



THE UNIVERSITY OF
TENNESSEE
HEALTH SCIENCE CENTER.

Induction of Labor

Anna Joy Rogers, MD, DrPH

Disclosures

- I have no financial relationships to disclose.

Learning Objectives

- Review historical perspectives on and the epidemiology of labor induction
- Understand the physiology of labor and mechanisms of action of cervical ripening and myometrial activation agents
- Discuss pharmacologic and mechanical methods of induction
- Define normal and abnormal labor progress
- Assess outpatient cervical ripening, adjunctive labor induction methods, and elective induction outcome data

History of Induction

- Historically: performed primarily for demised fetus or comfort of the mother
- Modern times: performed for certain obstetric, maternal, fetal, and placental or uterine conditions
 - Elective delivery at less than 39 0/7 weeks of gestation is not recommended
- The overall rate of labor induction:
 - 9.6% in 1990
 - 27.1% in 2018
 - 31.4% in 2020
 - According to National Center for Health Statistics

4.3%
increase

INTERIM UPDATE



ACOG COMMITTEE OPINION

Number 831

(Replaces Committee Opinion Number 818, February 2021)

Committee on Obstetric Practice Society for Maternal-Fetal Medicine

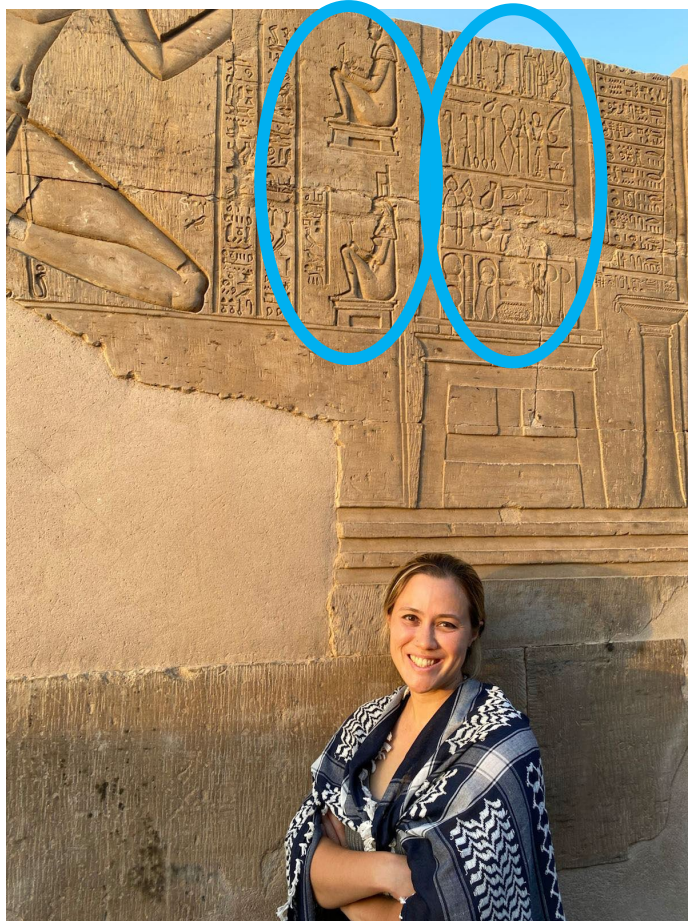
This Committee Opinion was developed by the Committee on Obstetric Practice in collaboration with Society for Maternal-Fetal Medicine liaison member Cynthia Gyamfi-Bannerman, MD, MS, committee members Angela B. Gantt, MD, MPH and Russell S. Miller, MD, and the Society for Maternal-Fetal Medicine.

INTERIM UPDATE: The content in this Committee Opinion has been updated as highlighted (or removed as necessary) to reflect a limited, focused change in delivery timing recommendations around preterm prelabor rupture of membranes.

Medically Indicated Late-Preterm and Early-Term Deliveries

ABSTRACT: The neonatal risks of late-preterm and early-term births are well established, and the potential neonatal complications associated with elective delivery at less than 39 0/7 weeks of gestation are well described. However, there are a number of maternal, fetal, and placental complications in which either a late-preterm or early-term delivery is warranted. The timing of delivery in such cases must balance the maternal and newborn risks of late-preterm and early-term delivery with the risks associated with further continuation of pregnancy. Deferring delivery to the 39th week is not recommended if there is a medical or obstetric indication for earlier delivery. If there is a clear indication for a late-preterm or early-term delivery for either maternal or newborn benefit, then delivery should occur regardless of the results of lung maturity testing. Conversely, if delivery could be delayed safely in the context of an immature lung profile result, then no clear indication for a late-preterm or early-term delivery exists. Also, there remain several conditions for which data to guide delivery timing are not available. Some examples of these conditions include uterine dehiscence or chronic placental abruption. Delivery timing in these circumstances should be individualized and based on the current clinical situation.

Ancient delivery practices



Kom Ombo, Egypt
Built starting 180 BC

History

- Now discredited theories:

- Mechanical intervention:

- “Western Indians had a custom in which a woman is tossed in a blanket, the four corners of which are held by four stout men, the idea being to correct any malposition of the baby and shake it out of the womb.”

- Chemical Interventions

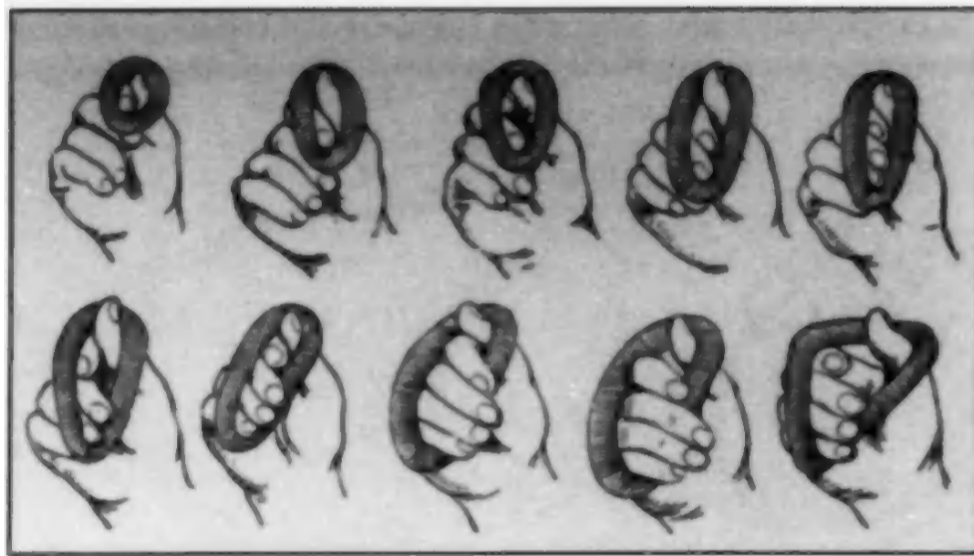
- Rattlesnake’s rattle powder
 - Venesection (bloodletting)

History

- Theories that persist:

