



Systematic Review of Hydrotherapy Research

Does a Warm Bath in Labor Promote Normal Physiologic Childbirth?

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ABSTRACT

Health sciences research was systematically reviewed to assess randomized controlled trials of standard care versus immersion hydrotherapy in labor before conventional childbirth. Seven studies of 2615 women were included. Six trials examined hydrotherapy in midwifery care and found an effect of pain relief; of these, 2 examined analgesia and found reduced use among women who bathed in labor. One study each found that hydrotherapy reduced maternal anxiety and fetal malpresentation, increased maternal satisfaction with movement and privacy, and resulted in cervical dilation progress equivalent to standard labor augmentation practices. Studies examined more than 30 fetal and neonatal outcomes, and no benefit or harm of hydrotherapy was identified. Two trials had anomalous findings of increased newborn resuscitation or nursery admission after hydrotherapy, which were not supported by additional results in the same or other studies. Review findings demonstrate that intrapartum immersion hydrotherapy is a helpful and benign practice. Hydrotherapy facilitates physiologic childbirth and may increase satisfaction with care. Maternity care providers are recommended to include hydrotherapy among routine labor pain management options and consider immersion to promote progress of normal or protracted labor, particularly among women with preferences to avoid obstetric medications and procedures.

Key Words: bath, hydrotherapy, immersion, labor, midwives, normal birth, pain, physiology

This article describes a systematic review of research on warm water immersion hydrotherapy during labor, followed by standard care and conventional childbirth. Use of nonpharmacologic comfort and pain relief methods remains limited in the United States where labor analgesia, anesthesia, and multiple obstetric procedures are routine.¹ Higher international utilization rates suggest a potential for increased US hydrotherapy utilization and benefits that may include support for labor physiology.^{1–3} Hydrotherapy promotes normal childbirth through reduced use of intrapartum interventions due to neuroendocrine, circulatory, musculoskeletal and psychological effects of immersion.⁴ Health research literature was searched to assess the state of hydrotherapy science and demonstrable effects of immersion in labor to promote safe and informed use. Randomized controlled trials (RCTs) were identified and synthesized to support evidence-based practice and consent discussions between healthcare providers and childbearing women.

BACKGROUND

Hydrotherapy is a common comfort measure and treatment intervention in self and healthcare. A warm bath at the end of a stressful day can be a relaxing activity in daily life, and immersion hydrotherapy is a prescribed therapy in multiple clinical specialties for its soothing and wellness-promoting qualities.^{5–7} However, intrapartum use remains limited compared with pharmacologic labor pain relief methods, and hydrotherapy utilization rates vary widely by country.^{4,8,9} Warm water immersion hydrotherapy warrants further investigation

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given these discrepancies and public health goals for evidence-based maternity care and normal childbirth promotion among healthy women.

Physiologic labor and birth are defined as processes that begin and progress spontaneously at term, with minimal or no use of medications or procedures, and result in an uncomplicated or normal vaginal birth, postpartum course, and newborn transition to extrauterine life.¹⁰⁻¹² Desirable positive outcomes of normal childbirth provide rationale for care practices that facilitate physiologic parturition and necessitate healthcare providers who actively assist women to avoid routine medications and procedures when appropriate, such as facilitating nonpharmacologic labor pain relief methods in accordance with patient preferences.¹³ Growing research evidence and interprofessional consensus support the potential to improve perinatal outcomes among low-risk women by adopting a more judicious approach to use of routine obstetric interventions,¹⁴ including pharmacologic pain relief methods and labor augmentation, which may be reduced with hydrotherapy.^{8,15}

The limited use of hydrotherapy among US labor pain relief and coping strategies belies its well-rated efficacy. Among US women who gave birth in 2011-2012, 8% reported using immersion hydrotherapy in labor and 17% experienced labor and birth without use of analgesia or anesthesia.¹ This may represent a modest recent increase in hydrotherapy use; prior national surveys found that 6% of US women used a tub or pool during labor in 2000-2002 and 2005.^{16,17} In a study of US births in 2000-2002, 89% of women who used hydrotherapy in labor reported that it was "very effective" compared with 24% of women who rated narcotics as such.¹⁷ Although immersion hydrotherapy was reported to provide more effective pain control than narcotics, rate of use was decreased 5-fold in comparison (6% of women used hydrotherapy and 30% used narcotics).¹⁷ A follow-up survey of US women who gave birth in 2005 found that fewer used narcotics for pain relief (16%) compared with the prior cohort, but use of pharmacologic labor pain relief methods remained stable otherwise, with reports that 67% of women used epidural or spinal analgesia, 7% had general anesthesia, 3% used inhaled nitrous oxide, 2% had a pudendal or other local anesthetic block, and 10% were unable to identify pain medications used.¹ Among survey respondents, just 13% reported normal childbirth without labor induction or augmentation, epidural analgesia/anesthesia, or assisted delivery, while 63% of respondents had 2 or more of these obstetric interventions and 31% gave birth by cesarean delivery.¹ These findings are consistent with US National Vital Statistics data, which indicate the cesarean delivery rate reached an all-time high of 32.9% in 2009 and slightly declined to 32.0% in 2015.¹⁸

The frequent use of multiple obstetric interventions and limited use of hydrotherapy are notable in comparisons between the US and global counterparts. The United Kingdom's 2010-2011 normal birth rate was 42% and more than 3-fold higher than for US women at that time.^{1,19} Approximately 20% of UK women used epidural analgesia/anesthesia for labor pain in 2000 and 2005 while US use more than tripled in the same time period.^{16,17,20} Nearly all UK birthing facilities have routinely provided intrapartum hydrotherapy since it was codified as a standard feature of birthing units more than 20 years ago.²¹ By 1993, 89% of maternity units in England and Wales offered both labor and birth in water.²

