Evidence-based labor and delivery management

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Our objective was to provide evidence-based guidance for managment decisions during labor and delivery. We performed MEDLINE, PubMed, and COCHRANE searches with the terms *labor*, *delivery*, *pregnancy*, *randomized trials*, plus each management aspect of labor and delivery (eg, *early admission*). Each management step of labor and delivery was reviewed separately. Evidence-based good quality data favor hospital births, delayed admission, support by doula, training birth assistants in developing countries, and upright position in the second stage. Home-like births, enema, shaving, routine vaginal irrigation, early amniotomy, "hands-on" method, fundal pressure, and episiotomy can be associated with complications without sufficient benefits and should probably be avoided. We conclude that labor and delivery interventions supported by good quality data as just described should be routinely performed. All aspects with lower data quality should be researched with adequately powered and designed trials.

Key words: delivery, evidence-based, labor

The word *obstetrics* is derived from the Latin "ob" and "stare," which mean "to stand by." Standing by, or in front of, the laboring woman is intended to be the assistance to the pregnant woman during labor and delivery. Management of labor and delivery is at the heart of the obstetric profession, is the most important aspect of the support to the pregnancy, and often is the aspect that made us go into 1 of the most rewarding and satisfying professions one could ever choose.

There are more than 130 million annual births in the world, of which more than 4 million occur in the United States. Management of labor and delivery is certainly 1 of the most common medical issues to face health personnel. Prevention of complications has priority over management of complications. Obstetric care has been blessed in the last few years by evidence-based research.[1,2] The aim of this article is to review the evidence for the management of labor and delivery, and offer recommendations that are based (where available) on randomized trials. Proper choice of interventions, proven to be associated with the highest safety and effectiveness, with avoidance of less safe and effective ones, will minimize the morbidity, and possibly the mortality, that can be associated with labor and delivery for both the mother and her fetus.

★ EDITORS' CHOICE ★

We aspire to stimulate better clinical management, promote education, and foster research trials in areas of uncertainty, focusing on prevention of possible complications rather than treatment. We intended to provide obstetricians with evidence-based guidance for management decisions made in labor and delivery suites throughout the world. We did not seek to review other aspects of labor and delivery, such as technique of cesarean delivery, which has been previously reported.[3] We assume that during labor and delivery, obstetricians would adhere to the best medical care to decrease infection, minimize tissue trauma, and avoid ischemia and inflammation. We present one aspect of the labor and delivery at a time, to show the effect of each management step individually.

Materials and methods

Searching

To achieve our aim, we performed multiple MEDLINE, PubMed, EMBASE, and COCHRANE searches with the terms *labor*, *delivery*, *pregnancy*, *randomized trials*, plus each management aspect (eg, *early admission*, *early rupture of membranes*). The search was between 1966 and 2008, and was not restricted by language.

Selection

The review was limited to the healthy woman, carrying a singleton healthy gestation in vertex presentation, entering spontaneous labor at term (37-41 6/7 weeks). We organized the management aspects related to her care into stages: early labor, first stage, and second stage (Table 1). We excluded specific aspects, such as induction, intrapartum fetal monitoring (and related interventions) other than admission tests, group B streptococcus prophylaxis, meconium, anesthesia, operative delivery, multiple gestations, early neonatal care, and management of the third stage of labor because each of these topics would require an extensive review beyond the previously described scope of this article. We also excluded management aspects related to cesarean delivery, because the technical aspects have been covered before.[3] Each retrieved article or Cochrane review was carefully evaluated, and any pertinent references from the articles were obtained and reviewed as well.

Data abstraction

Data abstraction was performed in duplicate.

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For Editors' Commentary, see Table of Contents