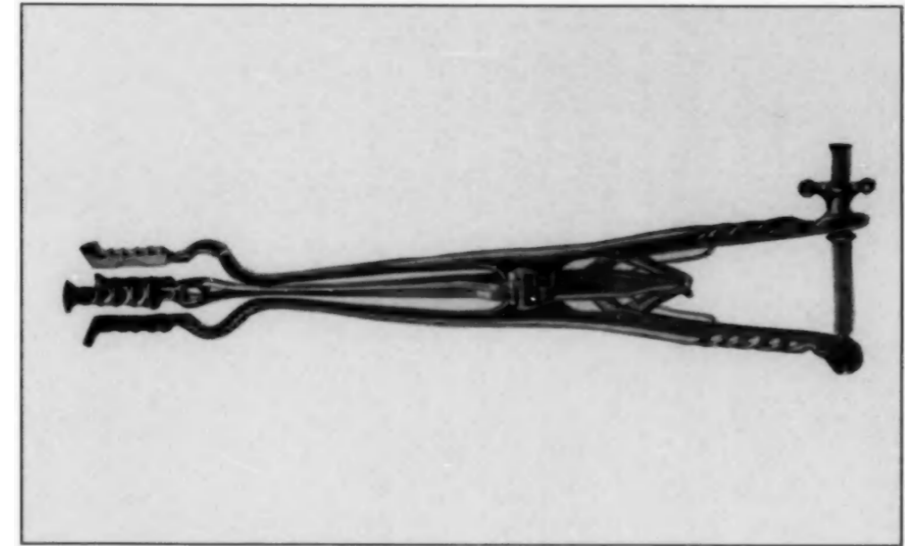
- Hippocrates (460-370 BC): described mammary stimulation and digital dilation of cervix
- Abulcassis (912-1013 AD) invented several instruments capable of cervical dilation and forceps
- Louise Bourgeois (1563-1636) initiated labor with strong enemas and several different mixtures of folk medicine
- Thomas Denman (1733-1815) first to write about artificial rupture of membranes
- James Hamilton (1767–1839) suggested digital separation of the membranes from the lower uterine segment

Historical Mechanical Ripening



OBSTETRICAL PRACTICE (2nd ed.) by Alfred C. Beck, Baltimore: Williams & Wilkins, 1939, p. 762.

- Digital dilation of cervix



THE PRINCIPLES AND PRACTICE OF OBSTETRICS (4th ed.) by Joseph B. DeLee, Philadelphia: Saunders, 1925, p. 964

- Bossi's four-branched cervical dilator

Historical Mechanical Ripening



Syntex International Ltd. and the Estate of Leon Fox, M.D.

- c. 1898; a series of woven rubber bags in graduated sizes, with syringe for filling with saline solution. Mattei used a water-filled balloon made of sheep bladder.



Old Operating Theatre Museum & Herb Garret, Lord Brock Trust, London, UK.

- Lee's obstetric membrane perforator used for amniotomy

History of Pharmacologic Ripening

- Sir Henry H. Dale (1875-1968) found that an extract from the human posterior pituitary gland contracted the uterus of a pregnant cat
 - 1943: Page suggested that the pituitary extract be given IV in small doses instead of intramuscularly in large doses
 - 1949: Theobald first publication in humans on pituitary extract IV
 - 1953: Oxytocin chemical formula discovered
 - 1955: Synthetic oxytocin produced

Oxytocin (aka. “quick birth” in Greek)

ON SOME PHYSIOLOGICAL ACTIONS OF ERGOT.

By H. H. DALE.

(From the Wellcome Physiological Research Laboratories,
Herne Hill.)

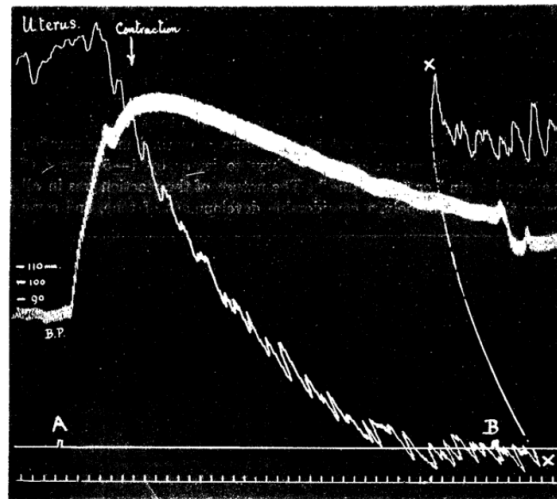


Fig. 21. $\times 1$. From same experiment as Fig. 20. Injection of 2 successive doses each of 10 mgms. impure cornutine (equivalent to about 1 mgm. dose of the purest specimen yet obtained). First, A produces large rise of blood-pressure and very pronounced contraction of uterus. As the lever was being pulled off the drum it was raised, by adjustment of pulleys, between X—X. At B, the second injection of 10 mgms., caused slight fall of blood-pressure and did not perceptibly affect the tone or rhythm of the uterus.

Dale, HH. On some physiological actions of ergot.

J Physiol . 1906 May 31;34(3):163–206. doi: 10.1113/jphysiol.1906.sp001148

14084

Response of Human Pregnant Uterus to Pitocin Tannate in Oil.*

ERNEST W. PAGE.

From the Division of Physiology and the Department of Obstetrics and Gynecology, University
of California Medical School, Berkeley.

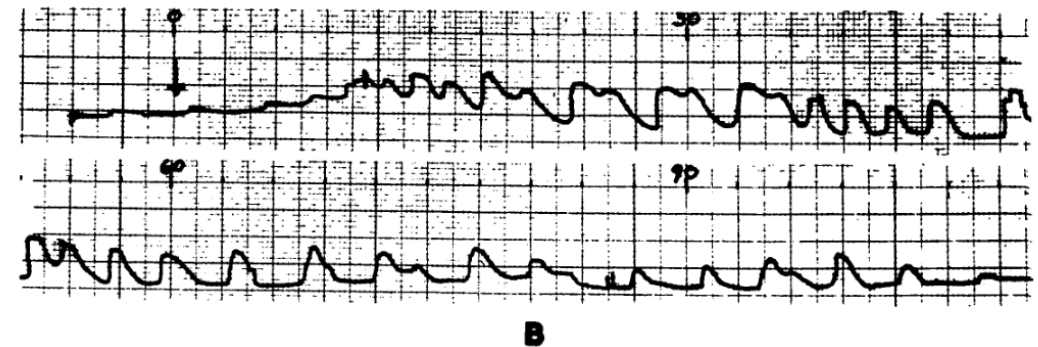
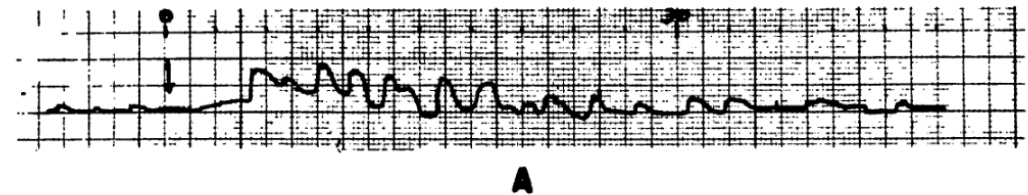


FIG. 1.
Tracings of tocograph records made on the same patient at term, not in labor, showing (A) the uterine response to 2 units of Pitocin and (B) the response one hour later to 7 units of Pitocin tannate in oil. Time in 3-minute intervals.

