Original Review

Evidence-Based Practice for Intrapartum Care: The Pearls of Midwifery

CEU

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Care for women in labor in the United States is in a period of significant transition. Many intrapartum care practices that are standard policies in hospitals today were instituted in the 20th century without strong evidence for their effect on the laboring woman, labor progress, or newborn outcomes. Contemporary research has shown that many common practices, such as routine intravenous fluids, electronic fetal monitoring, and routine episiotomies, do more harm than good. In 2010, the American College of Nurse-Midwives released a PowerPoint presentation titled Evidence-Based Practice: Pearls of Midwifery. This presentation reviews 13 intrapartum-care strategies that promote normal physiologic vaginal birth and are associated with a lower cesarean rate. They are also practices long associated with midwifery care. This article reviews the history of intrapartum practices that are now changing, the evidence that supports these changes, and the practical applications for the 13 Pearls of Midwifery. J Midwifery Womens Health 2014;59:572–585 © 2014 by the American College of Nurse-Midwives.

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"Many practices in health care, especially in maternity care, were developed because of expediency, habit, or logic and were not subjected to the rigors of good science."[1]

INTRODUCTION

Approximately 4 million women give birth in the United States each year and 1.5 million of them undergo a cesarean,[2] which is a 50% increase in the cesarean rate since 1990.[2] The current cesarean epidemic has not lowered indices of maternal or perinatal morbidity for low-risk nulliparous women at term who present in labor with a singleton fetus in a vertex presentation. In fact, in this low-risk population, cesarean is associated with greater morbidity than a vaginal birth.[3] Therefore, lowering the primary cesarean rate has become a national priority.[4,5] Multiple research studies have been conducted in the last few years that have identified intrapartum care practices associated with increased cesarean rates,[6–8] and professional associations have issued recommendations that address practices such as avoiding elective induction to reduce the cesarean rate.[4,5] Thus, identification of care practices that support normal physiologic labor and birth has also become a recent subject of increasing interest to intrapartum care providers.

The Evidence-Based Practice: Pearls of Midwifery is a PowerPoint presentation that reviews the evidence for intrapartum care that supports normal physiologic birth and offers practical techniques that clinicians can incorporate into their practices. This presentation is produced by the American College of Nurse-Midwives (ACNM) and is available for individual use. The presentation can be accessed on the ACNM Web site (http://www.midwife.org/Evidence-Based-Practice-Pearls-of-Midwifery). The presentation was initially developed by the second author (W.P.) and the Washington, DC,

chapter of ACNM for a grand rounds presentation on how to promote physiologic birth with minimal intervention. In 2009, ACNM purchased and assumed ownership of the presentation to make it available to a national audience. The current version is an ongoing project of ACNM, and new content is added as evidence becomes available. The current 13 Pearls of Midwifery are listed in Table 1. In addition to the 13 Pearls of Midwifery, the PowerPoint presentation reviews 2 overarching concepts that underlie adoption of the Pearls of Midwifery: 1) offer the use of nonpharmacologic methods of pain relief; and 2) collaborative multi disciplinary care improves all health-related outcomes.

This article reviews the research findings that support the 13 intrapartum-care practices associated with optimal birth outcomes that are reviewed in the Evidence-Based Practice: Pearls of Midwifery presentation. More importantly, the degree of evidence for each of these practices is reviewed. Knowledge of the strength of a particular benefit is essential for clinicians to accurately counsel women and appropriately individualize care. Ideally, the numbers needed to treat would be reported, but that information is not always available. Therefore, the actual number per 100 or 1000 women for which a care practice is effective has been calculated wherever possible and reported in the accompanying tables.

PEARL: ORAL NUTRITION IN LABOR IS SAFE AND OPTIMIZES OUTCOMES

Allow Women to Eat and Drink During Labor

In the United States, laboring women are routinely told not to eat or drink during labor. Routine labor admission orders typically include restricting oral intake (nothing by mouth) and insertion of an intravenous line. Rationales for this practice include hydration, a need for intravenous access in the event of an emergency, and the prevention of aspiration in the event of general anesthesia. Gastric emptying is delayed during

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Quick Points

◆ The Pearls of Midwifery are evidence-based intrapartum care strategies that support and facilitate normal physiologic birth.

◆ Midwives can use the Evidence-Based Practice: Pearls of Midwifery PowerPoint presentation to share with other health care providers.

◆ The Pearls of Midwifery improve maternal, neonatal, and labor outcomes.

◆ Grounded in evidence, the Pearls of Midwifery can and should be generalized to every intrapartum care practice setting, population, and provider.

active labor because peristalsis is inhibited during labor.[9] Use of opioids for pain relief further retards gastric emptying. Thus, laboring women have an increased risk for aspiration if they undergo general anesthesia.

A 1946 article by Mendelson first focused attention on the risks of pulmonary aspiration during labor. In Mendelson's review of 44,016 pregnant women, 66 of the women experienced pulmonary aspiration during labor. Two of the women died secondary to asphyxiation with solid particles and a gastric pH that was very low.[10] After the Mendelson article was published, the policy of prohibiting women from eating or drinking during labor became the norm in the United States in order to prevent aspiration pneumonia.

Today, the anesthesia-related maternal mortality has decreased dramatically to approximately 1.2 per one million live births.[11] Aspiration is related solely to general anesthesia, which is rarely used. The major causes of death in women who do receive general anesthesia are related to intubation failure and induction problems.[11] Thus, aspiration during labor or birth is almost nonexistent.

