

# Neonatal Outcomes After Delivery in Water

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**OBJECTIVE:** To assess neonatal intensive care unit (NICU) admissions and neonatal outcomes after water birth or land birth in an alternative birthing center.

**METHODS:** We conducted a prospective observational study of preselected low-risk parturients separated into three groups depending on their location for labor and delivery: land-land, water-land, and water-water. Delivery outcomes, labor length, maternal pain assessment, need for newborn resuscitation, and NICU admission and diagnoses were collected. The primary outcome was admission to the NICU.

**RESULTS:** There were 2,077 total deliveries from April 2015 to December 2019, consisting of 458 land-land deliveries, 730 water-land deliveries, and 889 water-water deliveries. The rate of NICU admission was 2.8% (95% CI 1.5–4.8%) for land-land deliveries, 4.1% (2.8–5.8%) for water-land deliveries, and 2.0% (1.2–3.2%) for water-water deliveries. A post hoc power analysis revealed a 70% power to detect a 2.1% difference in NICU admissions between the water-land and water-water groups.

**CONCLUSION:** In this cohort of low-risk pregnant women, births in water and on land were associated with similar rates of admission to the NICU.

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Primarily based on case reports and case series, the safety of water birth has been questioned. Reported and hypothesized risks of water birth include increased maternal and neonatal infectious morbidity, difficulties in neonatal thermoregulation, avulsion or rupture of the umbilical cord and subsequent neonatal hemorrhage, near drowning from aspiration with subsequent respiratory distress, and perinatal asphyxia and seizures.<sup>1–3</sup>

The American College of Obstetricians and Gynecologists has published a Committee Opinion on the topic of water birth (Immersion in water during labor and delivery. Committee Opinion No. 594 [withdrawn]. American College of Obstetricians and Gynecologists. *Obstet Gynecol* 2014;123:e912–e5. doi: 10.1097/01.AOG.0000445585.52522.14).<sup>3</sup> The current version, published in 2016, remains restrictive, with the summary recommendation that, “birth occur on land, not in water.”<sup>3</sup> This position contrasts with that of the Royal College of Obstetricians and Gynaecologists–Royal College of Midwives and that of the American College of Nurse-Midwives, which both affirm that women should be given the opportunity to remain immersed in water during labor and birth.<sup>4,5</sup>

The Cochrane systematic review of water birth concludes that there is limited evidence and that further research is needed.<sup>6</sup> Owing to ethical concerns and group assignment biases, water birth cannot be easily studied in a randomized trial. The highest quality evidence that may be expected will be from prospectively collected, well-controlled studies.<sup>7</sup>

Our hospital system has offered water births in hospital-based alternative birthing centers located at four sites since 1995. The alternative birthing centers offer eligible low-risk parturients the opportunity to experience labor and delivery with minimal intervention in a more “home-like” environment within a hospital space that is physically separate from a traditional labor and delivery unit. Owing to specific concerns regarding neonatal risks and the conflicting professional opinions on water birth, the objective of



our study was to compare neonatal intensive care unit (NICU) admissions and neonatal outcomes after water birth with outcomes of birth out of the water (“land”) in our alternative birthing centers.

## METHODS

This was a prospective observational study; institutional review board approval came from the Wright State University Institutional Review Board. Written informed consent was obtained for data collection on admission to the alternative birthing center, regardless of the woman’s desire for delivery location (water or land). The alternative birthing center requirements include preselection of low-risk parturients (Appendix 1, available online at <http://links.lww.com/AOG/C427>), it is accredited by the Commission for the Accreditation of Birth Centers. Neither pharmacologic nor neuraxial labor analgesia are provided for labor and delivery. Fetal heart rate monitoring was per a standard intermittent monitoring protocol.<sup>8</sup> Briefly, the fetal heart rate was determined by a handheld Doppler device for 15–60 seconds at 15–30-minute intervals before, during, and after a contraction during the active phase of labor and at 5-minute intervals during the second stage. In addition, women who desired a water birth consented to exit the tub if advised to do so by their caregiver. Additional provisions for water birth can be found in Appendix 1 (<http://links.lww.com/AOG/C427>). Most labors and deliveries were managed by certified nurse-midwives and, rarely, by resident and attending physicians. The hydrotherapy and delivery tubs (SANIJET Pipeless Hydromassage System) underwent standard contemporary sterilization procedures between uses and weekly if not used, using a bleach germicidal cleaner.