Page EW. Response of human pregnant uterus to pitocin tannate in oil. Proc Soc Exp Biol 1943;52:195–7.

Bishop Score

Table 1. Bishop Scoring System					
Score	Factor				
	Dilation (cm)	Position of Cervix	Effacement (%)	Station*	Cervical Consistency
0	Closed	Posterior	0–30	–3	Firm
1	1–2	Midposition	40–50	–2	Medium
2	3–4	Anterior	60–70	–1, 0	Soft
3	5–6	—	80	+1, +2	—
*Station reflects a –3 to +3 scale.					
Adapted with permission from Wolters Kluwer Health, Inc.: Bishop EH. Pelvic scoring for elective induction. Obstet Gynecol 1964;24:267.					

- Bishop score (1964) used to evaluate readiness of cervix for labor.
- Scores from 3-8 recommend cervical ripening before starting oxytocin.

Modern Mechanical Ripening



- Foley balloon: Single (1700s) or double balloon (1997)
- Physical forces dilate the cervix
- “Placing the catheter digitally seems to be less painful compared with placement with the use of a speculum.”
- Among women with intact membranes, foley catheter not associated with increased risk of infection
 - Data are conflicting on risk of chorioamnionitis in patients with ruptured membranes
 - No increased risk of foley catheter use and subsequent preterm birth

Modern Mechanical Ripening

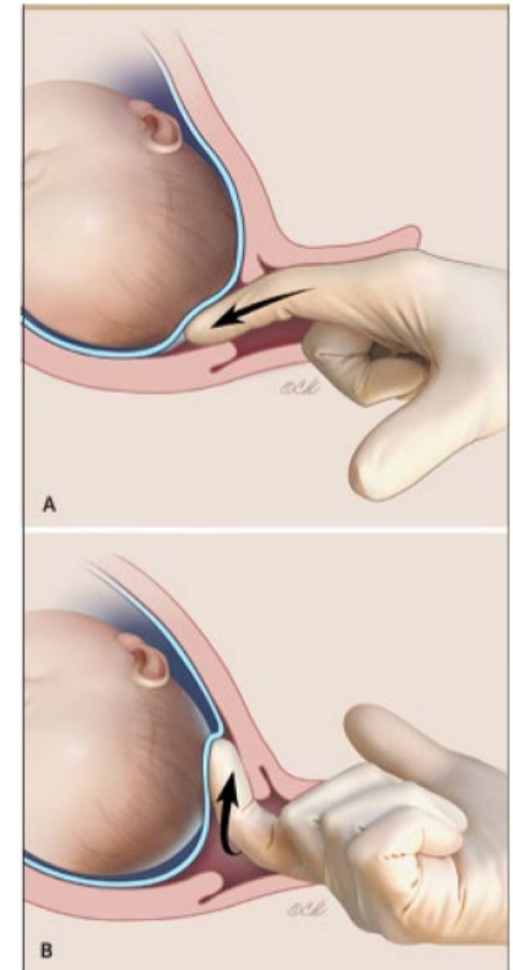
- Dilapan-S hygroscopic dilators and laminaria absorb fluid → expand → exerting radial pressure on the cervical canal
- Directions:
 - Insert using sponge forceps while using a vaginal speculum to directly visualize the cervix.
 - Individual rods are inserted into the cervix until achieving a tight fit.
 - Depending on baseline cervical dilatation, 2 to 5 rods are inserted within the endocervical canal.
 - The dilators are left in place for approximately 12 hours while the rods expand, slowly dilating the cervix.



FIG. 9
Artificial separation of membranes

Membrane Sweeping/Stripping

- A circular reaming or a scratching of the membranes with a provider's finger
 - Disrupts the decidual uterine interface to release collagenases and prostaglandins
 - Limited evidence suggests that it is safe
- Stimulates spontaneous onset of labor
 - Number needed to treat for going into labor within the next 24 hours = 8
- Advantages: free, easy, convenient
- Contraindications: ruptured membranes, active infection, Group B strep carriers, placental abnormalities

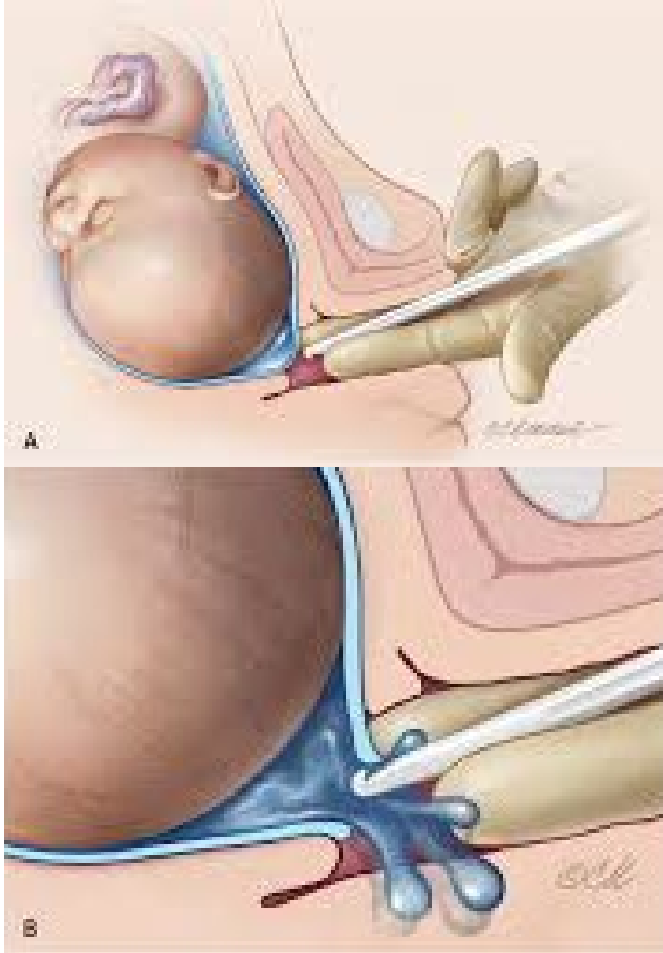


(Reproduced with permission from the artist, Christy Krames) ©Christy Krames. (A) The healthcare provider inserts a finger into the cervix. (B) The provider then gently separate (sweep) the membranes to separate the amniotic sac from the uterine lining. The sweep is done in a circular motion.

Patabendige. How labor induction methods have evolved throughout history, from the Egyptian era to the present day. Am J Obstet Gynecol MFM 2024.