In addition, the original rationale for limiting oral intake during labor was not well founded in the physiology of gastric emptying during labor. Gastric emptying times vary considerably between individuals, and fasting does not guarantee that an empty stomach will ensue within a defined period of time. Secretion of gastric juices continues despite the presence or absence of food. Therefore, it is possible that gastric pH may actually be lower in women who are fasting, putting them at increased risk for pneumonitis if they do aspirate. The studies that have evaluated maternal and neonatal outcomes in women who eat versus those who do not eat have not identified any clinically relevant differences between the 2 groups; however, given its rarity in occurrence, these studies have had too few numbers to assess the incidence of aspiration pneumonitis.[12]

Practical Application

When women are allowed freedom to eat and drink during labor, most choose small meals of semisolids during early labor, and few chose to eat at all during the active phase. Given the lack of evidence that oral intake is harmful, women who are at low risk for needing a cesarean should be offered the choice to eat or drink during labor.[13] Discuss aspiration risk related to general anesthesia with women prior to labor onset. Limit oral solids or fluids if the patient is at increased risk for cesarean.

No Routine Intravenous Fluids

Since the 1970s, intravenous hydration for women in labor has been routine in most US hospitals. Two of the reasons put forth for routine intravenous fluids are to counteract ketosis and prevent dehydration in women who are restricted from oral consumption of food and fluids. Labor is a demanding metabolic event, and laboring women are at risk for dehydration. In turn, dehydration may adversely affect myometrial contractility and can decrease blood volume, resulting in decreased uterine blood flow.[14] Laboring women produce ketones more rapidly than nonpregnant women, and ketones may lead to ketoacidosis, which in turn is associated with prolonged labor and an increased need for augmentation. However, clinically significant adverse effects of ketosis have not been documented.[15] Using the Cochrane meta-analysis methodology, Toohill et al found no studies that demonstrated either benefit or adverse effects of treating ketosis during labor.[15]

The amount of oral intake needed to prevent dehydration in labor is unknown and subject to extensive individual variation. The standard policy of intravenous fluids of 125 mL per hour for women who are restricted from oral intake is associated with an extended duration of labor when compared to women who are administered 250 mL per hour of intravenous fluids.[16] Thus, it appears that current practices of limiting oral intake and using intravenous fluids of 125 mL per hour as replacement therapy provides too little fluid and may be iatrogenically contributing to longer labors.

There are no published studies that have directly compared labor outcomes in women who were administered intravenous fluids versus women who had unrestricted oral intake only. That said, studies of labor outcomes in low-risk women who give birth in settings where intravenous fluids are not routinely administered have been shown to be as good as or better than outcomes of comparable populations of women who give birth in settings that routinely administer intravenous fluids.[17]

Practical Application

Do not routinely administer intravenous fluids. A policy that allows women to self-select their oral intake has benefits and no adverse effects; therefore, it is best to encourage women to maintain hydration via oral intake of fluids.[13] Use a saline lock when intermittent intravenous access is desired. Periodic

Table 1.	Pearls of Midwifery
1	Oral nutrition in labor is safe and optimizes outcomes.
2	Ambulation and freedom of movement in labor are safe, more satisfying for women, and facilitate the progress of labor.
3	Hydrotherapy is safe and effective in decreasing pain during active labor.
4	Continuous labor support should be the standard of care for all laboring women.
5	Intermittent auscultation should be the standard of care for low-risk women.
6	Do not routinely rupture the membranes.
7	Second-stage management should be individualized and support an initial period of passive descent and self-directed open-glottis pushing.
8	There is no evidence to support routine episiotomy or aggressive perineal massage at birth.
9	Delayed cord clamping improves neonatal outcomes.
10	Immediate skin-to-skin contact after birth promotes thermoregulation, improves initial breastfeeding, and facilitates early maternal-infant bonding.
11	Out-of-hospital birth is safe for low-risk women.
12	Have patience with labor progress.
13	Vaginal birth after cesarean is safe for most women.

Source: American College of Nurse-Midwives. Evidence Based Practice: Pearls of Midwifery. http://www.midwife.org/Evidence-Based-Practice-Pearls-of-Midwifery.

assessments to detect dehydration are warranted, and intravenous fluids may be beneficial for women who are at high risk for complications or who are unable to maintain adequate oral intake.

PEARL: AMBULATION AND FREEDOM OF MOVEMENT IN LABOR ARE SAFE, MORE SATISFYING FOR WOMEN, AND FACILITATE THE PROGRESS OF LABOR

Lying in bed during labor is a relatively new practice that developed in parallel with the use of technologies such as labor analgesia and continuous, electronic fetal heart rate monitoring (EFM). The disadvantages of lying in bed throughout labor are well known. The supine position reduces blood flow to the uterus; is associated with maternal hypotension, variant fetal heart rate patterns, and lowered fetal oxygenation; and may decrease the effectiveness of uterine contractions. Yet, only 2 of 5 women who give birth in hospitals today report being able to walk during their labors.[18]

Ambulation and upright positions during labor are associated with many advantages such as improved maternal satisfaction and reports of less pain, less use of analgesia, shorter duration of the first stage, increased strength and effectiveness of uterine contractions, and a lower incidence of fetal heart rate decelerations.[19] Older studies that conducted radiographic measurements of pelvic diameters of laboring women in upright versus supine positions found that upright positions increased room in the midpelvis and created approximately 20% more space in the pelvic outlet.[20]

Despite the plethora of studies that have documented positive effects of upright positions, it is difficult to study and isolate the independent effect of position on labor outcomes in a formal research study. Women do not stay in one position during the course of a study and cannot ethically be required to maintain one position. In addition, many practices such as epidural analgesia independently affect the duration of labor and may have a stronger independent effect than does maternal position. Despite these methodologic problems, the most recent meta-analyses that assessed the effect of upright maternal positions in labor found that upright positions shorten the duration of the first stage of labor by approximately one hour (mean difference [MD], −0.99; 95% confidence interval [CI], −1.60 to −0.39).[21] Gupta et al found that upright positions shorten the second stage and decrease the incidence of operative vaginal births.[22] Most observational studies of maternal position during labor have found that women spontaneously assume many different positions during the course of labor, often preferring upright positions in earlier labor and changing to side-lying later in labor.[21]

In summary, supine positioning during labor has clear adverse effects on labor progress, whereas ambulation and freedom of motion during labor have beneficial effects on labor progress and maternal satisfaction. In addition, Sims position or hands and knees positioning may facilitate rotation from occiput posterior to occiput anterior, although the data for using positions to rotate a fetus is not conclusive. Because the ability to choose a position that is most comfortable enhances feelings of control and decreases pain, freedom to assume any position of comfort should be encouraged.