Low comparative rates of US hydrotherapy utilization are surprising from this international perspective and may be changing along with provider attitudes and consumer demand. Women in Europe and Asia have ranked hydrotherapy availability among factors important in their selection of birth location²² and reported perceiving that it signals a healthcare provider's willingness to support maternal autonomy^{23,24} and physiologic childbirth²⁵ with personalized care. There are no comparable data on US women's perspectives, and little is known about their maternity care providers' knowledge or experience with hydrotherapy. Most US midwives provide hydrotherapy and believe that warm water immersion is a safe and effective pain relief method within their basic scope of practice,²⁶⁻²⁸ although postgraduate training is perceived to support knowledge and clinical application.²⁹ Nursing organizations have not issued intrapartum hydrotherapy statements or guidelines like other US maternal-child health organizations^{26,27,30-32} although labor support with promotion of physiologic processes and nonpharmacologic comfort measures are defined among key aspects of intrapartum nursing care.³³

There is consensus on perinatal safety and maternal benefit of immersion hydrotherapy during labor prior to conventional birth, unlike underwater birth for which there are international and interprofessional differences in assessment of best practices and evidence quality. Publications by US midwifery organizations concur with the latest American College of Obstetricians and Gynecologists committee opinion that was endorsed by the American Academy of Pediatrics and asserts,

Immersion in water during the first stage of labor may be associated with shorter labor and decreased use of spinal and epidural analgesia and may be offered to healthy women with uncomplicated pregnancies between 37 0/7 weeks and 41 6/7 weeks of gestation.^{31(pe321)}

In this context, why is US intrapartum hydrotherapy utilization limited and what can be gleaned from

research to help close the gap between theory and practice? A systematic review of the literature was undertaken to address these questions.

SEARCH METHODS AND RESULTS

Figure 1 describes the search for English language articles in the PubMed database and Cochrane Library using MeSH and other key terms in combination. Search results were checked against Google Scholar to ensure a comprehensive review of research across disciplines and assess information available to healthcare providers outside of academic institutions. Article titles were reviewed to identify possible studies of immersion hydrotherapy during labor (first or second stage, not including underwater birth), and abstracts were evaluated as needed to see whether pertinent research was described. A priori inclusion criteria ensured the quality of studies and reduced selection bias. Research was excluded if treatment (hydrotherapy) was not assigned randomly to reduce sample selection bias. Studies were required to compare outcomes of immersion hydrotherapy to no immersion hydrotherapy or standard maternity care. Studies of showering and underwater birth were excluded because of physiologic effects and risks that differ from immersion hydrotherapy during labor.

Table 1 describes 7 prospective RCTs identified and included in this review. Studies were published from 1993 to 2009 with 2615 women overall, and sample sizes ranging from 19 to 1237. Two studies were conducted in US hospitals, 1 trial was performed in a Brazilian birth center for physiologic childbirth and others took place at inpatient facilities in Sweden, England, Australia, and Canada. All but 1 study described immersion hydrotherapy in the context of midwifery care.

Studies were assessed for design, methods, analyses, bias, and outcomes including labor pain, length and augmentation, delivery method, obstetric laceration, postpartum satisfaction, Apgar scores, nursery admissions, and any other fetal, neonatal, or maternal parameter reported. Studies were evaluated for level of evidence using a standard rubric,³⁴ and for each perinatal outcome either level 1a (multiple RCTs) or level 1b evidence (1 RCT) was located.³⁵

Studies typically restricted enrollment to women with full-term pregnancies and no significant risk factors.³⁶⁻³⁹ Common inclusion criteria were vertex singleton pregnancies with normal fetal heart rate assessments prior to hydrotherapy and intermittently during immersion, and stable maternal vital signs throughout. Ohlsson and colleagues⁴⁰ included women at 35⁰/₇ weeks of gestation, but most studies limited trials to term pregnancies

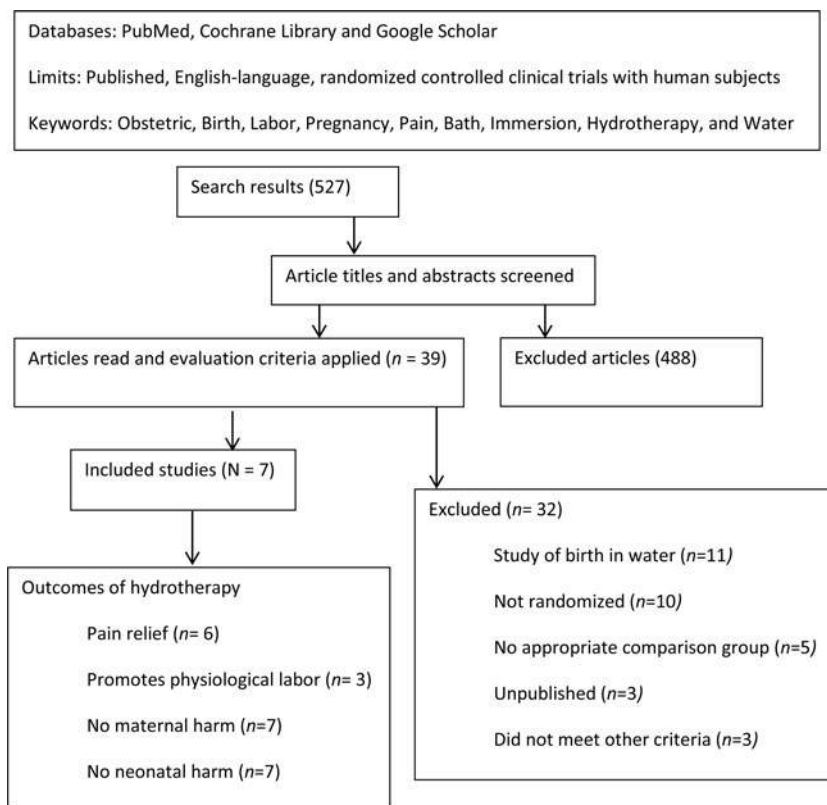


Figure 1. Literature search results.