Boulvain M, Stan C, Irion O. Membrane sweeping for induction of labour. Cochrane Database Syst Rev. 2005 Jan 25;2005(1):CD000451. doi: 10.1002/14651858.CD000451.pub2. Update in: Cochrane Database Syst Rev. 2020 Feb 27;2:CD000451.

Amniotomy



- Artificial rupture of membranes stimulates oxytocin release from the pituitary gland and prostaglandin release locally
- Contraindications: active herpes, HIV, vasa previa, or funic (cord) presentation
- Effective in isolation or conjunction with other methods
 - Cochrane review found that among 141 trials and 19 interventions, IV oxytocin combined with amniotomy had the lowest probability of vaginal delivery not being achieved within 24 hours

Prostaglandins



INDUCTION OF LABOUR WITH PROSTAGLANDIN $F_{2\alpha}$

BY
S. M. M. KARIM, *Senior Lecturer in Pharmacology*
R. R. TRUSSELL, *Professor of Obstetrics and Gynaecology*
K. HILLIER, *Lecturer in Pharmacology*

AND
R. C. PATEL, *Lecturer in Obstetrics and Gynaecology*
Makerere University College Medical School, P.O. Box 7072, Kampala, Uganda

THE physiology of human parturition is but imperfectly understood at present. It is not surprising, therefore, that although many drugs have been advocated for the initiation and augmentation of uterine action, few have proved satisfactory. At present only oxytocin enjoys the reputation of being relatively safe for the induction of labour.

A new group of chemically related substances discovered in 1935 and called prostaglandins (Euler, 1935; Goldblatt, 1935; Bergström, Carlson and Weeks, 1968) have been shown to possess smooth muscle stimulating activity. One of these, prostaglandin $F_{2\alpha}$ ($PGF_{2\alpha}$) (Fig. 1 for chemical structure) has a potent oxytocic effect on isolated strips of human pregnant and non-pregnant myometrium *in vitro* (Bygdeman, 1964; Pickles and Hall, 1963; Sandberg *et al.*, 1965). The effect of this prostaglandin on the human uterus *in vivo* is almost unexplored. Karim (1966), and Karim and Devlin (1967) have shown that prostaglandin $F_{2\alpha}$ is present in human amniotic fluid obtained during labour, and that prostaglandin $F_{2\alpha}$ appears in the maternal venous blood

in variable amounts during labour (Karim, 1968a). This work has prompted the suggestion that $PGF_{2\alpha}$ may play a part in the process of parturition.

To obtain more evidence for the possible role of $PGF_{2\alpha}$ in parturition and at the same time to explore its potential value as an oxytocic, the effect of intravenous infusion of this prostaglandin on the intact human uterus at term has been investigated. A preliminary report on the successful induction of labour with $PGF_{2\alpha}$ in ten women at or near term has been published (Karim, 1968b; Karim, Trussell, Patel and Hillier, 1968). The present paper describes in detail results of induction of labour in 35 women at or near term with prostaglandin $F_{2\alpha}$.

MATERIALS AND METHODS

Thirty-five women were studied between the 30th and 45th weeks of pregnancy. Labour would otherwise have been induced in all these cases by amniotomy or intravenous oxytocin or a combination of both. Indications for induction of labour are shown in Tables I and II. The following procedure was followed throughout. Clinical assessment of the patient was first carried out and the relation of the fetal head to the pelvic brim and the condition of the uterine cervix were recorded. Uterine activity was measured by recording changes in the amniotic fluid pressure using an external guard ring tocodynamometer (Stanley Cox Ltd.) sited over the upper part of the fundus uteri and attached to a Honeywell electronic recorder (Smyth,

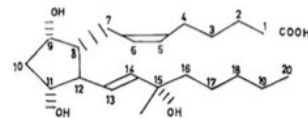


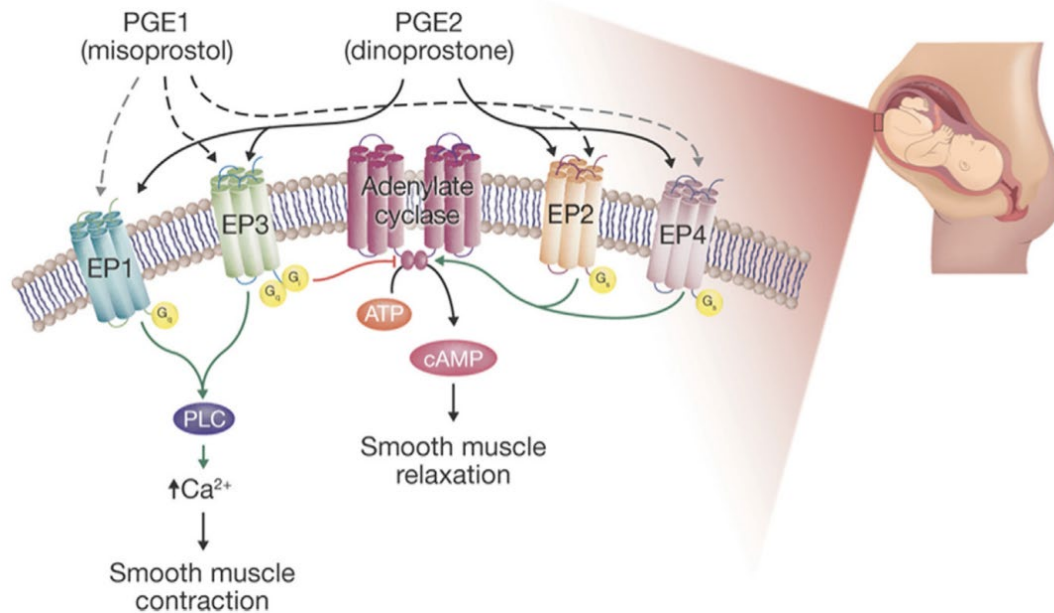
FIG. 1
Chemical structure of prostaglandin $F_{2\alpha}$ ($PGF_{2\alpha}$) used in the present investigation.

- In 1935, prostaglandins were discovered, as a derivative of seminal fluid from the prostate gland (hence its name).
- In 1987, Mariani Neto and colleagues first reported the use of oral misoprostol for labor induction.

Karim SMM, Trussell RR, Patel RC, Hillier K. Response of pregnant human uterus to prostaglandin F_2 alpha induction of labour. BMJ 1968;IV:621-3.