See related editorial, page 441

TABLE 1
Evidenced-based recommendations for labor and delivery

Intervention	Recommendation[a]	Quality[a]	Comment[b]
First stage			
Self-diagnosis of active labor	I	Poor	Fewer visits to L&D suite
Radiographic pelvimetry	D	Good	Higher CD
Home births	I	Poor	No trials
Home-like births	D	Good	Trend for higher perinatal mortality
Midwife vs conventional care	C	Good	1/100 less CD, 1/1000 more perinatal mortality
Teamwork training	I	Fair	One cluster RCT: no effect
Delayed admission	B	Fair	Trend for less CD
Fetal admissions tests			
Fetal heart rate tracing	C	Good	Similar neonatal
Amniotic fluid volume	D	Good	outcomes
Estimate of fetal weight	I	Poor	No effect on outcome
Enemas	D	Fair	Similar neonatal outcomes
Perineal shaving	D	Fair	Old trials
Chlorhexidine vaginal irrigation	D	Good	No benefit
Ingestion of liquids/ nutrition	C	Poor	No trials of solid foods
Intravenous fluids	C	Fair	250 or 125 mL/h studied
Ambulation (walking)	C	Good	Let the woman choose
Water immersion			
First stage	C	Good	Decrease in analgesia
Second stage	I	Poor	Trial too small
Massage	I	Fair	Only 1 small trial
Aromatherapy	I	Fair	Insufficiently powered trials
Support person (doula)	A	Good	One of the most effective interventions
Routine early AROM	D	Good	Trend for higher CD
Partogram	C	Fair	Most trials compared different "action lines" of Partogram
Cervical examinations	I	Poor	No specific trials
Oxytocin augmentation	I	Poor	No specific trials
Active management of labor	B	Good	Individual intervention should be tested, analyzed, and used clinically separately
Training of birth assistants	A	Good	In developing countries
IUPC	I	Poor	No trials
Meperidine for abnormal progression of labor	D	Fair	Worse perinatal outcome
Second stage			
Prophylactic oxygen	D	Fair	Lower cord pH
Prophylactic tocolysis	D	Fair	Labor prolongation
Upright position	A	Good	Includes sitting, semirecumbent, kneeling, and squatting
Delayed pushing	B	Good	Similar outcomes
Pushing using a "closed" glottis	C	Good	Similar neonatal outcomes
Perineal massage from 34 wks on	A	Good	Higher chance of intact perineum for nulliparous women
Perineal massage during second stage	B	Good	Lower chance of third-degree lacerations

Continued on page 447.

TABLE 1
Evidenced-based recommendations for labor and delivery

Continued from page 446.

Intervention	Recommendation[a]	Quality[a]	Comment[b]
Warm packs	B	Good	Lower incidence of third- and fourth-degree lacerations
Operative delivery for abnormal progression	I	Poor	No specific trials
"Hands on" method	D	Good	Higher incidence of third-degree lacerations and episiotomies
Fundal pressure	D	Good	Women less satisfied
Episiotomy	D	Good	Episiotomy should be avoided if at all possible

AROM, artificial rupture of membranes; *CD*, cesarean delivery; *IUPC*, intrauterine pressure catheter; *L&D*, labor and delivery; *RCTs*, randomized controlled trials.

[a] Level of evidence was based on the US Preventive Services Task Force recommendations (Table 2).[4]

[b] See text for more details.

Berghalla. Evidence-based labor and delivery management. Am J Obstet Gynecol 2008.

Study characteristics

All randomized trials covering management aspects of labor and delivery were included in the review (Table 1). In the absence of trials adequately covering the aspect, analytic data were reviewed. In the absence of experimental or analytic data, observational data were evaluated. Each step of labor and delivery was reviewed separately.

Quantitative data synthesis

The principal measure of effect was relative risk. Significance was inferred if confidence intervals did not cross unity. Outcomes appropriate for the intervention studied were reviewed, with emphasis on maternal and perinatal morbidity and mortality. After each technical step is reviewed, evidence levels and recommendation levels are reported according to the new method outlined by the US Preventive Services Task Force[4] (Table 2).

Our evidence-based review integrates individual clinical expertise with the best available external clinical evidence from systematic research.[5] Because this review evaluates several interventions, QUOROM reporting was followed as appropriate, but could not be totally applied. Because this was a review of the

TABLE 2
Standard recommendation language and quality of evidence according to the method outlined by the US Preventive Services Task Force[4]

Recommendation:
A: The USPSTF strongly recommends that clinicians provide [the service] to eligible patients. The USPSTF found good evidence that [the service] improves important health outcomes and concludes that benefits substantially outweigh harms.
B: The USPSTF recommends that clinicians provide [this service] to eligible patients. The USPSTF found at least fair evidence that [the service] improves important health outcomes and concludes that benefits outweigh harms.
C: The USPSTF makes no recommendation for or against routine provision of [the service]. The USPSTF found at least fair evidence that [the service] can improve health outcomes but concludes that the balance of benefits and harms is too close to justify a general recommendation.
D: The USPSTF recommends against routinely providing [the service] to asymptomatic patients. The USPSTF found at least fair evidence that [the service] is ineffective or that harms outweigh benefits.
I: The USPSTF concludes that the evidence is insufficient to recommend for or against routinely providing [the service]. Evidence that the [service] is effective is lacking, of poor quality, or conflicting and the balance of benefits and harms cannot be determined.
Quality of evidence:
Good: Evidence includes consistent results from well-designed, well-conducted studies in representative populations that directly assess effects on health outcomes.
Fair: Evidence is sufficient to determine effects on health outcomes, but the strength of the evidence is limited by the number, quality, or consistency of the individual studies, generalizability to routine practice, or indirect nature of the evidence on health outcomes.
Poor: Evidence is insufficient to assess the effects on health outcomes because of limited number or power of studies, important flaws in their design or conduct, gaps in the chain of evidence, or lack of information on important health outcomes.

