0.8]	16 (1.3) [0.7,2.1]	3 (0.3) [0.1,0.9]	12 (0.9) [0.4,1.5]	8 (0.5) [0.2,1.1]
Umbilical cord snap (n = 8,924)	2 (0.08) [0.0,0.2]	4 (0.2) [0.0,0.6]	3 (0.3) [0.0,0.7]	2 (0.2) [0.0,0.7]	6 (0.4) [0.1,0.9]	3 (0.2) [0.0,0.6]
Pyrexia/infection (n = 8,924)	10 (0.4) [0.1,0.7]	4 (0.2) [0.0,0.6]	5 (0.4) [0.1,0.9]	4 (0.4) [0.1,1.1]	10 (0.7) [0.3,1.3]	2 (0.1) [0.0,0.7]
Jaundice requiring treatment (n = 8,924)	9 (0.36) [0.1,0.7]	3 (0.17) [0.0,0.5]	9 (0.7) [0.3,1.4]	1 (0.1) [0.0,0.5]	2 (0.15) [0.0,0.5]	0
NICU admission (n = 8,923)	47 (1.9) [1.4,2.5]	13 (0.7) [0.4,1.3]	33 (2.7) [1.9,3.8]	6 (0.6) [0.2,1.4]	30 (2.2) [1.5,3.2] (n = 1,324)	14 (1.0) [0.5,1.7]
Time in NICU (days) mean (SD) (n = 8,841)	2.61(.737) (n = 2,405)	2.67(.516) (n = 1,691)	2.15(.881) (n = 1,169)	2.33(.816) (n = 905)	2.76(.752) (n = 1,309)	2.50(.548) (n = 1,362)

\*Parity missing for one community woman.  
NICU = neonatal intensive care unit.

for community multiparas, no evidence was found that care setting affected interventions or outcomes in multiparas or outcomes for newborns. These data will help practitioners inform women about using a birthing pool during labor in the hospital, midwife-led, and community settings.

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