Prostaglandins

FIGURE 3
Effect of prostaglandins on the myometrium

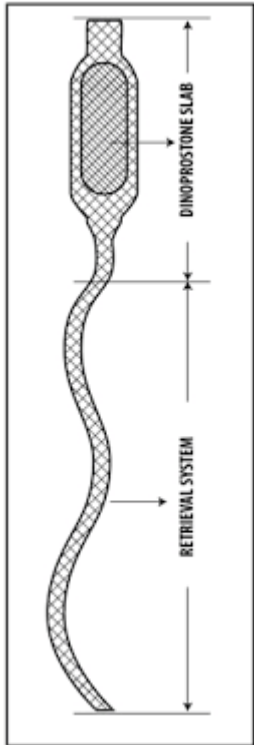


- Membrane phospholipids → arachidonic acid → prostaglandins → bind G protein-coupled receptors
 - Stimulate myometrial contractions
 - Stimulate collagenase secretion
- Formulations
 - Misoprostol = prostaglandin E1
 - Dinoprostone = prostaglandin E2
- Contraindication: history of uterine surgery including CS due to risk of uterine rupture.
- Note: Temperature elevations can occur

Misoprostol (PGE1)

- Half life:
 - 30 (oral) or 16 (vaginal) minutes
- In 2002, FDA withdrew its absolute contraindication to use during pregnancy.
 - However, similar to other labor induction methods, it is used “off-label” because it is not approved by the FDA as a cervical ripening and labor induction agent.
- Dosing:
 - Comes in 100mcg and 200mcg
 - Vaginally administered common doses are 25mcg and 25mcg
 - Oral, buccal, sublingual, suppository, vaginal release insert options available
 - ACOG recommends using 25-mcg doses of vaginal misoprostol with redosing intervals of 3 to 6 hours

Dinoprostone (PGE2)



- FDA approved for cervical ripening and labor induction
- Half-life: 2.5-5 minutes
- Formulations: vaginal suppositories, pessaries, and gels
- Must stay frozen
- 30 minutes after removal may start oxytocin

Mifepristone

- Progesterone helps maintain uterine quiescence
 - Downregulates oxytocin receptors
 - Reduces prostaglandin synthesis
 - Inhibits collagen degradation
 - Suppresses matrix metalloproteinases
- Vaginal progesterone as a treatment option for patients with a history of preterm labor and shortened cervix
- Progesterone antagonist
 - Blocks effect of progesterone leading to functional withdrawal
 - Causes the release of endogenous prostaglandins
 - Increases sensitivity of the myometrium to the contractile effects of prostaglandins.

Mifepristone

- Widely used for medication abortion in early pregnancy
- 200-mg oral is lowest effective dose, reaching optimal effect at 72 hours (half-life 12-72 hours)
 - Mifepristone vs. Foley balloon was associated with a markedly reduced interval to the onset of labor, improved Bishop scores at 24 hours, reduced need for oxytocin use, and reduced incidence of failed labor induction.
- Less effective compared with other pharmacologic methods, but may be useful adjunct for pretreatment

Sharma C, Soni A, Gupta A, Verma A, Verma S. Mifepristone vs balloon catheter for labor induction in previous cesarean: a randomized controlled trial. Arch Gynecol Obstet 2017;296:241–8.

Other pharmacologic methods

- Relaxin

- Elevated levels are associated with an increased risk of preterm birth
- RCT: IV administration resulted in no difference in modified Bishop score, length of the first and second stage of labor, and oxytocin requirements

- Hyaluronidase

- Intracervical injections of hyaluronidase may effectively promote cervical ripening, but with limited public interest

- Nitric oxide donors

- Intravaginally administered NO donors may reduce time to favorable cervix
- Less effective than prostaglandins and had more side effects including nausea, headache, emesis.

Combination Cervical Ripening

- Included 11 systematic reviews and extracted data from 207 randomized controlled trials with a total of 40,854 participants
- Combination of a single-balloon catheter with misoprostol was the most effective method in reducing the odds for cesarean delivery and prolonged time to vaginal delivery.

Systematic Review

ajog.org

Single-balloon catheter with concomitant vaginal misoprostol is the most effective strategy for labor induction: a meta-review with network meta-analysis



Luis Sanchez-Ramos, MD; Lifeng Lin, PhD; Gustavo Vilchez-Lagos, MD; Jose Duncan, MD; Niamh Condon, DO; Jason Wheatley, DO; Andrew M. Kaunitz, MD

OBJECTIVE: Several systematic reviews and meta-analyses have been conducted to summarize the evidence for the efficacy of various labor induction agents. However, the most effective agents or strategies have not been conclusively determined. We aimed to perform a meta-review and network meta-analysis of published systematic reviews to determine the efficacy and safety of currently employed pharmacologic, mechanical, and combined methods of labor induction.

DATA SOURCES: With the assistance of an experienced medical librarian, we performed a systematic search of the literature using PubMed, EMBASE, and the Cochrane Central Register of Control Trials. We systematically searched electronic databases from inception to May 31, 2021.

STUDY ELIGIBILITY CRITERIA: We considered systematic reviews and meta-analyses of randomized controlled trials comparing different agents or methods for inpatient labor induction.

METHODS: We conducted a frequentist random-effects network meta-analysis employing data from randomized controlled trials of published systematic reviews. We performed direct pairwise meta-analyses to compare the efficacy of the various labor induction agents and placebo or no treatment. We performed ranking to determine the best treatment using the surface under the cumulative ranking curve. The main outcomes assessed were cesarean delivery, vaginal delivery within 24 hours, operative vaginal delivery, hyperstimulation, neonatal intensive care unit admissions, and Apgar scores of <7 at 5 minutes of birth.

RESULTS: We included 11 systematic reviews and extracted data from 207 randomized controlled trials with a total of 40,854 participants. When assessing the efficacy of all agents and methods, the combination of a single-balloon catheter with misoprostol was the most effective in reducing the odds of cesarean delivery and vaginal birth >24 hours (surface under the cumulative ranking curve of 0.9 for each). Among the pharmacologic agents, low-dose vaginal misoprostol was the most effective in reducing the odds of cesarean delivery, whereas high-dose vaginal misoprostol was the most effective in achieving vaginal delivery within 24 hours (surface under the cumulative ranking curve of 0.9 for each). Single-balloon catheter (surface under the cumulative ranking curve of 0.8) and double-balloon catheter

Cervical ripening in Second Trimester



Cochrane
Library

Cochrane Database of Systematic Reviews

Tufa TH, Stewart F, Meckstroth K, Diedrich JT., Newmann SJ.
Cervical preparation for dilation and evacuation at 12 to 24 weeks gestation.
Cochrane Database of Systematic Reviews 2025, Issue 3. Art. No.: CD007310.
DOI: [10.1002/14651858.CD007310.pub3](https://doi.org/10.1002/14651858.CD007310.pub3).

- For the outcome of increased pre-procedure dilation and decreased procedure time,
 - Misoprostol or Mifepristone, **PLUS** osmotic dilators, are better than osmotic dilators alone
 - Laminaria may be superior to Dilapan-S

Outpatient Cervical Ripening

Systematic Review

OPEN

Outpatient Cervical Ripening

A Systematic Review and Meta-analysis

Marian McDonagh, PharmD, Andrea C. Skelly, PhD, MPH, Ellen Tilden, PhD, CNM, Erika D. Brodt, BS, Tracy Dana, MLS, Erica Hart, MST, Shelby N. Kantner, BA, Rongwei Fu, PhD, and Amy C. Hermes, MD, PhD

OBJECTIVE: To assess the comparative effectiveness and potential harms of cervical ripening in the outpatient compared with the inpatient setting, or different methods of ripening in the outpatient setting alone.