USPSTF, US Preventive Services Task Force.

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literature, this study is exempt from institutional review board approval.

Results

Results were by each management aspect of labor and delivery.

Before labor

Self-diagnosis of active labor involves education during pregnancy (eg, antenatal classes) on detection of contractions and timing of presentation for assessment for false or active labor. Education for self-diagnosis of active labor is compared with no such education in 1 randomized trial involving 245 women.[6] Self-diagnosis of active labor was associated with a decrease in the number of visits to the labor suite (0.29 vs 0.58 visits) compared with controls. It is not possible, because of how the data are reported, to analyze separately women whose fetuses have a cephalic or noncephalic presentation, or have a previous cesarean delivery (CD) or not. There is not much information on the effects of antenatal classes (recommendation: I; quality: poor; Table 2).

Radiographic pelvimetry was evaluated in 4 randomized trials including 895 women to assess the "passage" through the maternal pelvis (in comparison with the fetus, or "passenger"). Compared with no such procedure, radiographic pelvimetry is associated with an increase in CD (56% vs 39%). Magnetic resonance imaging (MRI) pelvimetry has not been studied in a randomized trial[7] (recommendation: D; quality: good; Table 2).

First stage

Home birth has never been studied in an adequately powered randomized trial. The only trial published on this subject randomly assigned just 11 women, and was too small to draw any conclusions.[8] Possibly because of this lack of data, there are diverging opinions on the safest, most effective setting for labor even in western countries, with about 30% of Dutch births occurring at home, vs < 1% of US births. Women with risk factors for abnormal outcome should deliver in a hospital setting. The safety and effectiveness of home birth needs further research, and for now can only be examined through randomized trials by evaluating the evidence for "home-like births" (recommendation: I; quality: poor; Table 2).

Home-like birth has been assessed to see if outcomes for physiologic term labor could still be the same in a less "hospital-like" environment. Birth centers represent the attempt at these home-like births. Compared with hospital births, home-like births are associated with decreased need for intrapartum analgesia/anesthesia and increased rates of spontaneous vaginal birth, preference for the same setting the next time, satisfaction with intrapartum care, and breastfeeding initiation and continuation to 6-8 weeks in 6 trials, including 8677 women.[9] Allocation to a home-like setting decreased the likelihood of episiotomy. There was a strong trend toward a 87% higher perinatal mortality in the home-like setting. It is important to note that, of all low-risk women randomly assigned to home-like births, about 50% have to be transferred to the hospital because of risks or complications arising during labor[9] (recommendation: D; quality: good; Table 2).

Midwife-led labor and delivery is associated with similar incidences of CD (4.8% vs 5.8%) and neonatal mortality (0.36% vs 0.28%) compared with obstetrician-led labor and delivery in 6 trials, including more than 16,500 low-risk women carrying singleton gestations at term. These numbers equate to 1 less CD per 100 births and about 1 more neonatal death in 1000 births associated with midwife-led management. In these trials, more than 40% of women assigned to midwifery care were transferred to conventional obstetrician-led care[10-15] (recommendation: C; quality: good; Table 2).

Teamwork training based on crew resource management principles is associated with no effect on maternal and perinatal outcomes in a cluster randomized trial, including 28,536 women.[16] Given the possibilities of ineffective training, inadequate follow-up, Hawthorne effect, inadequate outcome measures, or lack of power in this single trial, there is insufficient evidence to assess the effectiveness of this intervention (recommendation: I; quality: fair; Table 2).

Delayed admission involves allowing admission to the labor and delivery suite only after certain criteria for active labor have been met. Active labor was defined as regular painful contractions and cervical dilatation > 3 cm. Compared with direct admission to hospital, delayed admission until active labor is associated with less time in the labor ward, less intrapartum oxytocics, and less analgesia in 1 randomized trial, involving 209 women.[17] Women in the labor assessment and delayed admission group report higher levels of control during labor. CD rates are similar, with a nonsignificant 30% decrease. A 30-40% decrease in CD has been reported in retrospective studies with delayed vs direct admission. Suggested criteria for admission based on these studies are a cervix of at least 3-4 cm dilatation and regular painful contractions. Pregnant women should be informed of these data during prenatal care (recommendation: B; quality: fair; Table 2).