Table 1. Prospective randomized controlled trials included in review

First author, y sample size	Setting	Study description and evaluation
Benfield (2001) ³⁶ N = 19	US hospital, nurse-midwifery care	Pilot study with pre- and posttest design and repeated measures of maternal pain and anxiety (visual analogue scales and biomarkers) among women who did and did not use hydrotherapy between 4 and 6 cm of cervical dilation. Crossover among study groups was not apparent and newborn outcomes were not examined. Small exploratory study has limited generalizability to diverse populations, and experimental procedure (60-min bath vs semireclined in bed) may not reflect natural behaviors during labor.
Cluett (2004) ¹⁵ N = 99	English hospital, nurse-midwifery care	Trial of immersion compared with standard labor augmentation (amniotomy and intravenous oxytocin) among low-risk, nulliparas with labor dystocia diagnosis (<1-cm dilation per hour at 4 to 5 cm cervical dilation). Control group had amniotomy and then oxytocin 2 h later if no dilation. Cervical examinations were performed within 4 h of tub entry but not otherwise documented. Multiple standard perinatal outcomes were examined. Analyses were performed by intention-to-treat and group assignment adherence was high. Among women assigned to bathe, all but 1 did so (she requested amniotomy instead) and 2 women in standard care group progressed before augmentation. The dystocia requirement and definition, and low threshold for intervention, have implications for clinical application and limit comparisons with other studies.
da Silva (2009) ³⁷ N = 108	Brazilian birth center, nurse- midwifery care	Trial of hydrotherapy effect on pain scores among low-risk laboring nulliparous women in active labor (6-7 cm cervical dilation). Control group received standard care including ambulation, artificial rupture of membranes, and labor augmentation with synthetic oxytocin if no cervical change in 3 h. Bathing group had 1 h of immersion. No crossover among study groups was reported. Findings are consistent with other studies in this review despite unique setting in birth center for physiologic childbirth rather than hospital.
Eckert (2001) ³⁸ N = 274	Australian tertiary center, midwifery care	Trial of immersion compared with standard care. Notably, 29% (40) of the 137 women allocated to bath group did not enter the tub. Critical analyses, eg, pain medication, were performed by both intention-to-treat and actual treatment. Postpartum questionnaires and validated screening tools were used to assess satisfaction of care and distress after inpatient data collection of standard maternal and neonatal outcomes variables.
Ohlsson (2001) ⁴⁰ N = 1,237	Three Swedish hospitals, midwifery care	Trial compared women who took a bath with a control group (no hydrotherapy) in labor with at least 3- to 4-cm cervical dilation. The control group could shower if desired and the bath group could use the tub per their preference. Participants had at least 35 ⁰ / ₇ wk of gestation; Although the gestational age criteria was less than in other studies, the average gestational age of study participants was 39-40 wk. Analyses were by intention to treat with limited crossover of 0, 4.4%, and 11.1% at 3 sites. The primary outcome was special care nursery admission plus other standard perinatal variables. The low reported cesarean delivery rate (6%-9%) may limit generalizability.
Rush (1996) ³⁹ N = 785	Canadian hospital, care by physicians	Trial of hydrotherapy vs conventional care in labor. Women in bath group were more likely nulliparous ($P = .003$), with less cervical dilation ($P = .011$), and longer labor in first ($P = .003$) and second ($P = .03$) stages. It was not always clear how these differences were controlled in analyses done by intention to treat and actual treatment. Significant study group crossover was noted; of 393 women in hydrotherapy group, 183 (46%) did not use tub. Primary outcome was pain medication use, with additional standard perinatal variables. Baseline cesarean delivery rate (17%) was greater than found in other reviewed studies but lower than many published rates at local or national level. This complicated synthesis of review findings and warrants consideration in clinical application. The whirlpool vs still bath also sets this study apart from others, as do 76% of births that were attended by obstetricians rather than midwives as described in other included trials.

(continues)

Table 1. Prospective randomized controlled trials included in review (*Continued*)

First author, y sample size	Setting	Study description and evaluation
Schorn (1993) ⁴¹ N = 93	US university medical center, nurse-midwifery care	Study of low-risk and predominately Hispanic women in active labor (4- to 7-cm dilation). Women in immersion hydrotherapy group also used other comfort measures, eg, ambulation, rest, showers, and analgesics. Subjects in the no-immersion group could use all pain relief methods except a bath. This study was unique among those reviewed by requiring intact membranes at the time of intrapartum study enrollment. Outcome variables related to labor length, pain relief, and infection were examined with few fetal and newborn parameters. Descriptions of intention-to-treat analyses were limited and the crossover rate among study groups was not reported.