DATA SOURCES: Searches for articles in English included MEDLINE, EMBASE, CINAHL, Cochrane Library, ClinicalTrials.gov, and reference lists (up to August 2020).

METHODS OF STUDY SELECTION: Using predefined criteria and DistillerSR software, 10,853 citations were dual-reviewed for randomized controlled trials (RCTs) and cohort studies of outpatient cervical ripening using

prostaglandins and mechanical methods in pregnant women at or beyond 37 weeks of gestation.

TABULATION, INTEGRATION, AND RESULTS: Using prespecified criteria, study data abstraction and risk of bias assessment were conducted by two reviewers, random-effects meta-analyses were conducted and strength of evidence was assessed. We included 30 RCTs and 10 cohort studies (N=9,618) most generalizable to women aged 25–30 years with low-risk pregnancies. All findings were low or insufficient strength of evidence and not statistically significant. Incidence of cesarean delivery was not different for any comparison of inpatient and outpatient settings, or comparisons of different methods in the outpatient setting (most evidence available for single-balloon catheters and dinoprostone). Harms were inconsistently reported or inadequately defined. Differences were not found for neonatal infection (eg, sepsis) with outpatient compared with inpatient dinoprostone, birth trauma (eg, cephalohematoma) with outpatient compared with inpatient single-balloon catheter, shoulder dystocia with outpatient dinoprostone compared with placebo, maternal infection (eg, chorioamnionitis) with outpatient

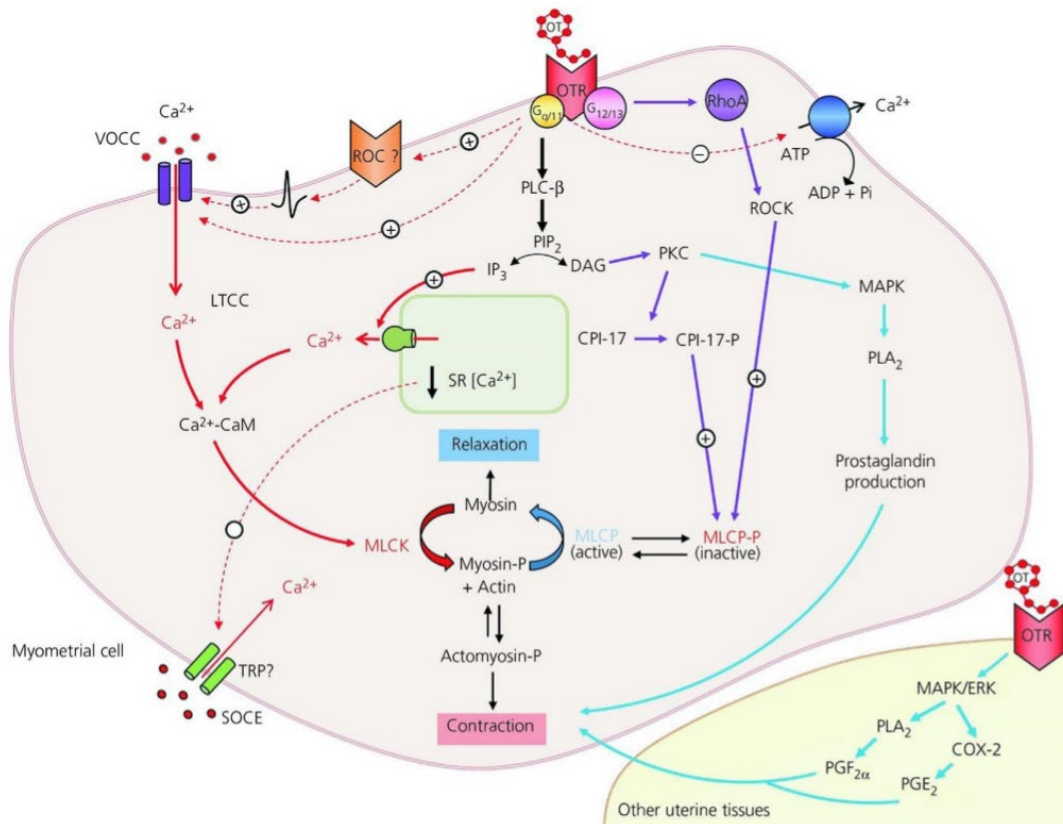
From the Pacific Northwest Evidence-Based Practice Center, Medical Informatics and Clinical Epidemiology, the Department of Nurse-Midwifery, School of Nursing, the School of Public Health, Portland State University, and Obstetrics and Gynecology, Oregon Health & Science University, Portland, Oregon; and Aggregate Analytics, Fircrest, Washington.

This work was funded under Contract No 290-2015-00009-1 from the Agency for Healthcare Research and Quality (AHRQ), U.S. Department of Health and Human Services (HHS). The Patient-Centered Outcomes Research Institute (PCORI) funded the report (PCORI Publication No. 2020-SR-03). The authors of this manuscript are responsible for its content. The content does not necessarily represent the official views of or imply endorsement by PCORI, AHRQ, or of the U.S. Department of Health and Human Services.

- 30 RCTs, 10 cohort (N = 9,618)
- In women with low-risk pregnancies,
 - Outpatient cervical ripening with dinoprostone or single-balloon catheters did not increase cesarean deliveries.
- Differences not found in maternal or neonatal infection
- Vaginal misoprostol 25mcg and synthetic osmotic dilators have also been investigated

Oxytocin

FIGURE 5
Oxytocin receptor signaling in the myometrium



- In late pregnancy, oxytocin receptors increase in density in myometrium
- Oxytocin binding causes release of calcium from intracellular stores via G protein-coupled reaction
- Calcium activates calmodulin and myosin light-chain kinase to contract myocytes

Oxytocin

- Pharmacokinetics of “Pitocin”

- Onset of action: 3-5 minutes
- Half life: 1-6 minutes
- Steady state: 40 minutes
- Response: dose-dependent
- Persistence: uterotonic effect may persist up to 1 hour

- Administration

- Infusion: 10-20 units in 1L of lactated Ringer's

Oxytocin

- Early augmentation?

- Out of 20 women, may lead to 1 additional spontaneous vaginal delivery
- Higher risk of tachysystole
- Higher pain scores
- Lower antibiotic use
- Decrease duration of labor by 1.28 hours

- Discontinue once patient reaches active phase?

- May lower risk of cesarean delivery (RR 0.64; 95% CI 0.48-0.87)
- Increased active phase of labor by 0.46 hours

Oxytocin

ACOG recommends either low-dose or high-dose oxytocin strategies as reasonable approaches to the active management of labor to reduce operative deliveries.