Fetal admission tests assessed for efficacy have been fetal heart rate tracing and sonographic amniotic fluid volume. Compared with intermittent monitoring, fetal heart rate tracing for 20 minutes on admission is associated with similar neonatal morbidity and mortality, with increased incidences of epidural anesthesia, continuous fetal monitoring, and fetal blood sampling in 3 trials, involving 11,259 low-risk women[18,19] (recommendation: C; quality: good; Table 1).

Compared with no such assessment, *assessment of amniotic fluid volume* as a fetal admission test is associated with an increased risk of CD and similar neonatal outcomes in 1 trial, involving 883 women.[20] Neither a 2 × 1-cm pocket (abnormal in 8%) nor an amniotic fluid index (AFI) ≤ 5 cm (abnormal in 25%) on admission for labor identifies a pregnancy at risk for adverse outcome such as nonreassuring fetal heart rate (NRFHR) or CD for NRFHR in 1 trial, involving 499 women[21] (recommendation: D; quality: good; Table 1). Vibroacoustic stimulation and Doppler ultrasound have not been evaluated in trials as fetal

admission tests (recommendation: I; quality: poor; Table 2).

Estimate of fetal weight may be more accurate by clinical estimation than by ultrasound, based on 1 trial, including 758 women admitted for labor with singleton gestations at term.[22] Neither estimate was very accurate, as only 58% vs 32% of estimations were within 10% of actual birthweight, respectively. No effect of the knowledge of these estimates on any maternal or perinatal outcome was reported. There is no trial comparing fetal weight estimation to no such estimation. Therefore, there is insufficient evidence to assess the effect of fetal weight estimation on labor outcomes (recommendation: I; quality: poor; Table 2).

Enemas have been assessed as an intervention at admission for term labor. Compared with women receiving no enemas, enemas in the first stage of labor are associated with similar length of labor and most maternal and neonatal outcomes in 2 trials, involving 665 women.[23] There is a trend for lower infection rates, and significance for less need for postpartum systemic antibiotics. The newborn children have less lower respiratory tract infections and also less need for systemic antibiotics. These benefits are very modest, as the incidence of each of these complications in the no enema groups is $< 3\%$. This intervention (enema) generates discomfort in women and increases the costs of delivery, so that the small benefits do not supplant these limitations. The 2 trials were not blinded[23] (recommendation: D; quality: fair; Table 2).

Perineal shaving on admission for labor is associated with similar maternal febrile morbidity, wound infection, and neonatal infection compared with just selective clipping of hair in 3 randomized trials, involving 997 women.[24,25] The potential for complications (redness, multiple superficial scratches, burning and itching of the vulva, embarrassment, and discomfort afterwards when the hair grows back) suggests that shaving should not be part of routine clinical practice. Two of the trials are old (1922 and 1965), and all included the clipping of long hairs in their control groups to aid in operative procedures, which is itself usually unnecessary and can lead to complications (recommendation: D; quality: fair; Table 2).

Chlorhexidine vaginal irrigation in labor has been associated with similar rates of infection, including chorioamnionitis, endometritis, and neonatal sepsis compared with no irrigation in 3 trials, involving 3012 women.[26] The incidence of perinatal mortality is also similar. The effectiveness of vaginal chlorhexidine might depend on the concentration and volume of the solution used. Chlorhexidine solution is inexpensive and safe, and vaginal irrigation is easy to perform, but apparently not beneficial (recommendation: D; quality: good; Table 2).

Nutrition is usually very limited for the laboring woman. There are no trials evaluating the ingestion of solid foods in labor. A carbohydrate drink (mean intake 44 g in 350 mL) in early labor is associated with an increased risk of CD compared with placebo in women allowed to drink "at-will" in 1 trial, involving 202 women,[27] but a carbohydrate drink (25 g) in late (8-10 cm) labor is associated with similar rates of CD compared with placebo in 1 randomized trial by the same group, involving 201 women.[28] There are no other trials on nutrition in labor, and so current management is based mostly on expert opinion. Ice chips to moisten the mouth and sips of clear liquids are the only oral intake recommended by US authorities (the American Society of Anesthesiologist Task Force on Obstetrical Anesthesia).[29] Some experts also allow sport drinks, yogurt, or sherbet. In The Netherlands, women in labor are allowed to eat and drink. Maternal glucose may potentially increase neonatal lactic acidosis. The reason given for avoiding solid food is risk of aspiration, which is rare. Airway precautions are the most important methods to avoid aspiration (recommendation: I; quality: poor; Table 2).