Practical Application

Encourage upright positions during labor and allow women to labor and birth in any position that feels comfortable and natural. Encourage ambulation and frequent position changes during labor to enhance maternal comfort and optimal fetal positioning.

The use of the reclining position is reserved for periods of rest or to help the fetus to rotate by placing the women in a side-lying position.

PEARL: HYDROTHERAPY IS SAFE AND EFFECTIVE IN DECREASING PAIN DURING ACTIVE LABOR

Immersion in water during active labor has been consistently associated with relaxation, decreased reported pain, less use of analgesics, and a shorter duration of the first stage of labor.[23]

Immersion in water does not affect the second stage of labor, mode of birth, perineal outcomes, or neonatal outcomes; and there is no increase in maternal or neonatal infection associated with water immersion.

Water immersion has physiologic effects that could slow labor or speed labor. Water immersion induces a central blood volume bolus that may dilute plasma oxytocin levels and cause a decrease in uterine contraction frequency.[24] Conversely, high levels of anxiety and pain induce a release of catecholamines that can slow uterine contractility. In this instance, reduction of anxiety associated with bathing may improve uterine contractility. However, Eriksson et al compared outcomes of women who bathed early in labor (before 5-cm dilatation) versus those who bathed in active labor. The women in the early bath group had longer labors and were more likely to need oxytocin augmentation and use epidural analgesia.[25]

Cluett et al evaluated the use of water immersion in nulliparous women who had been diagnosed with dystocia (< 1 cm/hr dilation) and who would have been offered amniotomy and/or oxytocin augmentation in usual care. The participants were randomized to water immersion for up to 4 hours (n = 49) or amniotomy followed by oxytocin augmentation (n = 50). Thirty-five (71%) of the women in the water immersion group subsequently required oxytocin augmentation. Water immersion did not prolong the ultimate duration of labor.[23] The results of this trial suggest that water immersion may help a significant number of women avoid labor augmentation; however, there were 6 newborns in the water immersion group who required admission to the neonatal intensive care unit (NICU) compared to no newborns in the augmentation group. The reasons for NICU admission varied, and only 2 were potentially associated with water immersion.

Practical Application

Hydrotherapy and water immersion are nonpharmacologic pain-relief methods that should be made available to all low-risk laboring women. Prolonged immersion, especially during the latent phase, may slow labor. The use of water immersion as a treatment for dystocia probably has no adverse effects; although it requires more investigation.

PEARL: CONTINUOUS LABOR SUPPORT SHOULD BE THE STANDARD OF CARE FOR ALL LABORING WOMEN

Historically, women have supported other women through labor and birth. This cross-cultural practice was abandoned in the United States in the early 20th century when hospital birth and interventions designed to prevent puerperal infection became the norm. In 1986, Klaus and Kennell published the results of a randomized controlled trial (RCT) that evaluated the effects of continuous support during labor provided by nonmedical laypersons in a large Guatemala hospital (N = 465).[26] The women who had a companion with them throughout labor had significantly shorter labors (7.7 h vs 15.5 h; $P < .001$), less oxytocin augmentation (2% vs 13%; $P < .001$), and fewer cesareans (7% vs 17%; $P < .01$).

Subsequent RCTs and a meta-analysis of 15 trials that included 15,288 women found that the one-to-one continuous presence of a support person improves several maternal and labor outcomes, albeit these are modest improvements in the aggregate[27] (Table 2). The positive effects of having a continuous support person are more robust when that individual is a layperson previously unknown the woman. Women who do not have extensive support also have better health outcomes when they have continuous support throughout labor.

Practical Application

Continuous one-to-one support during labor should be the standard of care for all women. Continuous nonmedical support during labor has positive effects for the woman, her labor course, and the initial postpartum adjustment of both the woman and her newborn.

PEARL: INTERMITTENT AUSCULTATION SHOULD BE THE STANDARD OF CARE FOR LOW-RISK WOMEN

Continuous EFM was introduced into clinical practice in the 1960s in the United States under the assumption that EFM would allow the detection of fetuses at risk for asphyxia. Several large RCTs comparing intermittent auscultation (IA) to EFM were conducted in the 1980s and early 1990s. The Cochrane meta-analysis of these trials (N = approximately 37,000 women) found that the use of EFM is associated with more cesareans and more vaginal operative births without improvement in neonatal outcomes[28] (Table 3). Newborns of women in the EFM groups had approximately half the incidence of neonatal seizures, but long-term follow-up of these children found that the newborn seizures were not associated with permanent neurodevelopmental abnormalities.[29]

Assessment of fetal well-being can also be obtained via IA with a Doppler (or Pinard) fetoscope. IA allows for freedom of movement and upright positions. In addition, the technique for using IA effectively requires one-to-one continuous care, which has an independent positive effect on childbirth outcomes. Maternal and neonatal outcomes of women who give birth in settings for which IA is the standard of care are better than the outcomes of women with similar characteristics who give birth in hospitals.[17]

Practical Application

Discuss the risks and benefits of continuous versus intermittent fetal heart rate monitoring with all patients. IA should be the standard of care for monitoring the fetus during labor. Follow national guidelines for the frequency of auscultation. Auscultation through contractions may improve the detection of periodic or episodic changes in the heart rate.[30] Strategies for making the change from routine EFM to IA for low-risk women who give birth in hospitals are needed.