(37-42 weeks) or were more restrictive, for example, 36 to 41⁴¹ or 38 to 41 weeks.³⁶ Ruptured membranes^{36,41} and meconium^{37,38} were contraindications to study enrollment in 2 studies each, while 2 studies examined meconium as an outcome,^{39,40} and 1 trial did not include this variable among study criteria or results.¹⁵ New neonatal resuscitation guidelines may inform different protocols in the future.⁴² Abnormal labor precluded study participation or was measured as an outcome in all trials except 1 that required the diagnosis of labor dystocia upon enrollment.¹⁵

Descriptions of hydrotherapy implementation were generally minimal and inconsistent, although authors all described a 30- to 60-minute treatment period or average duration of immersion hydrotherapy and water temperatures 35°C to 38°C. The description of immersion hydrotherapy use by Rush and colleagues³⁹ was particularly informative; 73% of women in the hydrotherapy group used the tub once, while others did 3 to 6 times. The study reported the highest group crossover rate among reviewed trials; of 393 women randomized to hydrotherapy, 183 (46%) did not actually use the tub for reasons reported as pain or distress (64), desired epidural (32), no tub available (16), meconium or fetal distress (15), and labor induction or augmentation (4).³⁹ Other trials reported that 0% to 29% of women randomized to hydrotherapy did not utilize the treatment. Studies reported analyses by intention to treat for all or key outcome variables.

Maternal outcomes

Table 2 outlines study findings and maternal outcomes variables ranging from pain relief and comfort to labor duration, augmentation, complications, and method of delivery. Results that were common among multiple studies or clinically significant are described.

Pain relief and relaxation

Six studies found a pain-relieving effect of hydrotherapy with varied measurements. Four studies examined

women's report of pain in labor and each found less in the hydrotherapy versus standard care group using visual scales and other measures.^{15,36,37,39} In 1 study, women were asked to complete a postpartum survey about their experience; words most frequently associated with hydrotherapy were pain relief and relaxation.³⁹ Among 6 studies that examined immersion hydrotherapy and pharmacologic pain relief methods,^{36,38,40,41} just 2 found less medication use among women in the hydrotherapy versus standard care groups.^{15,39} One study was uniquely focused on women diagnosed with labor dystocia and demonstrated a reduction in epidural analgesia and anesthesia among women randomized to hydrotherapy ($n = 23$ or 47%) compared with standard labor augmentation ($n = 33$ or 66%), with a relative risk of 0.71 (95% confidence interval, 0.49-1.01), low number needed to treat (5) and equivalent resolution of dystocia with less need for amniotomy and exogenous oxytocin administration.

Labor physiology and coping were examined in 1 study of women's experiences and stress biomarkers during hydrotherapy in labor versus standard care.³⁶ Significantly less anxiety and pain were reported by women in the hydrotherapy versus control group after 15 minutes of immersion despite equivalent catecholamine measurements. Reports of pain relief continued but changed during the treatment hour; after 15 minutes, pain scores among all bathers decreased from baseline compared with just 43% of the control group, and 83% of women in the hydrotherapy group reported less pain after an hour when pain scores were all increased in the control group. This rapid action and effective short-term relief of acute pain by hydrotherapy were supported by findings from 2 other included studies.^{15,39}

Labor duration and augmentation

Five studies found no significant impact of hydrotherapy on cervical dilation, or labor progress, duration, or augmentation.^{36-38,40,41} One study found less fetal

Table 2. Maternal hydrotherapy outcomes

First author, y	Findings		
	Pain and comfort	Labor and birth	Postpartum and miscellaneous
Benfield (2001) ³⁶	Use of labor epidurals and pain medication was equivalent among groups. Women reported more baseline pain in the hydrotherapy vs control group ($P = .03$) and a greater decrease after 15 min ($P = .001$) plus less anxiety ($P = .03$). Forty-five minutes later, pain scores still differed by group and hydrotherapy decreased scores by 24.5 points while standard care scores increased 8 points ($P < .0001$).	No significant difference was seen in labor duration, augmentation with synthetic oxytocin, or operative delivery. Cesareans and perineal outcomes were not assessed.	Satisfaction was not assessed. No difference in urine catecholamines or maternal complications including infection and hemorrhage. Hydrotherapy group had plasma volume shift, which was increased (7.8%) at 15 min of immersion ($P = .03$) compared with control group (0.4%) but not 45 min later.
Cluett (2004) ¹⁵	Nulliparous women who used hydrotherapy required fewer labor epidurals (23, 47%) compared with nonbathers (33, 66%) with relative risk of 0.71 (95% CI, 0.49-1.01) and low number needed to treat (5).	No difference in labor duration was seen, but hydrotherapy reduced the need for amniotomy and synthetic oxytocin among women with slow dilation (35, 71%) vs standard care (48, 96%) with a relative risk of 0.74 (95% CI, 0.59-0.88, $P = .001$) and low number needed to treat (4). Perineal outcomes and method of delivery were not reported.	More satisfaction with ease of movement in labor ($P = .001$) and feelings of privacy ($P = .029$) were reported by hydrotherapy vs control group, but no differences in overall satisfaction with care was seen. On average, 6 h elapsed between women leaving the tub and giving birth conventionally (range: 2-10 h). There were no differences in infection among groups.
da Silva (2009) ³⁷	Behavioral and numeric pain scales were used by nulliparous women to report less pain with hydrotherapy vs standard care during repeated measures (1.9 vs 2.4, $P < .001$).	No differences in cervical dilation, duration of second-stage labor, use of synthetic oxytocin, amniotomy, meconium, perineal laceration, or episiotomy were seen. Method of delivery was not examined.	Satisfaction with care was not assessed, nor were any additional maternal variables.
Eckert (2001) ³⁸	No differences in use of analgesia were seen among study groups whether analyzed by allocated or actual treatment, despite examination of pharmacological pain relief methods separately and in combination (epidural, pethidine, and fentanyl).	No differences were seen among groups in labor length, duration of ruptured membranes, number of cervical examinations, labor induction or augmentation, delivery method, or obstetric laceration.	Women in both groups rated their labor experiences highly overall; the standard care group reported a more positive experience at initial measurement (mean: 74.62, SD: 22.08) compared with hydrotherapy group (mean: 68.74, SD: 24.31) but not 8 mo later. Other psychological outcomes were equivalent, including postpartum depression and satisfaction with care. No differences in infection or hemorrhage were seen.