Intravenous (IV) fluids have not been compared with no IV fluids in labor. The data on IV fluids type and infusion rate is insufficient for a strong recommendation. Compared with 125 mL/hour, a rate of 250 mL/hour is associated with significant decreases in length of the first stage (by 71 minutes), and in labor lasting $\geq$ 12 hours in 1 trial, involving 195 women.[30] Although the data in pregnancy is limited to this single trial, the benefits are substantiated by the fact that several trials in nonpregnant adults demonstrate that increased fluid intake improves exercise performance (recommendation: C; quality: fair; Table 2).

Ambulation (walking) during labor at 3-5 cm of dilatation is associated with similar length of the first stage of labor, use of oxytocin, rate of operative vaginal delivery, and neonatal outcomes compared with a policy of restrictive walking in the largest, best trial evaluating 1067 women.[31] Walking in other groups of laboring women evaluated in 4 older trials, either small (3 trials involving a total of 132 women)[32-34] or evaluating walking together with amniotomy in 630 women,[35] supports these results. On the basis of this evidence, women should be allowed to choose freely regarding the duration (if any) of walking during labor (recommendation: C; quality: good; Table 2).

Water immersion has been evaluated in 8 trials, involving 2939 women, mostly in the first stage of labor.[36] Compared with no water immersion, water immersion is associated with decreases in the use of analgesia and in reported maternal pain, and similar labor duration, incidence of perineal trauma, incidence of operative delivery, and neonatal outcome (such as Apgar score < 7 at 5 minutes, neonatal unit admissions, or neonatal infection rates). Blinding is not possible (recommendation: C; quality: good; Table 2).

One trial explores delivery (second stage) in water, but is too small ($n = 120$) to determine significant differences in outcomes for women or neonates.[37] The effects of immersion in water during the third stage are unclear, given the absence of trials (recommendation: I; quality: poor; Table 2).

Massage is associated with less subjective pain scores up to 7 cm in labor compared with no massage in a small trial, involving 60 women.[38] This is insufficient evidence to make a recommendation, given also the impossibility of

blinding (recommendation I; quality: fair; Table 2).

Aromatherapy has only been evaluated in a small trial, including 22 women,[39] and a pilot trial, including 533 women,[40] with no significant differences in the outcomes studied, including pain and mode of delivery (recommendation: I; quality: poor; Table 2).

A **support person (doula)** present during labor is associated with decreased use of analgesia, decreased incidence of operative birth, increased incidence of spontaneous vaginal delivery, and increased maternal satisfaction in 15 trials, including 12,791 women.[41] The most effective form of support starts early in labor, is continuous, and is not provided by a member of the hospital staff. The mother should be encouraged to select her doula during pregnancy; they establish a relationship (which is likely to involve the woman's partner, if any) and discuss the mother's and partner's preferences and concerns before labor. The doula brings her experience and training (often to the level of certification) to the labor support role during childbirth, and the mother and doula frequently have telephone and/or face-to-face contact in the early postpartum period. Other models of support, for which there are little or no data, include support by a female family member and support by the husband/partner.[41] If a doula cannot be present or is not desired, women should still be encouraged to invite a family member or friend to commit to being present at the birth and assuming this role (recommendation: A; quality: good; Table 2).

Routine **early artificial rupture of membranes** (AROM, or amniotomy) is associated with shorter duration of labor ($\leq$ 60 min, mostly because of shorter first stage), decrease in use of oxytocin, similar incidence of NRFHR monitoring, a trend for a 26% increase in CD, and similar neonatal outcomes compared with selective (later or no) AROM in 9 specific trials, including more than 4000 women with singleton, vertex, term gestations.[42] Given this evidence of both benefits and risks of routine early AROM, this intervention should probably be reserved just for abnormal labors, that is, labors with failure to progress (recommendation: D; quality: good; Table 2).

The **Partogram** is associated with similar incidence of interventions and CD compared with progress of labor charted in written notes in a trial of 1932 primiparous term women.[43] In this study neither group had a mandatory management of labor protocol. Another trial compared outcomes "before" and "after" introduction of the Partogram for labor management.[44] The 3 other trials evaluating the Partogram compared different action lines (ie, different Partograms), and so did not assess its effect compared with a "sham" arm.[45-47] Therefore, there is insufficient evidence to recommend the routine use of the Partogram (recommendation: C; quality: fair; Table 2).

The need and/or frequency of cervical examinations in labor has never been evaluated in a trial. Most studies, including trials of active management, usually perform cervical examinations every 2 hours in labor. The risk of chorioamnionitis though increases with the increasing number of examinations.[48] There are no trials to assess the effect of stripping of membranes at the time of cervical examinations during labor. Transvaginal ultrasound assessment of the cervix has not been compared in a trial with traditional digital manual cervical assessment in term laboring women. Therefore, there is insufficient evidence to assess the need and/or best frequency of cervical examinations during labor (recommendation: I; quality: poor; Table 2).