Women were categorized into three groups based on where the first and second stage of labor occurred: those who labored and delivered on land (land–land), those who labored in water and delivered on land (water–land), and those who labored and delivered in water (water–water). Water birth occurred only in the alternative birthing center. Women who were initially admitted to the alternative birthing center then transferred to the labor and delivery department had the option of continuing hydrotherapy in smaller tubs located in labor and delivery without water birth. Women who spent any time during the first stage of labor immersed in the labor and delivery tub were assigned to one of the two water labor groups. The delivery assignment group (land or water) was based on where the second stage was completed. All patients in the study had immediate access to emergency obstetric and neonatal care. The alternative birthing

centers are located on the same hospital floor as the traditional labor and delivery unit, with prompt access to obstetric interventions or cesarean delivery achieved by transport by ambulation, wheelchair, or gurney.

Demographic and birth outcome data were extracted from the electronic medical record at the time of delivery and neonatal discharge. Maternal body mass index (BMI, calculated as weight in kilograms divided by height in meters squared) was evaluated as a continuous variable and as a discrete variable (30 or higher or less than 30). Low Apgar score was defined as less than 7 at 5 minutes. The length of labor was calculated from the time of admission to completion of the second stage. Maternal pain assessment was obtained by a written survey given to the mother as soon after delivery as feasible. Overall pain and the worst pain were rated on a scale from 1 to 10, with 10 being the highest. Perineal lacerations were counted when a first-degree or higher laceration was noted. Maternal race was assessed to identify existing disparities. Race was self-identified at the time of initial hospital registration. The options for self-selection of race are Caucasian, Black or African American, Native Hawaiian, Other Pacific Islander, and Patient declined to answer or Unreported. In addition, patients have the option to identify their ethnicity as Hispanic or Latina.

The primary outcome was NICU admission. There was insufficient historical data on the frequency of adverse neonatal outcomes to conduct an a priori power analysis. Instead, an enrollment goal of approximately 1,000 water–water births was chosen. Planned interim analyses were conducted after 200 and 600 water births, and this report represents the third analysis. Data were collected by observation and questionnaires. Data were summarized using Microsoft Excel, with continuous data expressed as mean (95% CI) and binary data expressed as n (%) (95% CI of the calculated percentages). Because the groups were self-selected, statistical comparisons were not made among groups.

All NICU admissions were evaluated and categorized into one of three groups: infectious morbidity, respiratory morbidity, and other. Infectious morbidity consisted of rule out sepsis, clinical or culture-proven sepsis, and inadequate prophylaxis for maternal group B streptococcus. Respiratory morbidity consisted of neonatal respiratory distress syndrome, meconium aspiration syndrome, tachypnea, and apnea. The other category of NICU admissions consisted of congenital anomalies, seizures, hyperglycemia, hyperbilirubinemia, and respiratory depression.