PEARL: DO NOT ROUTINELY RUPTURE THE MEMBRANES

Amniotomy or artificial rupture of membranes is a routine practice for laboring women. Amniotomy is also an intervention used to induce labor or treat dystocia. It is theorized that amniotomy releases prostaglandins that stimulate oxytocin,

Table 2. The Effects of Continuous Support During Labor on Maternal, Neonatal, and Labor Outcomes

Maternal, Neonatal, and Labor Outcomes	N	Continuous Labor Support Group Versus Usual Care Group, n/100 live births	Effect RR[a] (95% CI)	Degree of Difference
Use of any analgesia	12,283	73 vs 75	0.90 (0.84-0.96)	Statistically significant but clinically small difference
Duration of labor, h	5366	7.75 vs 8.22[b]	−0.58[b] (−0.85 to −0.31)	Approximately 30-min shorter duration of labor in continuous labor support group
Cesareans	15,175	12 vs 14	0.93 (0.88-0.99)	Small decrease in continuous labor support group
Spontaneous vaginal birth	14,119	71 vs 67	1.08 (1.04-1.12)	Small increase in continuous labor support group
Operative vaginal birth	14,118	18 vs 20	0.90 (0.85-0.96)	Small decrease in continuous labor support group
Dissatisfaction with labor	11,133	12 vs 17	0.69 (0.59-0.79)	Less dissatisfaction in continuous group

Abbreviations: CI, confidence interval; RR, relative risk.
[a] The relative risk is slightly different than the difference between percentages of events in each group secondary to weighting of the studies.
[b] Mean difference in hours.
Adapted from Hodnett et al.[27]

thereby increasing the strength and effectiveness of uterine contractions.

However, routine amniotomy is controversial. Some authors suggest that the bag of waters protects the fetus during labor and that amniotomy is associated with variable fetal heart rate decelerations, an increased risk of chorioamnionitis, and umbilical cord prolapse.[31,32] Others have found amniotomy is an effective means of accelerating labor that, when combined with oxytocin augmentation, results in a small decrease in the number of cesareans performed.[33]

The most recent meta-analysis of RCTs that compared amniotomy to no amniotomy in women who were in spontaneous labor at term found that routine amniotomy does not shorten the duration of labor (MD, −20.43 min; 95% CI, −95.93-55.06). There is a trend toward an increased risk for cesarean (relative risk [RR], 1.27; 95% CI, 0.99-1.63) and a trend toward more fetal heart rate decelerations (RR, 1.09; 95% CI, 0.97-1.23) in women who experience amniotomy.[34] This meta-analysis did not find a difference in duration of labor if the amniotomy was performed early or later in labor, nor did amniotomy accelerate labor for either multiparous or primiparous women.[34]

Practical Application

Routine amniotomy should be abandoned. An intact bag of waters prevents fetal heart rate decelerations due to cord compression, prevents chorioamnionitis, and allows for fetal rotation. Allowing the bag of waters to remain intact decreases both the risk of cord prolapse and emergency cesarean. Selective amniotomy for resolving dystocia needs more study.

PEARL: SECOND-STAGE MANAGEMENT SHOULD BE INDIVIDUALIZED AND SUPPORT AN INITIAL PERIOD OF PASSIVE DESCENT AND SELF-DIRECTED OPEN-GLOTTIS PUSHING

Offering nulliparous women who have epidural analgesia an initial period of rest after the cervix is 10-cm dilated is based on the theory that a short rest period will allow the fetus to passively descend and rotate while conserving the woman's energy for expulsive efforts.[35] This practice has variously been termed *delayed pushing*, *laboring down*, and *passive descent*. Several RCTs of delayed pushing have found that this practice increases the incidence of spontaneous vaginal birth; reduces the risk of instrument-assisted birth; decreases active pushing time; and has no effect on the cesarean rate, genital tract lacerations, or episiotomies.[35,36] Both meta-analyses of these trials found that approximately 10% more vaginal births occur when maternal pushing is delayed and the period of active pushing is shortened by a mean of approximately 12 to 20 minutes. However, the Tuuli analysis found that the increase in vaginal birth rates was not statistically significant when only high-quality studies were included (RR, 1.07; 95% CI, 0.98-1.16).[36] Table 4 presents a comparison of these 2 meta-analyses.

The largest RCT on delayed pushing found a lower rate of umbilical artery cord pH values lower than 7.10 in the delayed pushing group (RR, 2.45; 95% CI, 1.35-4.43). However,

Table 3. Meta-Analysis of Electronic Fetal Monitoring Versus Intermittent Auscultation

Maternal, Neonatal, and Labor Outcomes	N	EFM Group versus IA Care Group, n/1000 live births	Effect RR[a] (95% CI)	Degree of Difference
Cesareans	18,861	52 vs 36	1.63 (1.29-2.07)	Approximately 50% more cesareans in EFM group, but the cesarean rate in both groups was very low.
Operative vaginal birth	18,615	118 vs 102	1.15 (1.01-1.33)	Statistically higher in EFM group but clinically small difference
Apgar score < 4 at 5 min	1919	1 vs 0.7	1.80 (0.71-4.59)	No difference
Cord blood acidosis	2494	28 vs 24	0.92 (0.27-3.11)	No difference
Cerebral palsy	13,252	4 vs 3	1.75 (0.84-3.63)	No difference
Hypoxic ischemic encephalopathy	1428	1 vs 3	0.46 (0.04-5.03)	No difference. Based on one trial that included preterm births.
Perinatal mortality	33,513	3 vs 3	0.86 (0.59-1.23)	No difference
Neonatal seizures	32,386	1 vs 3	0.50 (0.31-0.80)	Infants in EFM group had an increased risk that was 50% higher than the risk of neonatal seizures in the IA group.