Oxytocin augmentation has not been studied as a primary isolated intervention for human labor. In fact, dozens of different doses have been used in different studies, without direct comparison in a randomized trial. Therefore, there is insufficient evidence to assess the effect of any specific regimen (eg, starting dose, rate of increase, maximum dose) for oxytocin use in labor. A reasonable approach based on oxytocin's pharmacology includes the use of a starting dose of 2 mU/min, increasing by 2 mU/min every 45 minutes until adequate contractions or a maximum of 20-30 mU/min.[49] The necessity of awaiting a steady state (5 half-lives) before deciding that dosing is inadequate is unproven in prospective trials (recommendation: I; quality: poor; Table 2).

Active management of labor was devised originally to prevent prolonged labor, not to affect the rate of CD.[50] Active management has been usually defined as antenatal classes (including self-diagnosis of active labor), doula support, routine early AROM, use of Partogram, and oxytocin augmentation. Unfortunately, not all studies or trials define active management similarly. We have analyzed previously the individual interventions of active management of labor for which specific trials are available. As these interventions can have differing outcomes (eg, early AROM: trend for increase in CD; doula support: significant decrease in CD), trials of active management are difficult to interpret.

Nonetheless, overall, 4 trials of active management of labor involving 3676 women have shown: (1) a decreased duration of labor of about 50-100 minutes, mostly in the first stage, probably secondary to early AROM; (2) a reduction in prolonged (lasting $>$ 12 hours) labor; (3) less maternal fever; (4) no significant effect on incidence of CD (possibly a balance of differing effects); (5) similar perinatal outcomes; and (6) similar maternal satisfaction.[51-54] Interestingly, dissimilar results were observed between the United States and Europe, which may have resulted from bias because the investigators could not blind the randomized intervention.

Individual interventions part of active management should be tested and analyzed separately. There are no trials to evaluate the timing and dosing of oxytocin in labor per se. There are also no trials to evaluate specifically the best frequency of cervical examinations in labor. Most studies, including those with active management, perform cervical examinations every 2 hours in labor. The risk of intrauterine infection though increases with the increasing number of examinations (recommendation: B; quality: good; Table 2).

Training of birth assistants in the developing world is associated with a 26% trend for a decrease in maternal mortal-

ity, and a 30% trend for a decrease in perinatal mortality in 1 trial, including 20,557 Pakistani women.[55] Given these results, several governmental and nongovernmental organizations (eg, nonprofit foundations) are in the process of organizing and starting programs for the training of birth assistants, which is the most promising of all interventions studied so far to successfully decrease maternal and perinatal mortality[56] (recommendation: A; quality: good; Table 2).

Intrauterine pressure catheter (IUPC) has not been evaluated in any randomized trials. Abnormal progression of labor, including terms such as dystocia, dysfunctional labor, failure to progress, cephalopelvic disproportion and others, is the most common problem in labor, and the reason for the majority of CDs. Risk factors for dystocia are: obesity, induction, Bishop score < 5 at start of labor, station higher than -2, persistent occiput posterior, macrosomia, and epidural anesthesia.[57] Athough these variables are predictive of a higher chance for operative/CD, no intervention has been tested by a trial. In the active phase of the first stage of labor, in a woman at term with epidural and oxytocin, the fifth percentile dilatation is about 0.5 cm/h. Proposed cutoffs for failure to progress in the active phase of the first stage are arrest for ≥ 4 hours if uterine activity > 200 Montevideo units, and arrest for ≥ 6 hours if > 200 Montevideo units cannot be sustained.[58] These suggestions assume normal fetal heart rate (FHR) monitoring (recommendation: I; quality: poor; Table 2).

Meperidine 100 mg IV, in women at term with singleton gestations and requiring oxytocin by obstetrician because of "dystocia" at 4-6 cm, does not affect operative delivery rates and worsens neonatal outcomes compared with placebo in 1 trial involving 407 women[59] (recommendation: D; quality: fair; Table 2).

Second stage

Prophylactic oxygen for preventing NRFHR monitoring given continuously to the mother is associated with a 350% increase in the incidence of low umbilical artery cord pH < 7.20 in 2 small trials, including 245 women.[60] There are no differences in other outcomes. Brief oxygen for treating NRFHR is potentially beneficial (recommendation: D; quality: fair; Table 2).

Prophylactic tocolysis for preventing NRFHR monitoring has been studied in a small ($n = 100$) trial that evaluated ritodrine, a beta-mimetic drug. It was associated with prolongation of labor and an increased incidence of forceps delivery, probably because the trial protocol required forceps to be used if the second stage of labor exceeded 30 minutes, in both groups.[61] There were no other significant effects associated with this intervention (recommendation: D; quality: fair; Table 2).