**Table 1. Maternal Demographics**

Demographic	Land–Land (n=458)	Water–Land (n=730)	Water–Water (n=889)
Gestational age at delivery (wk)	39.5 (39.4–39.5)	39.7 (39.6–39.7)	39.6 (39.5–39.6)
Maternal age (y)	29.8 (29.3–30.2)	29.37 (29.0–29.7)	30.03 (29.7–30.4)
Maternal BMI (kg/m <sup>2</sup> )	30.3 (29.9–30.8)	30.5 (30.2–30.9)	31.7 (31.3–32.0)
BMI higher 30	214 (46.7) (42.1–51.4)	306 (41.9%) (38.3–45.6)	362 (40.7%) (37.5–44.0)
Length of education (y)	14.9 (14.6–15.1)	14.6 (14.4–14.8)	14.72 (14.5–14.9)
Prior preterm birth	21 (4.5) (2.9–6.9)	22 (3.0%) (1.9–4.5)	40 (4.5%) (3.2–6.1)
Nulliparous	125 (27) (23.3–31.6)	330 (45) (41.6–48.9)	211 (24) (20.1–26.7)
Married	367 (80) (76.2–83.7)	590 (81) (77.8–83.6)	743 (83.6) (81.0–86.0)
Alcohol use	5 (1) (0.4–2.5)	3 (0.4) (0.08–1.2)	2 (0.2) (0.03–0.8)
Tobacco use	3 (0.7) (0.1–1.9)	6 (0.8) (0.3–1.8)	8 (0.9) (0.4–1.8)
Recreational drug use	0 (0) (0.0–0.8)	0 (0) (0.0–0.5)	7 (0.8) (0.3–1.6)

BMI, body mass index.

Data are mean (95% CI) or n (%) (95% CI).

## RESULTS

There were 2,077 deliveries from April 2015 to December 2019. These deliveries consisted of 458 land–land deliveries, 730 water–land deliveries, and 889 water–water deliveries (Table 1).

The rate of NICU admission was 2.8% (95% CI 1.5–4.8%) for land–land deliveries, 4.1% (95% CI 2.8–5.8%) for water–land deliveries, and 2.0% (95% CI 1.2–3.2%) for water–water deliveries. There was no difference in the mean length of labor or percentage of perineal lacerations among the three groups (Table 2). Patients in the water–water group reported less overall pain and lower pain levels for the worst pain experienced during delivery. Those in the land–land group had a higher rate of cesarean delivery (10.5%, 95% CI 7.8–13.7%) compared with those in the water–land group (6.0%, 95% CI 4.3–7.9%, Table 2).

There was no difference in the primary outcome of NICU admission or in the secondary outcomes of birth weight, low 5-minute Apgar score, neonatal resuscitation, and neonatal mortality among the three groups (Table 3). A post hoc power analysis revealed a 70% power ( $\alpha=0.05$ ) to detect a 2.1% difference in NICU admissions between the water–land and water–water groups. There were 30 neonates admitted to the NICU born to women who initially

labored in water then delivered on land (water–land). The maternal reasons for leaving the tub in the water–land group were evaluated for each of the NICU admissions. Twenty-five (83%) left for maternal choice to deliver on land, and five (17%) because of physician recommendation (two for labor arrest and augmentation, one for fetal heart rate decelerations, one for maternal fever, and one for fetal tachycardia).

There was one neonatal death, in the water–land group, to a woman who had intended to deliver in water and experienced an umbilical cord prolapse after spontaneous rupture of membranes. Fetal bradycardia was detected by handheld Doppler, and the woman was transferred for emergent cesarean delivery; however, the newborn did not survive. There was no difference in admission diagnostic categories among the three groups for any category: infectious, respiratory morbidities, or other (Table 4 and Appendices 2–4, available online at <http://links.lww.com/AOG/C427>).

## DISCUSSION

This prospective study of water birth demonstrates an overall low rate of adverse neonatal outcomes, with no increase when delivery occurred immersed in water compared with delivery on land in a low-risk

**Table 2. Maternal Outcomes**

Outcome	Land–Land (n=458)	Water–Land (n=730)	Water–Water (n=889)
Length of labor (h)	11.5 (10.6–12.4)	11.6 (10.9–12.3)	11.3 (10.7–12.0)
Overall pain score (1–10)	8.3 (8.2–8.5)	8.1 (8.0–8.2)	7.7 (7.6–7.8)
Worst pain (1–10)	9.4 (9.3–9.5)	9.4 (9.3–9.5)	9.2 (9.1–9.3)
Perineal laceration	87 (19.0) (15.5–22.9)	161 (22.1) (19.1–25.2)	183 (20.6) (18.0–23.4)
Cesarean delivery	48 (10.5) (7.8–13.7)	43 (6.0) (4.3–7.9)	n/a

n/a, not applicable.