(continues)

Table 2. Maternal hydrotherapy outcomes (*Continued*)

First author, y	Findings		
	Pain and comfort	Labor and birth	Postpartum and miscellaneous
Ohlsson (2001) ⁴⁰	No difference in use of epidural analgesia or paracervical nerve blocks for labor pain relief was observed among study groups.	Cervical dilation and secondary arrest of labor were equivalent across groups. Labor augmentation was not examined. There was no difference in operative delivery, severe perineal laceration, or low cesarean delivery rate across 3 sites (6%-9%).	Satisfaction with care was not assessed in this study. There were no differences among study groups in rate of retained placenta, hemorrhage, or length of postpartum stay.
Rush (1996) ³⁹	The overall low rate of narcotic use for labor pain was significantly decreased with hydrotherapy vs standard care (OR: 0; 95% CI, 0-0.7; $P = .02$). More than half of women had labor epidurals; use significantly differed by study group only when combined with narcotics ($P = .04$). Odds of epidural or local anesthesia for labor pain and/or perineal repair were no different among groups. A subset of 68 bathers and 39 nonbathers completed a questionnaire; the words most frequently associated with hydrotherapy were pain relief and relaxation.	183 women (46%) were allocated to the tub group but did not use hydrotherapy. No difference in cesarean delivery rate was observed among study groups, but women who used hydrotherapy were less likely to experience forceps (65, 16.5%) or vacuum (86, 22%) delivery after 41 ineligible women were removed ($P = .011$). There were no differences in maternal position at birth; 86% of participants were supine or semireclined while 10% were side-lying. Women were more likely to have an intact perineum after hydrotherapy vs standard care ($P = .019$).	Thematic analysis of narrative comments submitted in the postpartum survey identified 2 common responses: "Satisfaction with the tub and having a coach or nurse directly with them during labor." ^(p142) There were no differences in infection measurements (fever, obstetrical laceration or cesarean incision with erythema, <i>Streptococcus B</i> identification, or diagnosis of urinary tract, upper respiratory tract infection, or flu).
Schorn (1993) ⁴¹	No differences in use of pharmacological pain relief methods were seen. Most women in the hydrotherapy group (76%) chose to stay immersed 31-60 min and self-selected an average water temperature of 96°F (36°C) with a range of 90°F-105°F (32°C-41°C).	No differences in uterine contraction pattern, cervical dilation, synthetic oxytocin administration, labor stages, or duration were seen when parity was controlled in analyses. Artificial rupture of membranes was not controlled in analyses or routinely performed except for labor augmentation purposes in protracted labors. There were no differences in duration of admission or delivery method among study groups, and just 2 cesareans overall (2%). Obstetrical lacerations were not examined.	Satisfaction with care was not assessed. There were no cases of chorioamnionitis or 30-d postpartum readmissions, or differences in postpartum endometritis. Systolic and diastolic blood pressures were similar across groups, with increased mean pulse (8.8 vs 1; $P = .046$) and temperature changes (0.4° vs -0.5°; $P = .04$) with hydrotherapy compared with standard care, but vital signs were within normal ranges without clinical significance.

Abbreviations: CI, confidence interval; OR, odds ratio.

malpresentation (occiput posterior and deep transverse positions) among women who bathed in labor than among nonbathers, but no impact of hydrotherapy on mean random cervical dilation or secondary arrest of labor was noted, and no examination of labor duration or augmentation was reported.⁴⁰ The trial of hydrotherapy versus standard augmentation practices for slow labor progress among nulliparas found no differences in study groups' labor lengths.¹⁵ Women who took a bath in labor had equivalent cervical dilation compared with women who had amniotomy and synthetic oxytocin; the tub group (80%) was less likely than the control group (98%) to require these obstetric interventions with a relative risk of 0.81 (95% confidence interval, 0.67-0.92), and a low number needed to treat (5).¹⁵ The hydrotherapy contribution to physiologic labor was noted by researchers who observed that "almost 30% of women in the water arm did not receive augmentation and 20% received no obstetric intervention, without evidence of longer labour."^{15(p3)}

Birth method

There were no differences in 4 studies that examined method of birth after hydrotherapy in labor.^{36,38,40,41} One trial found a significant difference in delivery type, with operative vaginal deliveries (forceps and vacuum) decreased among women who bathed in labor compared with the control group ($P = .011$) but equivalent cesarean delivery rates.³⁹

Obstetric laceration

Insufficient data were found to support any impact of hydrotherapy on perineal outcomes. Three studies did not examine obstetric lacerations,^{15,36,41} and 3 others found no differences in perineal laceration occurrence or severity and/or episiotomy among study groups.^{37,38,40} One trial found that women who used hydrotherapy during labor were significantly less likely to experience obstetric laceration than women with standard care ($P = .019$), which may be related to fewer operative vaginal births (forceps or vacuum) in the hydrotherapy group ($P = .011$).³⁹