Abbreviations: CI, confidence interval; EFM, electronic fetal monitoring; IA, intermittent auscultation; RR, relative risk.
[a] The relative risk is slightly different than the difference between percentages of events in each group secondary to weighting of the studies.
Adapted from Alfirevic et al.[28]

Table 4. Meta-Analyses of Delayed Pushing

Variable	Brancato et al 2008 (N = 2827)		Tuuli et al 2012[a] (N = 3115)		Difference
	Delayed pushing group vs immediate pushing group n/100 live births	RR (95% CI)	Delayed pushing group vs immediate pushing group n/100 live births	RR (95% CI)	
Spontaneous vaginal birth	59 vs 54	1.08 (1.01-1.15)	59 vs 54	1.07 (0.98-1.16)	10% more vaginal births with delayed pushing
Active pushing time	12 minute difference	−0.19[b] (−0.27 to −0.12)	60 min vs 80 min	−22.43[b] (−34.44 to −10.44)	Small to moderate decrease in active pushing time in delayed group
Cesarean	4.2 vs 5.3	0.8 (0.57-1.12)	4.9 vs 5.8	0.85 (0.63-1.14)	No difference

Abbreviations: CI, confidence interval; RR, relative risk.
[a] Analysis includes only studies that were rated high quality.
[b] Mean difference in hours.
Adapted from: Brancato et al[35] and Tuuli et al.[36]

it found no difference in the rate of umbilical artery cord pH values lower than 7.0 between the groups and no difference in other clinical newborn outcomes such as Apgar scores or NICU admission.[37]

No studies have evaluated long-term effects of delayed pushing such as pelvic floor integrity, urinary incontinence, or fecal incontinence. In addition, although there are no nationally recommended contraindications to delayed pushing, it is not recommended when chorioamnionitis or recurrent fetal heart rate decelerations are present.

Studies of spontaneous bearing-down efforts in women who do not have epidural analgesia have found that women exhibit a pattern of intermittent open-glottis efforts that begin after the contraction starts. When spontaneous bearing down efforts begin, the woman usually pushes 2 or 3 times during each contraction. Some contractions may pass without pushing, and the pushing efforts become more frequent and longer in duration while the second stage progresses. Women may spontaneously bear down without a contraction while the fetus is crowning.[38]

In contrast, use of the Valsalva maneuver, during which the woman holds her breath (closed glottis) while bearing down, has been standard practice for many years. Studies of repeated Valsalva maneuvers have documented adverse physiologic effects such as decreased cardiac output, increased incidence of fetal heart decelerations, and lower umbilical-cord blood pH values.[39] When compared to spontaneous bearing-down efforts, Valsalva pushing is also associated with more maternal fatigue and damage to the maternal pelvic floor.[38,40]

A meta-analysis of 4 RCTs found no difference in neonatal indices or rates of operative birth when Valsalva pushing is compared to open-glottis pushing. The authors concluded that closed-glottis pushing is associated with a shorter second stage[41] (MD, 18.59 min; 95% CI, 0.46-36.73 min). However the wide confidence interval that crossed one suggests that this finding is not significant. In contrast, Valsalva pushing adversely impacted maternal urodynamic parameters such as decreased bladder capacity and urodynamic stress incontinence at 3 months postpartum in one well-designed RCT (16% [11/67] in Valsalva group vs 12% [7/61] in noncoached group).[40]

Practical Application

The Valsalva maneuver should be excluded from second-stage care practices. In women laboring without epidural analgesia, wait for and support the spontaneous bearing-down efforts. For the woman with epidural analgesia who does not have a contraindication to delayed pushing, place her in a side-lying position with liberal use of pillows for comfort. Placing her so that the fetal back is up may encourage the rotation and descent of the fetal vertex. The period of time that delayed pushing should last is undetermined, but most studies used 1 to 2 hours or until the woman has a rectal urge. Once pushing, discourage prolonged breath holding and Valsalva maneuvers. Individual practices that adopt a policy of routine delayed pushing for women who have epidural analgesia should also develop a list of contraindications to this practice.

PEARL: THERE IS NO EVIDENCE TO SUPPORT ROUTINE EPISIOTOMY OR AGGRESSIVE PERINEAL MASSAGE AT BIRTH

Routine episiotomy became the norm in the United States in the 1920s and has remained a routine practice until it was revisited in the 1990s. It was initially believed that an episiotomy had multiple benefits, including reduction in the incidence of third- and fourth-degree perineal lacerations; provision of a cleaner incision for repair, which would enhance wound healing; decrease in postpartum pain; and reduction in the risk of fecal or urinary incontinence via shortening the duration of the second stage.

In 1989, Green et al published the results of an observational study of perineal outcomes in women who had an episiotomy versus those who did not have an episiotomy.[42] In this cohort of 3065 women who had spontaneous vaginal births, anal sphincter injury occurred in 2.2% of those who did not have an episiotomy and 28.4% of those who did have an episiotomy ($P < .00001$). Logistic regression confirmed that epi-

siotomy is an independent risk for anal sphincter lacerations (odds ratio [OR], 8.9; 95% CI, 6.1-13.0).[42]

Many RCTs ensued, followed by a systematic review[43] and a Cochrane meta-analysis of routine versus selective episiotomy.[44] The results of this body of work are robust and consistent in showing that routine episiotomy has adverse effects without concomitant benefits (Table 5). Routine episiotomy is not recommended by the American College of Obstetricians and Gynecologists (ACOG) or ACNM, and the incidence has been steadily declining in recent years.[45,46]

Aggressive perineal massage results in trauma to the perineal tissue and does not prevent or decrease the incidence of perineal lacerations.[47] Practices that help reduce the incidence of perineal lacerations include antenatal perineal massage, the application of warm compresses just prior to birth, giving birth in the lateral position, and controlling extension of the head slowly between contractions.[47]

Practical Application

Teach interested women antenatal perineal massage to prevent lacerations. There is no evidence to support routine episiotomy or aggressive perineal massage during the second stage. Wait for and support spontaneous bearing-down efforts; discourage Valsalva maneuvers; apply warm heat and/or oil for comfort; and maintain a quiet, low-light environment. Perform episiotomies only when indicated for fetal or maternal conditions.