(STRONG RECOMMENDATION, HIGH-QUALITY EVIDENCE)

ACOG Clinical Practice Guideline 8: First and Second Stage Labor Management

TABLE 2

Low-dose and high-dose oxytocin regimens for labor induction

Oxytocin regimens for labor induction

Regimen	Starting dose (mU/min)	Interval (min)	Incremental increase (mU/min)
Low dose	0.5–2.0	15–40	1–2
High dose	6.0	15–40	3–6 ^a

Data were obtained from the American College of Obstetricians and Gynecologists,⁵⁸ Merrill et al,⁹⁰ Satin et al,^{91,92} Xenakis et al,⁹³ and Cunningham.⁹⁴

^a If an incremental increase of 6 mU/minute is chosen, the American College of Obstetricians and Gynecologists recommends that the incremental increase in the oxytocin infusion be decreased to 3 mU/minute if uterine hyperstimulation occurs. If hyperstimulation persistent, the incremental infusion should be further decreased to 1 mU/min.

Sanchez-Ramos. *Efficacy and safety of labor induction methods*. *Am J Obstet Gynecol* 2024.

- No difference in:

- Rate of vaginal deliveries in 24h
- Rate of Cesarean delivery
- Morbidity or mortality of mother or neonate

- High-dose regimen

- May decrease mean time to delivery
- Associated with higher risk of tachysystole

Oxytocin

- Rare adverse side effects
- Main adverse effect is uterine tachysystole
- Unpredictable therapeutic index
 - variability in patient uterine receptivity based on oxytocin receptor status
- Institute for Safe Medication Practices (2008)
 - Oxytocin to the list of “high-alert” medications that “bear a heightened risk of harm when used in error.”

Patient perspectives

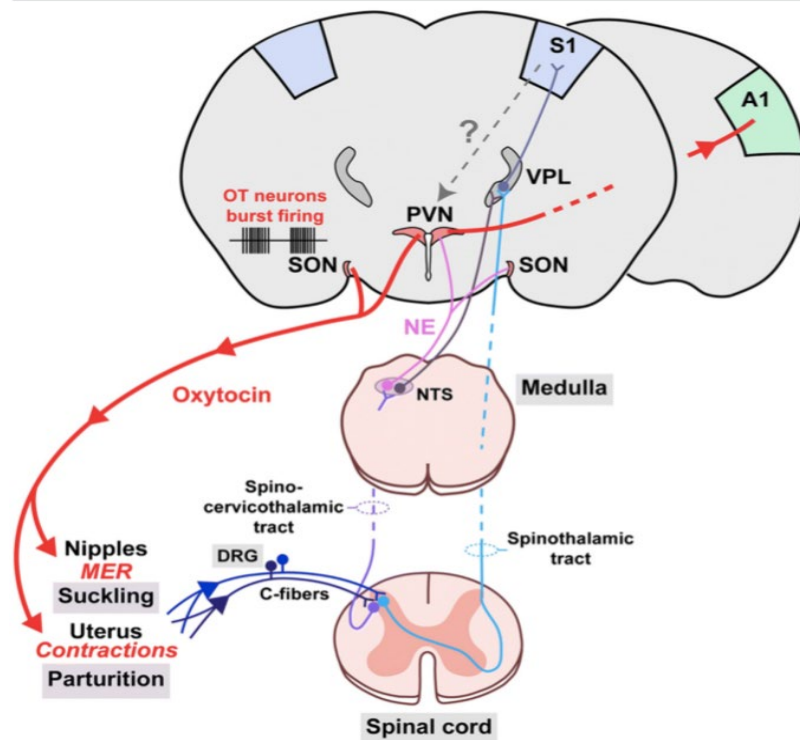
- Expectations relating to:
 - Delivery timing
 - Interventions in labor
 - Pain control
 - Birth experience
- TEAMBIRTH
 - Every person deserves a voice in their care when having a baby



Sanchez-Ramos L, Levine LD, Sciscione AC, Mozurkewich EL, Ramsey PS, Adair CD, Kaunitz AM, McKinney JA. Methods for the induction of labor: efficacy and safety. Am J Obstet Gynecol. 2024 Mar;230(3S):S669-S695. doi: 10.1016/j.ajog.2023.02.009. Epub 2023 Jul 13. PMID: 38462252.
<https://www.ariadnelabs.org/delivery-decisions-initiative/teambirth/>

Complementary Methods: Nipple Stimulation

FIGURE 13
Effect of nipple stimulation on oxytocin production



- Mechanism
 - Stimulates production of endogenous oxytocin
- Evidence
 - Compared to no induction method: fewer patients not in labor at 72 hours
 - (62.7% vs 93.6%; RR, 0.67; 95% CI, 0.60-0.74)
 - Compared to oxytocin:
 - Both have significant increase in uterine activity, but less intense
 - Only appropriate for low-risk patients if fetal-monitoring is not available due to unpredictable fetal heart rate patterns

Sanchez-Ramos L, Levine LD, Sciscione AC, Mozurkewich EL, Ramsey PS, Adair CD, Kaunitz AM, McKinney JA. Methods for the induction of labor: efficacy and safety. *Am J Obstet Gynecol*. 2024 Mar;230(3S):S669-S695.

Complementary Methods

TABLE 3

Complementary and alternative medicine for labor induction

Method	Dose and route	Frequency	Contraindications
Acupuncture	Per provider	Daily as needed	Not applicable
Black cohosh	Sublingual: 10 drops	Every hour as needed	Known allergy
Blue cohosh	Oral: 2–8 drops	Every 30 min until the onset of uterine contractions	Known allergy
Castor oil	Oral: 60 mL (mixed with beverage of choice)	Once	Nut or known allergies
Membrane sweeping	Intracervical	As needed	Placental abnormalities, unknown source of bleeding, active infection
Nipple stimulation	Manual or mechanical via breast pump	3 times a day for 1 h as needed	High-risk pregnancy
Primrose oil	Oral: 1 capsule	Every 8 h for up to 4 wk	Known allergy
Red raspberry leaves	Oral: 2.4 mg	Every 8 h until the onset of uterine contractions	Known allergy
Sexual intercourse	Vaginal: variable duration	As needed	Infection, placental abnormality, ruptured membranes

Sanchez-Ramos. Efficacy and safety of labor induction methods. Am J Obstet Gynecol 2024.