Satisfaction

Maternal outcomes of hydrotherapy in labor related to satisfaction with care were rarely measured in reviewed studies and appear equivalent overall. Limited data indicate that hydrotherapy may afford greater satisfaction with certain aspects of labor, for example, greater ease of movement and sense of privacy versus standard labor augmentation but no difference in ratings of overall satisfaction with maternity care.¹⁵ On the contrary, 1 trial found that nonbathers rated their overall experience of

childbirth more favorably than women randomized to hydrotherapy initially, but not when measured again 8 months postpartum, and no other differences in psychological outcomes or dimensions of satisfaction were observed among study groups.³⁸ One study analyzed narrative comments in a postpartum survey and found that the 2 most common responses overall were satisfaction with tub use and presence of a nurse or a coach during labor.³⁹ Among women who were randomized to use hydrotherapy, the words most frequently associated with immersion were pain relief and relaxation.³⁹

Fetal and neonatal outcomes

Table 3 outlines more than 30 fetal and neonatal outcomes reported in reviewed articles. Variables included fetal malpresentation and heart rate, newborn Apgar scores, umbilical cord pH, resuscitation, special care nursery admission, tachypnea, seizure, jaundice, infection, birth weight, temperature, and breastfeeding. There were no differences consistently found among study groups, and no evidence of fetal or neonatal harm of hydrotherapy was observed overall.

Two trials each had 1 outlying result: increased newborn resuscitation or special care nursery admission after immersion hydrotherapy in labor, which was inconsistent with other reported results. The study unique in reporting more neonatal special care nursery admissions after hydrotherapy compared with standard care ($P = .013$) found that subsequent diagnoses were 2 cases of hypothermia and 1 each of the following: cardiac diagnosis, fever, infection (day 2), and feeding difficulties (day 3).¹⁵ In this study, all newborns admitted to the nursery from the hydrotherapy group experienced operative vaginal delivery without further complications and were rooming in with parents within 48 hours, except for the newborn with a congenital cardiac condition. This study's nursery admission findings were inconsistent with other results, including equivalent Apgar scores, umbilical cord pH values, and physical and serum indicators of 5 infections.¹⁵ The single trial which observed that newborns required significantly more resuscitation after hydrotherapy versus standard care did so only with pooled analyses of oxygen, bag and mask, and positive pressure ventilation (relative risk: 1.41; 95% confidence interval, 1.06-1.89; $P = .01$).³⁸ This finding was not consistent with other fetal and newborn outcomes in the study that were equivalent among groups: heart rate patterns, Apgar scores, umbilical cord pH values, nursery admissions, birth weight, breastfeeding, and infection symptoms, diagnoses, or treatment with antibiotics. The incidence of newborn resuscitation was not specifically reported by other reviewed studies.

Table 3. Fetal and newborn hydrotherapy outcomes

First author, y	Findings		
	Apgar scores	Special care nursery admission	Other
Benfield (2001) ³⁶	Not examined	Not examined	No differences in abnormal fetal heart rate patterns were observed and no newborn outcomes were reported.
Cluett (2004) ¹⁵	Equivalent at 5 min	Increased in bath group (6 vs 0; $P = .013$)	No difference in fetal heart rate patterns, umbilical cord pH, or 5 types of infection (physical and serum indicators) was seen.
da Silva (2009) ³⁷	Equivalent (1 and 5 min)	Not examined	Standard fetal heart rate assessments were described but observations were not. No differences in newborn temperatures or birth weights were observed.
Eckert (2001) ³⁸	Equivalent at 5 min scores <7	No differences	No differences were seen in fetal heart rate patterns, birth weight, umbilical cord pH, high rate of breastfeeding, or any infection symptom, diagnosis, or treatment with antibiotics. Newborns in hydrotherapy group required more resuscitation than control group, when analyses pooled use of oxygen, bag, and mask, plus positive pressure ventilation (RR: 1.41, 95% CI: 1.06-1.89, $P = .01$).
Ohlsson (2001) ⁴⁰	No difference in 5 min score <7	No differences	The bath group was significantly less likely to have fetal occiput posterior or transverse presentation (13 vs 29 malpresentations, OR: 0.5; 95% CI: 0.2-0.9). No differences among study groups at 3 sites in newborn distress, tachypnea, jaundice, or seizures; umbilical pH studied at single site and equivalent.
Rush (1996) ³⁹	No differences at 1 or 5 min	Not examined	Continuous fetal monitoring orders upon admission precluded study enrollment. No differences in birth weight, fever, or conjunctivitis. No newborn antibiotics required.
Schorn (1993) ⁴¹	No differences at 1 or 5 min	Not examined	No difference in fetal heart rate patterns during continuous tracing upon admission or intermittently auscultated thereafter. A significant increase in fetal heart rate was noted with immersion (144.7 beats per min) compared with nonimmersion (136.9 beats per min), but both remained within normal limits without clinical sequelae ($P = .0001$).

Abbreviations: CI, confidence interval; OR, odds ratio; RR, relative risk.

With these 2 exceptions, fetal and neonatal data were reassuring that outcomes are equivalent regardless of hydrotherapy use in labor. Continuous and intermittent fetal heart rate patterns were similar among study groups in the 4 studies that examined this variable.^{15,36,40,41} There were no differences in Apgar scores in the 6 studies that examined them at 1 and/or 5 minutes of life.^{15,37-41} Three trials examined umbilical cord pH and found no differences following maternal hydrotherapy use.^{15,38,40} Overall, there was no evidence that hydrotherapy in labor significantly impacts fetal or newborn outcomes compared with standard labor care.