PEARL: DELAYED CORD CLAMPING IMPROVES NEONATAL OUTCOMES

Delayed cord clamping (DCC) has been variously defined in the literature. Most commonly practiced, the cord is clamped 60 seconds or more and up to 5 minutes after birth or when the cord stops pulsating. In contrast, early cord clamping (ECC) occurs when the cord is clamped at less than 60 seconds after the birth, which in practice usually occurs within the first 15 seconds.[48]

DCC allows for a placental transfusion of up to 30% of the total fetal–placental blood volume. This transfusion includes many types of pluripotent stem cells that may have significant long-term value for the child. More directly, this transfusion supplies approximately 60% more red cells and about 81 mL (range 50 to 163 mL) of whole blood.[49] The placental transfusion that occurs with DCC supplies approximately 30 to 35 mg of iron, which is sufficient to sustain the newborn for 3 to 4 months longer than if the cord was clamped immediately after birth.[50] When DCC occurs at 2 minutes after the birth or later, benefits include a 47% reduction in the risk of iron-deficiency anemia (RR, 0.53; 95% CI, 0.40-0.70) and a 33% reduction in the risk of having deficient iron stores at 2 to 3 months of age (RR, 0.67; 95% CI, 0.47-0.96).[48] Older physiologic studies of human newborns substantiated animal studies that showed the newborn responds with a profound bradycardia if ECC occurs before the first breath is taken.[51] Similar well-conducted observational studies in humans found that DCC is associated with improved cardiopulmonary adaptation after birth, better cutaneous perfusion and

Table 5. Meta-analysis of Episiotomy Versus No Episiotomy

Maternal, Neonatal, and Labor Outcomes	N	Restricted vs Routine Episiotomy, n/100 women	Effect RR (95% CI)	Degree of Difference
Severe perineal trauma	4404	2.8 vs 4.2	0.67 (0.49-0.91)	Approximately 30% more women in routine group had severe perineal trauma.
Healing complications	1119	20.5 vs 29.7	0.69 (0.56-0.85)	Approximately 30% more women in routine group had healing complications.
Anterior perineal trauma	4896	19.5 vs 11.2	1.84 (1.61-2.10)	Approximately 60% more women in restricted group had anterior perineal trauma.

Abbreviations: CI, confidence interval; RR, relative risk.
Adapted from: Carroli & Mignini.[44]

higher skin temperature, increased renal blood flow and more urine output, and increased blood flow to the brain and gut.[50]

The possible adverse effects of DCC are hyperbilirubinemia and polycythemia secondary to overperfusion. Protection against these 2 newborn disorders has been the primary reason that ECC has been recommended in obstetric texts. A systematic review of DCC versus ECC did not find that DCC is associated with hyperbilirubinemia (RR, 1.16; 95% CI, 0.85-1.58).[48] Although there does appear to be an increase in asymptomatic polycythemia (RR, 3.82; 95% CI, 1.11-13.21) that was no longer statistically significant when only high-quality studies were included in the analysis (RR, 3.91; 95% CI, 1.00-15.36), none of the newborns with asymptomatic polycythemia required treatment.[48]

The amount of placental transfusion is affected by the duration of DCC, height that the newborn is held, milking the cord, and possibly uterotonic medications. Approximately 80 mL is transferred after 60 seconds and reaches approximately 100 mL after 3 minutes.[49] Lowering the newborn at least 10 cm below the vaginal introitus speeds the time needed for placental transfusion to complete. Lowering the newborn 40 cm or more led to complete transfusion in the one study that specifically evaluated the height of the newborn after birth.[49]

The effect of uterotonic medications depends on the medication used and the route of administration. Uterine contractions definitely facilitate placental transfusion, but the effect of oxytocin (Pitocin) given after birth is likely minimal because it takes 3 to 5 minutes to generate uterine contractions after the drug is administered. In addition, intravenous fluids may dilute plasma levels of endogenous oxytocin and slow contraction activity.

Milking or stripping the blood in the cord from the placenta toward the newborn has been proposed as an alternative to DCC. Although milking the cord significantly increases iron stores and does not appear to have adverse effects in term or preterm newborns, study protocols have varied and it is not clear how many times one should milk the cord or how long the cord should be to transfuse an adequate supply of blood to the fetus.[51,52] Replacing DCC with cord milking appears to be a reasonable option if it is necessary to move the newborn quickly.

Practical Application

DCC should be the standard of care. DCC improves both the short-term and long-term hematologic status for the newborn and does not have clinically significant adverse effects. The optimal duration of DCC appears to be up to 3 minutes, unless the cord stops pulsing sooner. Healthy newborns should be placed on the mother's chest to encourage skin-to-skin contact while waiting to cut the cord. If there is a need to move the newborn for resuscitation, one can hold the newborn below the introitus and/or milk the cord to increase the amount of transfusion in a short time.

PEARL: IMMEDIATE SKIN-TO-SKIN CONTACT AFTER BIRTH PROMOTES THERMOREGULATION, IMPROVES INITIAL BREASTFEEDING, AND FACILITATES EARLY MATERNAL–INFANT BONDING

Historically, newborns were placed skin-to-skin on their mother's chest to protect against heat loss and facilitate breastfeeding. This practice, also referred to as *kangaroo care*, is recommended by the World Health Organization for all newborns regardless of birth weight or clinical condition.[53] Common practice in the United States has been to hand the newborn to a second health care provider immediately after the umbilical cord has been cut so that the newborn can be dried, wrapped in a warm blanket, and examined.

Several RCTs and one meta-analysis[54] have shown that placing the newborn skin-to-skin on the mother's chest, with the newborn's head covered with a dry cap and the back covered with a blanket, improves several newborn physiologic indices (eg, cardiorespiratory stability, glucose levels), reduces newborn crying, and increases the rate of breastfeeding initiation and breastfeeding continuation at one to 4 months after birth.[54]

Practical Application

Placing healthy newborns skin-to-skin on the mother's abdomen immediately after birth should be the standard of care. This practice has substantial positive benefits and no adverse

effects. Once can assess the newborn's vital signs, assign Apgar scores, and perform routine procedures on the mother's chest. Encourage breastfeeding with newborn self-attachment during the first hour. Defer routine newborn evaluations until after successful breastfeeding initiation.