Data are mean (95% CI) or n (%) (95% CI).



**Table 3. Neonatal Outcomes**

Outcome	Land–Land (n=458)	Water–Land (n=730)	Water–Water (n=889)
NICU admission	13 (2.8) (1.5–4.8)	30 (4.1) (2.8–5.8)	18 (2.0) (1.2–3.2)
Neonatal mortality	0 (0–0.8)	1 (0.1) (0–0.8)	0 (0–0.4)
5-min Apgar score less than 7	4 (0.9) (0.2–2.2)	4 (0.6) (0.2–1.4)	3 (0.3) (0.1–1.0)
Need for resuscitation	3 (0.7) (0.1–1.9)	5 (0.7) (0.2–1.6)	9 (1.0) (0.5–1.9)
Birth weight (g)	3,610 (3,565–3,655)	3,597 (3,565–3,629)	3,559 (3,531–3,587)

NICU, neonatal intensive care unit.

Data are n (%) (95% CI) or mean (95% CI); the CI for binary data with zero occurrences is one-sided 97.5%.

population admitted to an alternative birthing center. Low 5-minute Apgar scores and neonatal resuscitation were not different among the groups. Neonatal intensive care unit admission diagnoses were similar among the groups, with no difference in the morbidity categories. We found a significantly lower rate of cesarean birth when women labored in water and delivered on land compared with labor and delivery on land.

In a systematic review published in 2003, Pinette et al reported freshwater drowning, neonatal hyponatremia, neonatal waterborne infectious disease, cord rupture with neonatal hemorrhage, hypoxic ischemic encephalopathy, and death as possible complications of water birth.<sup>1</sup> The specific waterborne infections described were pseudomonas sepsis and legionella, which we propose were due to noncontemporary protocols for tub cleansing. The one neonatal death in our study was after spontaneous rupture of membranes while laboring in the water. We did not observe any of the other complications reported in Pinette et al's review.

The initial concerns regarding potential increased neonatal morbidity and mortality with water birth were likely fueled by low-level evidence. The 2014 Committee Opinion quoted individual case reports and case series that were 10–20 years old (Immersion in water during labor and delivery. Committee Opinion No. 594 [withdrawn]. American College of Obstetricians and Gynecologists. *Obstet Gynecol* 2014;123:e912–e5. doi: 10.1097/01.AOG.0000445585.52522.14). The current Committee Opinion, published in 2016, relies on systemic reviews and meta-analyses to conclude, “there are insufficient data on which to draw conclu-

sions regarding the relative benefits and risks of immersion in water during the second stage.”<sup>3</sup>

Sidebottom et al in 2020 reported a 2.9% proportion of NICU or special care nursery admission in a retrospective study of 314 water immersion deliveries.<sup>9</sup> When the water immersion births were compared with a matched group that did not labor or deliver in water, they found that the NICU admissions were significantly lower in the water immersion deliveries. Our chosen comparison groups were women who met the eligibility criteria for alternative birthing center labor and delivery and chose to deliver on land with either land or water labor, and we did not find a difference in NICU admissions.

A strength of our study is its prospective nature, with two comparable comparison groups. We also had a large sample size compared with prior publications. In addition, our protocols include the use of contemporary tub sterilization procedures, which we believe mitigated the neonatal infectious morbidity described in earlier reports. The relatively large number of water births in our study adds to the volume of data supporting this practice. A limitation of our study is that it was not intent to treat. If a woman who intended to deliver in water required labor augmentation, desired pain relief, or needed an operative vaginal or cesarean delivery, she was placed in the water–land group. The selection of the delivery location for group assignment compared with the woman's stated intent at the time of alternative birthing center presentation was pragmatic. Many women were uncertain about where they wanted to deliver, whereas others who planned for delivery on land precipitously delivered in the tub.