Stages of Labor

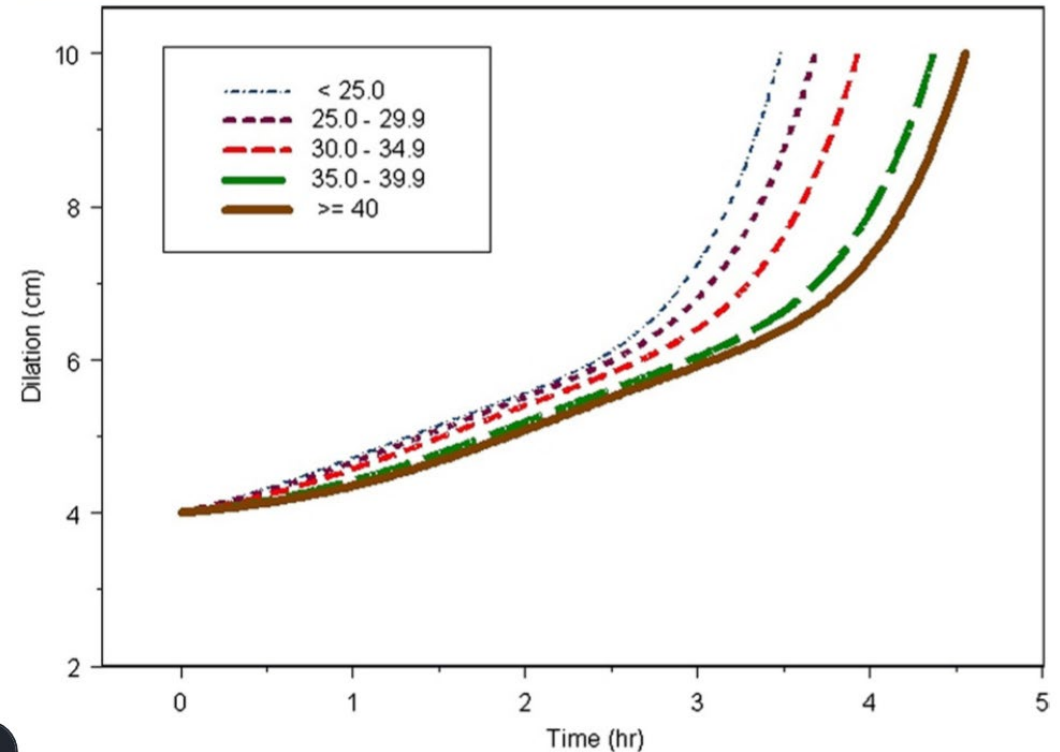
- First Stage – Onset of labor until complete cervical dilation
 - Latent Stage = prior to 6cm
 - Active Stage = ≥ 6 cm
- Second Stage – Complete cervical dilation until expulsion of fetus
- Third Stage – Expulsion of fetus until expulsion of placenta

Factors Affecting the Labor Curve

- Maternal factors
 - BMI
 - Hypertension
 - Age
 - Induction of labor
- Fetal factors
 - Multiple gestation
 - Gestational age
 - Fetal size
 - Fetal anomalies and sex

FIGURE 3

Labor curves in multiparas by body mass index category



Kominiarek. Labor patterns by BMI. Am J Obstet Gynecol 2011.

First Stage: Latent phase

- Normal = Most patients will ultimately enter the active phase
 - With expectant management
 - With amniotomy or oxytocin
- Prolonged
 - Defined as >16 hours (which is the 95th percentile for duration between admission and active phase in nulliparous patients)
 - Cesarean delivery for prolonged latent phase in setting of reassuring maternal and fetal status should be avoided
- Arrest
 - There is no evidence-based definition for latent phase arrest

First Stage: Active Labor

- Normal = Most patients will dilate at least 0.5cm/hour
 - 95th percentile for Nulliparous (0.5-0.7cm/hr) and multiparous (0.5-1.3cm/hr)
- Prolonged
 - Protracted active phase is dilation <1cm in two hours
- Arrest
 - No progression despite rupture of membranes
 - For 4 hours with adequate uterine activity (200 MVUs)
 - For 6 hours with inadequate uterine activity

Second Stage

- Normal = Most women (95th percentile) will deliver in 1.3 – 2.8h
 - Affected by: parity, delayed pushing, BMI, fetal OP position, birth weight
 - Epidural at 95th percentile adds 1 hour
- Prolonged
 - Nulliparous = 3 hours, Multiparous = 2 hours
 - However, patient preference may allow time to extend beyond these parameters
- Arrest
 - No specific definition – but consider if lack of fetal rotation or descent despite adequate contractions, pushing efforts, and time

Second Stage Arrest

- Longer pushing is associated with lower Cesarean delivery rates, **BUT**
- At more than 4 hours of pushing
 - Maternal risks – postpartum hemorrhage, Cesarean delivery, operative vaginal delivery, third/fourth degree lacerations
 - Neonatal risks – NICU admission, acidemia, but absolute composite difference in neonatal risks was 1%



ACOG recommends
“allowing individual extension
if progress in fetal descent is
observed and documented”

Factors Slowing Labor

- Induced labor

- The latent phase in induced labor is longer than spontaneous (Active phase is similar)
- 5% of induced women remain in latent phase after 18 hours
- Recommend that oxytocin be administered for at least 12-18 hours after membrane rupture prior to calling “failed induction”

- Epidural analgesia

- No impact on duration of first stage
- Up to 1 hour difference in duration of second stage
- Neither type nor timing of placement affected risk of cesarean delivery

Factors Speeding Labor

- Early amniotomy (AROM within 1 hour of foley bulb removal)
 - Shorter duration of labor
 - No change in risk of Cesarean
 - One systematic review suggested shorter interval from induction to delivery
- Early oxytocin (at diagnosis of dystocia) & high-dose oxytocin
 - Associated with higher pain and discomfort
 - Shorter duration of labor
 - No change in Cesarean delivery rate
 - Stopping after reaching active phase may decrease risk of Cesarean⁷⁵

Second Stage Dystocia

- Immediate vs. Delayed pushing
 - ACOG recommends pushing commence immediately when cervical dilation is complete
- Manual rotation
 - Rotating fetal head to accomplish more favorable presentation
 - Compared with EM, lower rates of Cesarean, perineal laceration, hemorrhage, chorioamnionitis. NNT = 4
- Operative vaginal delivery
 - ACOG recommends assessing for operative delivery prior to Cesarean

Adjunctive Considerations

- Continuous support in labor
 - Decreases Cesarean rate, neuraxial anesthesia, dissatisfaction
- Peanut ball
 - No significant difference in time in labor or SVD/CD rate
- Hydration
 - Oral hydration may be encouraged to meet hydration and caloric needs
 - Higher IVF 250cc/hr vs. 125cc/hr shortened labor and decreased CD
- Positional changes – especially ambulation and upright
 - Shortened first stage by ~1.5 hours

ARRIVE Trial

- Elective induction at 39 weeks?
- Neonatal composite morbidity outcome:
 - Occurred in 4.3% (induced) vs. 5.4% (expectant management, RR 0.80, CI 0.64-1.00)
- Maternal outcomes:
 - Lower Cesarean delivery, operative vaginal delivery, hypertensive disorders of pregnancy
 - Longer duration of stay in L&D unit and postpartum

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Labor Induction versus Expectant Management in Low-Risk Nulliparous Women

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ABSTRACT

BACKGROUND

The perinatal and maternal consequences of induction of labor at 39 weeks among low-risk nulliparous women are uncertain.

METHODS

In this multicenter trial, we randomly assigned low-risk nulliparous women who were at 38 weeks 0 days to 38 weeks 6 days of gestation to labor induction at 39 weeks 0 days to 39 weeks 4 days or to expectant management. The primary outcome was a composite of perinatal death or severe neonatal complications; the principal secondary outcome was cesarean delivery.

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Where do we go from here?

Future directions in cervical ripening and induction of labor