PEARL: OUT-OF-HOSPITAL BIRTH IS SAFE FOR LOW-RISK WOMEN

Women in the United States have the choice of giving birth in a hospital, a birth center, or at home. Currently, 1 in 85 births in the United States takes place outside of a hospital.[55] Maternal and neonatal outcomes have been reported for both birth centers[17,56] and home births in the United States.[57-59]

Stapleton et al analyzed the outcomes of 15,574 women who planned a birth center birth between 2007 and 2010, of which 14,881 (95.6%) were admitted to the birth center in labor.[17] The intrapartum transfer rate was 12.4%; the vaginal birth rate was 92.8%; the cesarean rate was 6.1%; and 1.2% of the women had an assisted vaginal birth. There were no maternal deaths; and the neonatal mortality rate was 0.4 per 1000.[17]

Studies have found home birth to be associated with high vaginal birth rates, excellent maternal satisfaction, and lower rates of interventions. Maternal mortality is essentially zero, and neonatal mortality ranges from 0.2 per 1000 to 1.8 per 1000 live births.[57-59] Reported neonatal mortality rates are consistent with the neonatal mortality rate in the United States for low-risk women who give birth vaginally, identified in birth certificate data, which is 0.62 per 1000 live births.[60]

The most recent large analysis of home birth outcomes in the United States included 16,924 women. The vaginal birth rate in this cohort was 93.6%, and the cesarean rate was 5.2%.[59] The intrapartum transfer rate was 10.9%. The most common reason for intrapartum transfer was failure to progress. In this cohort, there was one maternal death, which occurred on the third postpartum day. Although the death was attributed to pregnancy by the medical examiner, there were no obvious perinatal complications. Neonatal mortality was calculated for intrapartum deaths (1.3/1000; n = 22), early neonatal deaths (0.41/1000; n = 7), and late neonatal deaths (0.35/1000; n = 6).[59]

The intrapartum fetal death rate in this cohort was slightly higher than the one found in the birth center cohort by Stapleton et al (1.3/1000 vs 047/1000, respectively).[17] The primary difference appears to be the inclusion of a small number of women who had higher-risk pregnancies (eg, breech presentation, multiple gestation) in the home birth cohort. When the outcomes of these women were removed from the sample, the intrapartum death rate was 0.85 per 1000 (95% CI, 0.39-1.31), which is similar to the death rates found in other studies of home birth and birth center births.

Practical Application

Women should be counseled regarding the risks and benefits of giving birth in the hospital, birth center, and home settings. Women have the right to self-determination and choice in the selection of birth setting. Access to safe transfer for out-of-hospital birth is imperative.

PEARL: HAVE PATIENCE WITH LABOR PROGRESS

Since the 1950s, the Friedman curve has been used to define the normal length and duration of labor stages.[61] Friedman plotted cervical dilation against time in a cohort of 500 nulliparous women and calculated the mean times for cervical dilation over the course of labor. Until very recently, the resultant sigmoid curve that Friedman divided into latent, active, and transition phases has been used by all maternity care providers in the United States to identify women who have labor dystocia.

Studies conducted in the last several years have indicated that the Friedman curve is not an accurate reflection of the true course of labor for several reasons.[8,62-67] First, laboring women today are more likely to be obese, ethnically diverse, and older.[67] Second, labor practices have changed. In Friedman's cohort, 13.8% of women had oxytocin for induction or augmentation, the majority had morphine or twilight sleep (a mixture of morphine and scopolamine) for labor analgesia, and the cesarean rate was 1.8%. Third, Friedman averaged the times for each phase to generate a mean and standard deviations, which does not allow the actual variation in time interval between each cervical dilatation to be revealed.

Current analyses of labor progress have found that labor is hyperbolic rather than sigmoid; it takes longer to reach the active phase; and in the active phase there is significant variability between women in the time that it takes to progress from 1 cm of cervical dilatation to the next.[8,62-67] Use of the Friedman curve today results in higher rates of dystocia diagnoses and cesareans than is necessary.[68]

Table 6 summarizes the contemporary studies that have evaluated labor progress. Nulliparous women may not be in the active phase until 5- or 6-cm dilatation.[64] In addition, the time interval between each cervical dilatation shortens as labor advances. Thus, it may take a nulliparous woman up to 3 hours to progress from 5- to 6-cm dilatation, but it should not take longer than 1.5 hours to progress from 8- to 9-cm dilatation based on the 95% values determined by Zhang et al.[64,69] Finally, clinical factors such as obesity, racial or ethnic differences, and induction versus spontaneous labor have an effect on labor progress that must be taken into account when individualizing care.[70,71]

Practical Application: Six Is the New 4

The Friedman curve should be abandoned as a tool for labor progress; and women should be given significantly more time during latent and early active labor before a diagnosis of dystocia is made. In general, until new partograms have been validated, active labor may not begin until 5 cm of dilatation in multiparous women and 6 cm of cervical dilatation in nulliparous women.