The upright position in the second stage is associated in women without epidural anesthesia with a 4-minute shorter interval to delivery, less pain, lower incidences of NRFHR monitoring and of operative vaginal delivery, as well as higher rates blood loss of > 500 mL compared with other positions in 20 trials, including 6135 women.[62] The upright positions studied include sitting (obstetric chair/stool); semirecumbent (trunk tilted backwards 30° to the vertical); kneeling; squatting (unaided or using squatting bars); and squatting aided with birth cushion. The benefits of the upright position may be related to gravity, less aortovagal compression, improved fetal alignment, and larger anterior-posterior and transverse pelvic outlets. The higher blood loss may be secondary to easier collection of blood in the upright position. In women with mostly epidural anesthesia, 1 small trial assessed lateral vs supported sitting position, without enough power for meaningful conclusion[63]; another trial compared 2 upright positions, and associated kneeling with no difference in duration of second stage but less pain compared with sitting[64] (recommendation: A; quality: good; Table 2).

Delayed pushing (waiting 1-3 hours or until "urge to push") of term, singleton, vertex gestations with epidural in place is associated with longer second stage, similar pushing time, significantly higher incidence of spontaneous vaginal delivery but similar incidences of operative vaginal and CD, and similar neonatal outcomes, compared with early (immediate on entering second stage) pushing in 9 trials, including 2953 women.[65] Careful monitoring, with assurance of reassuring fetal status, should be used during delayed pushing (recommendation: B; quality: good; Table 2).

Pushing method using a closed glottis (Valsalva) is associated with a significantly shorter (by 13-18 min) duration of the second stage of labor, and similar neonatal outcomes compared with using a woman's own urge (open glottis) in 2 trials, including 670 women.[66,67] Urodynamics 3 months after delivery are slightly worse in the closed glottis group in 1 trial, involving 128 women.[68] Given this evidence, each woman's own choice should be supported. Most women spontaneously choose Valsalva in the second stage of labor (recommendation: C; quality: good; Table 2).

Perineal massage from 34 weeks until delivery with sweet almond oil for 5-10 minutes daily is associated with a significantly higher chance of intact perineum compared with no massage in nulliparous, but probably not multiparous women in 3 trials, including 2434 women[69] (recommendation: A; quality: good; Table 2).

Perineal massage and stretching of the perineum in the second stage of labor with a water soluble lubricant is associated with similar rates of intact perineum, but decreased incidence of third degree lacerations in 1 trial, involving 1340 women.[70] In this trial, perineal massage before labor was not performed, so it is unknown if the combination of "prelabor" and "in-labor" perineal massage are beneficial. In another trial, perineal massage in the second stage was associated with similar very low ($< 2\%$) incidence of third- or fourth-degree lacerations in 807 women managed by midwives[71] (recommendation: B; quality: good; Table 2).

Warm pack applied to the perineum in the second stage of labor is associated with a reduction in the incidence of third- and fourth-degree lacerations in 2 trials, involving 1525 women (odds ratio [OR], 0.52; 95% CI, 0.29-0.92),[71,72] with only the study with the higher incidence

of perineal lacerations[72] reporting significant benefit (recommendation: B; quality: good; Table 2).

Operative intervention for abnormal progression of the second stage has not been evaluated in any trials, so that effective management of the prolonged second stage is unclear. Operative intervention is not warranted just because a set number of hours have elapsed in the second stage. The length of the second stage is not associated with poor neonatal outcome, as long as fetal testing is reassuring. If contractions are adequate, the chance of vaginal delivery decreases progressively after 3-5 hours of pushing in the second stage. Therefore, studies have proposed as minimal cutoffs to begin considering dystocia: $\geq$ 3 hours with epidural and $\geq$ 2 hours without an epidural for nulliparous women; and $\geq$ 2 hours with epidural and $\geq$ 1 hour without an epidural for multiparous women.[73] If there are no signs of infection (maternal or fetal), no maternal exhaustion, and normal fetal heart monitoring, labor can be allowed to continue beyond these limits as long as some progress has been made.[73] Mandatory second opinion is associated with 22 fewer intrapartum CDs per 1000 deliveries, without affecting maternal or perinatal outcome, in 1 large cluster randomized trial, involving 149,276 women[74] (recommendation: I; quality: poor; Table 2).