DISCUSSION

Study findings

This review found no maternal, fetal, or neonatal harm resulting from hydrotherapy in labor. Studies support a hydrotherapy benefit of pain relief and indicate that there are additional effects. Relief of acute anxiety was observed during hydrotherapy in the study that examined this parameter, without differences in biomarkers or availability of comparative data.³⁶ Qualitative data from included studies indicate that women appreciate the movement and privacy afforded by hydrotherapy¹⁵

and commonly comment on hydrotherapy when discussing satisfaction with maternity care.³⁹

Three studies demonstrated that immersion hydrotherapy promotes normal physiologic labor and birth in varied ways, and additional articles supported further inquiry in this area. Two trials found reduced use of pharmacologic pain relief methods with hydrotherapy compared with standard care^{15,39} while 4 did not, and 1 trial found each of the following: greater maternal movement,¹⁵ less fetal malpresentation,⁴⁰ and equivalent cervical dilation with less amniotomy and synthetic oxytocin for labor dystocia in first-stage labor among nulliparas.¹⁵ However, 4 trials found no difference in labor duration or augmentation when comparing hydrotherapy with standard care in women with normal labor progress.^{36–38,41}

This review found little evidence that hydrotherapy has a protective effect against operative delivery or obstetric laceration. One trial found fewer operative vaginal deliveries and obstetric lacerations among women who bathed in labor than among those who did not,³⁹ but 5 trials found no difference in delivery method (forceps, vacuum, and cesarean birth), and 3 found no difference in perineal trauma.^{37,38,40} Additional maternal outcomes were measured infrequently among reviewed studies with inconsistent results.

No differences in fetal or neonatal outcomes were observed among study groups overall. Two trials reported concerning newborn results for a single variable; these outliers were inconsistent with findings from the same and other included articles. This suggests possible type I error, bias, and/or clinical hypervigilance of the treatment group. Regardless, the preponderance of data demonstrated equivalent outcomes among hydrotherapy and conventional care groups, and no evidence was found to contradict endorsement and facilitation of immersion by maternity care providers.

Study limitations

Studies focused on biophysical outcomes and did not specifically investigate hydrotherapy barriers related to providers or childbearing families, apart from 3 studies of women's satisfaction and plans for the selection of future labor care practices and coping methods.^{15,38,39} The exclusion of nonrandomized trials from this review prevented assessment of factors that women prioritize in decision making for labor pain relief and hydrotherapy, or patterns of use outside of study treatment protocols, which need priority future assessment. However, rigorous study designs (prospective RCTs) and standard research methods ensured the validity and reliability of findings for outcomes that were examined.

Overall risk of bias among studies was low, except related to treatment performance. Hydrotherapy assign-

ments were randomized in all studies but women, clinicians, and researchers could not be blinded, and a range of strategies to reduce bias was described. Additional research limitations included frequent failure to assess immersion hydrotherapy outcomes in appropriate samples and comparisons, that is, women who chose not to use hydrotherapy despite medical eligibility and healthy women with preferences to avoid pharmacologic pain relief methods.

Type I and II errors are possible in reviewed studies and may be addressed with future research, including investigation of any dose response of hydrotherapy related to the duration, timing, or other characteristics of immersion. Trials included 30 to 60 minutes of hydrotherapy use during labor at 4- to 7-cm cervical dilation; it is possible that findings would differ if self-selected shorter or longer baths were studied at different times during parturition. Nonetheless, reviewed studies demonstrated a causal relationship between immersion hydrotherapy and reduced labor pain, with limited data supporting additional effects including normal physiologic birth promotion.

Clinical and research implications

International comparisons demonstrate potential for significantly greater use of hydrotherapy in labor and increased normal physiologic birth rates among US women. Review findings support this potential, and the safety and efficacy of hydrotherapy use for comfort in labor and nonpharmacological prevention and resolution of slow labor progress and dystocia in the first stage of labor. On a larger scale, hydrotherapy could meaningfully decrease use of obstetric medications and procedures with concomitant side effects and risks, for example, greater incidence of fever,⁴³ catheter-associated bladder infection,⁴⁴ and operative vaginal delivery with regional labor anesthesia,²⁰ or risk of uterine tachysystole and fetal intolerance resulting from labor augmentation with synthetic oxytocin administration.^{45,46} For these reasons, increased use of hydrotherapy may confer both physical and psychological health benefits beyond the scope of included studies and outcomes variables.^{47,48}

Review findings also indicate that hydrotherapy may offer additional benefits related to quality improvement in maternity care delivery and systems. Further research is needed to address outstanding questions in these areas that range from the comparative cost of starting a new hydrotherapy program versus savings from resultant decreased use of expensive obstetric interventions,⁴⁹ to how increased hydrotherapy use might impact activities by interprofessional maternity care team members. For example, increased hydrotherapy utilization may change nurses' use of intermittent

versus continuous fetal monitoring or labor support practices with an impact on patient outcomes, as well as staffing levels and continuing education requirements.