PEARL: VAGINAL BIRTH AFTER CESAREAN IS SAFE FOR MOST WOMEN

The proportion of women who had a vaginal birth after a previous cesarean (VBAC) dropped from 29% in 1996 to 9% in 2014.[72,73] Although the reasons for this change are multifactorial and reviewed elsewhere,[74] the primary problem has been that fewer women undergo trial of labor after a

Table 6. Normal Labor Progress in Nulliparous Women at Term

Author, Date	N	Duration of Active Phase, mean (2 SD), h	Key Findings	Clinical Implications
Friedman[61] 1955	500	2.5 (12)	Frequent use of opioids, caudal anesthesia, oxytocin, and forceps	The Friedman curve should not be used to monitor labor progress.
Peisner & Rosen[66] 1986	1060	NR	Cohort of primiparous and multiparous women at term who had no obstetric risks at the onset of labor. < 50% in active labor by 4 cm. 74% in active labor by 5-cm overall. 89% in active labor by 5 cm, when women who had dystocia were eliminated from the analysis.	Do not make the diagnosis of active labor until at least 5-cm cervical dilatation.
Albers et al[65] 1996	1513	7.7 (19.4)	Length of active phase of labor was longer in Hispanic and American Indian women when compared to non-Hispanic white women.	Racial differences in labor length need to be explored in more detail.
Albers et al[65] 1996 1996	1513	7.7 (19.4)	Length of active phase of labor was longer in Hispanic and American Indian women when compared to non-Hispanic white women.	Racial differences in labor length need to be explored in more detail. Individual institutions can determine normal time frames for their setting.
Zhang et al[8] 2002	1329	5.5 (13.7)[b]	Marked interindividual variability in cm at which active phase starts (3-5 cm). Time interval of no change > 2 hours not uncommon before 7 cm.	Allow at least 2 h between each cm of cervical dilation before 7 cm.
Zhang et al[64] 2010	26,838	4.4 (16.7)	Active phase not entered until 5-6 cm. Speed of cervical dilation progressively accelerates.	Do not make the diagnosis of active labor until at least 5-6 cm.
Neal et al[62] 2010	7009	6 (13.4)	Systematic review included studies of women with analgesia and oxytocin augmentation. Slowest normal rate of cervical dilation approximates 0.5-0.6 cm/h.	Allow at least 2 h between each increment of cervical dilation in late active phase of labor.
Harper et al[70] 2012	1647	NA	Analysis of labor duration in women whose labor was induced vs women in spontaneous labor. Time to progress from latent to active labor is significantly longer in women whose labor is induced vs women in spontaneous labor (median hours 5.5 vs 3.8, respectively; $P < .01$).	Allow more time for the onset of active labor in women whose labors are induced. The duration of the active phase should be the same in women who are induced vs those who are in spontaneous labor.

Continued

Table 6. Normal Labor Progress in Nulliparous Women at Term

Author, Date	N	Duration of Active Phase, mean (2 SD), h	Key Findings	Clinical Implications
Norman et al[71] 2012	5204	NA	Time to advance between each cm increment after 6 cm was similar for both groups. Duration of labor is longer in women whose BMI is > 30 (4.7 h vs 4.1 h; $P > .01$).	Women whose BMI is > 30 may need longer to progress at each cm of cervical dilatation.

Abbreviations: BMI, body mass index; NA, not applicable; NR, not reported; SD, standard deviation.
[a]First stage of labor as defined by patient history.
[b]90th percentile.
Adapted from King TL.[69]

previous cesarean (TOLAC).[75] Because the US cesarean rate is now 32.8%,[73] all strategies that could lower the overall rate need to be implemented. Increasing the number of women who undergo TOLAC is one of the most important.[68]

TOLAC carries an overall risk of uterine rupture of less than 1%.[76] TOLAC is recognized to be the safest option for women who have had one prior cesarean and no concurrent conditions that increase the risk for uterine rupture (eg, a pregnancy condition that precludes vaginal birth such as previous classical incision or uterine surgery). The overall success rate of TOLAC is 74% but varies between 54% and 94%, depending on clinical factors in the woman's history, current pregnancy, and labor status.[76]

Since 2010, the National Institutes of Health and ACOG have recommended that women who are candidates for TOLAC be offered this option.[76,77] It was hoped that more hospitals would offer TOLAC after these guidelines were released, but thus far they do not appear to have made a significant impact.[78] Strategies that increase the TOLAC rate include interventions at all levels from health policy to individual patient counseling. Tort reform that relieves physicians from the worry about medical–legal risks will have to play a role.[76]

Several studies have found that decision aids and prenatal counseling for women who have had a previous cesarean assist women in making an informed decision that is reflective of their core values.[79–81] Prenatal counseling in a culturally sensitive manner that accommodates patient values and encourages shared decision making is essential and has promise as a strategy that will aid women while they learn about the benefits and risks of TOLAC versus elective repeat cesarean.[80]

Practical Application

Both TOLAC and VBAC rates are higher in institutions where midwives care for laboring women.[82] Counsel all women prenatally about the risks and benefits of TOLAC. Encourage TOLAC as the safest option for women who are appropriate candidates. Follow the Pearls of Midwifery to optimize each woman's chance of a normal vaginal birth, including women attempting TOLAC. Institute modifications to the Pearls of Midwifery for women attempting TOLAC as needed, including modifications of food and fluid intake and fetal monitoring guidelines.

CONCLUSION

The practices reviewed in this article are as old as midwifery, and many of them predate the advent of hospital birth. As this review has demonstrated, modern research techniques have affirmed the value of midwifery strategies in optimizing normal vaginal birth. Epidemiologic and observational studies have long documented that midwifery care is associated with improved perinatal outcomes,[83–86] yet the concern about selection bias has haunted this work. Does midwifery care improve outcomes, or are women who chose midwives inherently more likely to have better outcomes? Analysis of the research that supports the Pearls of Midwifery care practices, which are midwifery practices, sheds some light on this question. Although each of the Pearls of Midwifery has a modest independent contribution to improving childbirth outcomes, the combined effects contribute to and may be largely responsible for exemplary midwifery outcomes.

The Pearls of Midwifery clearly improve maternal and neonatal outcomes, facilitate normal physiologic birth, and prevent cesareans. They should resume their place as a standard of care for women in labor. Midwives are the health care providers most responsible for ensuring that these practices again become the norm in maternity care for women and their newborns. Rooted in evidence, the Pearls of Midwifery can and should be generalized to every practice setting, population, and provider. By following the recommendations for practical applications outlined for each of the Pearls of Midwifery, all maternity care providers can improve childbirth outcomes for women and their families.

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CONFLICT OF INTEREST

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