The "hand-on" method described by Ritgen in 1855 usually involves pressure on the infant's head on crowning, and support with the other hand of the perineum, with the aim of protecting for lacerations. In the "hands poised" method, the fetal head and perineum are not touched or supported by the delivering personnel. These 2 methods are associated with similar incidences of perineal and vaginal tears, but the hand-on method is associated with higher incidence of third-degree tears and episiotomies in 1 trial, involving 5471 women.[75] A policy of "hands-poised" has also been supported by a quasi-randomized study, reporting less third-degree tears compared with "hands-on"[76] (recommendation: D; quality: good; Table 2).

Fundal pressure applied manually to aid in vaginal delivery has never been studied in a trial. In the second stage of labor, fundal pressure can be provided with an obstetric belt wrapped around the woman's abdomen above the level of the uterine fundus. The belt inflates with each contraction to a maximum of 200 mm Hg for 30 seconds. Compared with no belt, the inflatable obstetric belt is associated with similar incidence of spontaneous vaginal delivery in nulliparous women with singleton term pregnancies and an epidural at term in 1 trial, involving 500 women. All other maternal and neonatal outcomes are similar, but women with no belt have greater satisfaction[77] (recommendation: D; quality: good; Table 2).

Routine episiotomy use is associated with more posterior perineal trauma, suturing and healing complications, and later pain with intercourse, with decreased risk of anterior perineal trauma, and similar urinary and fecal incontinence, compared to restrictive episiotomy, in 7 trials, involving 4,996 women.[78,79] The episiotomy use in these studies was about 73% for routine use and 28% for restrictive use. There is insufficient evidence to evaluate if there are (if any) indications for the use of episiotomy, such as assisted delivery (forceps or vacuum), abnormal fetal testing, preterm delivery, breech delivery, predicted macrosomia, and presumed imminent tears. Episiotomy should be avoided if at all possible, but, if used, it is unknown which episiotomy technique (mediolateral or midline) provides the best (or worst) outcome (recommendation: D; quality: good; Table 2).

Comment

Quality in labor and delivery management should always be judged by the lowest maternal and perinatal morbidity and mortality, not by preset limits on specific interventions. Even after dozens of trials and hundreds of excellent manuscripts, experts' opinions frequently guide decisions as to the management details of labor and delivery. Too often we do not take advantage of all the knowledge already available. Complications that occur because of improper technique put both the mother and fetus at unnecessary but significant risks.

Table 1 summarizes our evidence-based recommendations for management of labor and delivery for the healthy woman carrying a vertex, singleton, term gestation entering spontaneous labor. Clinically, good quality recommendations favor hospital births, delayed admission, support by doula, training birth assistants in developing countries, and upright position in the second stage. These labor and delivery techniques should be routinely performed. Home-like births, enema, shaving, routine vaginal irrigation, early amniotomy, "hands-on" method, fundal pressure, and episiotomy can be associated with complications without sufficient benefits, and should probably be avoided. Ingestion of ice or liquids, walking, water immersion, delayed vs early pushing, and method of pushing should probably be left for the woman to decide. All technical aspects that have recommendations with less than good quality should be researched properly with adequately powered and designed trials.

There are several limitations to our review. Existing search strategies for retrieving randomized studies and meta-analyses in various databases are limited, and this may have impacted our findings, especially regarding publication bias and the overreporting of positive trials.[80] Although we emphasized results related to maternal and perinatal morbidity and mortality, some of these have not been well reported for some interventions, especially long-term outcomes. For most of the issues described, outcomes for nulliparous and multiparous patients can differ significantly, such that the findings may not be valid for both groups. In addition, for some of the outcomes, the recommendation lack effect size or draw conclusions based on a single study. Because this review evaluates several interventions, QUOROM reporting was followed as appropriate, especially given its advantages in structuring the Methods sction, but could not be totally applied.

Obstetricians in practice or training should be educated to be better aware of

these clinical and research recommendations (Table 1). Moreover, they should review the data as even the most objective of review is based on some degree of subjectivity on evidence levels and recommendations. Management of labor and delivery requires a team approach, with good communication between the medical providers, patient, and family, so we are all on the same page and have as a common goal the education of the patient regarding the evidence-based interventions that are beneficial. The concept of teamwork in labor and delivery has been evaluated in a cluster-randomized study,[81] and deserves further research. Evidence-based medicine complements personal judgment, so that these general clinical recommendations need to be considered in the context of the individual patient. This review is aimed not only at clinical improvements, but also research and education.

It is some of these improvements that have lead to the decrease of 99% in maternal mortality and of 90% in infant mortality in the last century. Although we used to be the field with the worst use of randomized trials,[82] obstetrics is now the pioneer for numbers of metaanalysis and extension of work for evidence-based reviews.[83] Obstetricians are now blessed with lots of data, and should make the best use of it. ■

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