Studies included in this review did not directly examine physiologic changes in response to immersion hydrotherapy with 2 exceptions.^{36,41} Prior research has established that pain and relief vary by individual, and hydrotherapy likely reduces pain perception through competing stimuli (sensations of immersion and warmth decrease pain signal transmission), hydrostatic counterpressure, and a conditioned relaxation response among women accustomed to bathing for hygiene and comfort.^{50–53} Hydrotherapy bioeffects may also include hydrostatic pressure mobilization of extravascular fluid, which could result in measurably increased maternal blood volume as seen in 1 reviewed study that examined this parameter.³⁶ This physiologic effect of immersion could decrease edema with implications for maternal comfort,⁵⁴ increase uterine perfusion with potential to optimize contractility and labor progress,^{15,55} and/or improve placental perfusion and fetal oxygenation.⁵⁶ These theoretical physiologic pathways could contribute to review findings that hydrotherapy promotes cervical dilation in labor dystocia and warrant further exploration given new knowledge about labor physiology and benefits of normal childbirth.¹⁵

New research on labor physiology has informed recent quality initiatives, for example, the benefits of normal birth warrant promotion with a revised labor dystocia definition that permits more time for spontaneous progress before augmentation and expedited delivery are initiated.^{14,57} Contemporary labor curves indicate that progress from 4- to 6-cm dilation may normally take 9 hours, followed by accelerated dilation rates that vary by parity.⁵⁸ From this perspective, the included trial of hydrotherapy versus standard augmentation for labor dystocia involved participants who were not yet in active labor, and findings may be applicable to women with dysfunctional and normal progress of latent and active first-stage labor. Regardless, findings pertain to large numbers of childbearing women given the widespread use of pharmacologic pain relief methods and labor augmentation methods in US obstetrics.¹

A growing understanding of the physiologic effects of immersion hydrotherapy suggests that there may be additional benefits throughout the childbearing year for pain relief and conditioning during pregnancy, labor, birth, and the postpartum period.^{59–61} Hydrotherapy may also be useful to study in women with conditions that are related to known biophysical effects of immersion, for example, those with maternal-fetal circulation complications such as hypertensive disorders, fetal intrauterine growth restriction, or oligohydramnios.^{36,62–64}

Review findings include additional fetal and newborn clinical and research implications. Notably, no study specifically examined neonatal consequences or benefits, either immediately or across the life span, of decreased exposure to pharmacologic pain relief methods due to hydrotherapy,^{15,20,39,65} or a higher physiologic birth rate for other reasons.¹⁵ This is a priority area of inquiry since obstetric interventions are not without risk, may enhance or detract from maternal and neonatal well-being, and can confer intergenerational effects. Although difficult to measure, long-term population outcomes of labor pain relief methods and normal birth are critical to explore among continuous quality improvement efforts.

Continued research on the relationships between hydrotherapy and reduced use of intrapartum interventions will be especially helpful to women and their care providers. Women with a strong preference for physiologic childbirth are rarely reflected in research populations and may prefer, utilize, or experience hydrotherapy differently than women who were randomized to prescribed hydrotherapy treatments in reviewed studies.⁶⁶ Future research should also address clinical decision making and assist healthcare providers to conduct informed consent discussions while grappling with how to describe and weigh neonatal data that do not currently demonstrate any overall harm or direct benefit of hydrotherapy in labor. This would also contribute to an overall paucity of data to inform care for women who wish to use nonpharmacological pain relief methods and experience physiologic birth without interventions common in contemporary obstetrics.^{1,18}

Patient and provider education

Education, informed consent, and patient advocacy are keys to high-quality maternity care. Healthcare ethics require the disclosure and provision of evidence-based labor pain relief strategies with risks, benefits, and alternatives including intrapartum hydrotherapy. Maternity care providers must facilitate parturients' understanding of options and help them make decisions from the full range of choices appropriate for their condition and preferences without coercion or undue limitations. This obligation is underscored by a lack of risk-free, effective, and freely available comfort measures that satisfy all stakeholders' requirements.^{20,67}

Education specific to hydrotherapy includes outcomes of the best available research without bias in selection or reporting of information.⁶⁸ Best practices in hydrotherapy have been published with supporting data and can be used to create site-specific health information materials⁶⁹ and clinical policies and procedures as needed.^{9,30,70,71} Additional considerations for

healthcare providers include safe tub filling and cleaning,⁹ financial costs,⁴⁹ and risk reduction with robust documentation practices as well as preparation for inadvertent underwater birth.

Hydrotherapy providers are recommended to engage in proactive quality assessment initiatives if not clinical research, with participation by all stakeholders including parturients. Regular reviews of hydrotherapy practices and outcomes, and any new research literature, will support ongoing knowledge development and timely revision of clinical policies to support optimal care. Hydrotherapy may be highlighted as one strategy to promote normal physiologic childbirth during professional and community education activities.^{22, 23, 25} Popular media may also be useful in physiologic childbirth promotion and hydrotherapy advertising at the local and population levels.^{72, 73} In taking these efforts, maternity care providers can comply with mandates for high-quality, data-driven, and family-centered care that innovates in accordance with scientific knowledge and public health needs.

CONCLUSIONS

There is strong evidence from prospective RCTs to support the continued and expanded use of warm water immersion hydrotherapy for labor pain relief and normal physiologic childbirth facilitation among healthy women. Research demonstrates that low-risk women who wish to use immersion hydrotherapy in labor may safely do so and are less likely to require obstetric medications and procedures as a result. In addition to pain relief, this review demonstrated multiple additional mechanisms by which hydrotherapy may facilitate normal physiologic childbirth and obstetric nonintervention. Studies demonstrate a hydrotherapy effect of reduced maternal anxiety and greater movement in labor, less fetal malpresentation, and progressive cervical dilation with reduced use of amniotomy and synthetic oxytocin among nulliparas with a diagnosis of labor dystocia randomized to hydrotherapy versus standard care. In these ways, immersion hydrotherapy may contribute to family-centered care and quality improvement efforts to facilitate normal birth and judiciously limit obstetric interventions that carry health risks. These are critical actions to address the complex challenges of equitably providing safe and cost-effective maternity care that is responsive to all participants and health sciences research.

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