**Table 4. Overall Neonatal Intensive Care Unit Admissions**

Morbidity Category	Land–Land (n=13)	Water–Land (n=30)	Water–Water (n=18)
Infectious	5 (38) (14–68)	13 (43) (25–63)	5 (28) (10–53)
Respiratory	1 (8) (0.2–36)	6 (20) (8–39)	4 (22) (6–47)
Other	7 (54) (25–81)	11 (37) (20–56)	9 (50) (26–74)

Data are n (%) (95% CI %).



The rate of NICU admissions in the water–land group (4.1%, 95% CI 2.8–5.8%) was not higher but may have been biased by the NICU admissions of neonates born to women who intended to deliver in the water but delivered on land. To assess the potential bias from not using the intended delivery location for group assignment, the rate of NICU admissions based on where women intended to deliver was calculated. There would have been 25 (3.4%, 95% CI 2.2–5.1%) NICU admissions in the water–land group and 23 (2.6% 1.6–3.8%) in the water–water group. There is little reason to suspect that laboring in the water with subsequent delivery on land would affect the neonatal outcome. In fact, the five parturients who left the tub on physician recommendation had conditions (ie, protracted labor, maternal fever, fetal tachycardia) that predisposed to NICU admission. The post hoc power of 70% raises the possibility of type 2 error; however, rates of NICU admission were lower in the water–water group.

The results of this study suggest that water birth is not associated with increased risks of adverse neonatal outcomes, including infectious or respiratory causes, when compared with delivery on land. There has been increasing patient desire for delivery in water, and our study adds to the evidence supporting this delivery choice. This study was conducted in hospital-based alternative birthing centers in low-risk parturients, and the results should not be generalized to home births or high-risk women. Women have the autonomy to make delivery decisions, and we believe that, with appropriate counseling, the decision to deliver in water should be honored and supported in appropriately selected low-risk patients.

## REFERENCES

1. Pinette MG, Wax J, Wilson E. The risks of underwater birth. *Am J Obstet Gynecol* 2004;190:1211–5. doi: 10.1016/j.ajog.2003.12.007
2. Nguyen S, Kuschel C, Teele R, Spooner C. Water birth—a near-drowning experience. *Pediatrics* 2002;110:411–3. doi: 10.1542/peds.110.2.411
3. Immersion in water during labor and delivery. Committee Opinion No. 679. American College of Obstetricians and Gynecologists. *Obstet Gynecol* 2016;128:e231–6. doi: 10.1097/AOG.0000000000001771
4. American College of Nurse-Midwives. Position statement: hydrotherapy during labor and birth. American College of Nurse-Midwives; 2014.
5. Royal College of Obstetricians and Gynaecologists/Royal College of Midwives. Joint statement No.1: immersion in water during labor and birth. Royal College of Obstetricians and Gynaecologists and Royal College of Midwives; 2006.
6. Cluett ER, Burns E, Cuthbert A. Immersion in water during labour and birth. *The Cochrane Database of Systematic Reviews* 2018, Issue 5. Art. No.: CD000111. doi: 10.1002/14651858.CD000111.pub4
7. Vanderlaan J, Hall PJ, Lewitt M. Neonatal outcomes with water birth: a systematic review and meta-analysis. *Midwifery* 2018;59:27–38. doi: 10.1016/j.midw.2017.12.023
8. Intermittent auscultation for intrapartum fetal heart rate surveillance. *J Midwifery Women's Heal* 2015;60:626–32. doi: 10.1111/jmwh.12372
9. Sidebottom AC, Vacquier M, Simon K, Wunderlich W, Fontaine P, Dahlgren-Roemmich D, et al. Maternal and neonatal outcomes in hospital-based deliveries with water immersion. *Obstet Gynecol* 2020;136:707–15. doi: 10.1097/AOG.0000000000003956

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