

# We are IntechOpen, the world's leading publisher of Open Access books Built by scientists, for scientists

6,900

Open access books available

186,000

International authors and editors

200M

Downloads

Our authors are among the

154

Countries delivered to

TOP 1%

most cited scientists

12.2%

Contributors from top 500 universities



WEB OF SCIENCE™

Selection of our books indexed in the Book Citation Index  
in Web of Science™ Core Collection (BKCI)

Interested in publishing with us?  
Contact [book.department@intechopen.com](mailto:book.department@intechopen.com)

Numbers displayed above are based on latest data collected.  
For more information visit [www.intechopen.com](http://www.intechopen.com)



# Induction of Labor: Review of Pros, Cons, and Controversies

*Donald Morrish and Iffath Abbasi Hoskins*

Abstract

Although induction of labor (IOL) has increased over the years, corresponding improvements in perinatal outcomes have not occurred. IOL may result in increased risks for mother and baby, due to factors like gestational age (GA), Bishop score of cervix, and the methods used. Failed IOL resulting in increased cesarean sections may be due to unripe cervix, inadequate Pitocin use, and incorrect patient choice. Medically indicated IOL does not require awaiting 39 weeks GA. Nonmedically indicated IOL prior to 39 weeks GA may result in neonatal morbidity. Patients at 39 weeks GA can be induced electively and need not await labor. Cervical ripening methods include vaginal, oral, or IV medications and can be administered as outpatients rather than in hospitals, in order to decrease financial and time constraints. Ethical issues regarding indications, GA, choice of agent, location of cervical ripening, and failed IOL can have an impact on healthcare resources.

**Keywords:** induction of labor, evidence-based management

## 1. Introduction

Induction of labor (IOL) is defined as the initiation of uterine contractions to achieve a vaginal birth before the onset of spontaneous labor. Although IOL rates, including those of elective inductions, have almost doubled, the perinatal outcomes have not improved proportionately [1].

While IOL can occur at any GA after 20 weeks, in general this intervention is reserved for those occurring at early term or late term. The definitions for the different gestational ages are shown in **Table 1** [2].

Definition	GAs
Preterm	<37 weeks GA
Term	40 weeks
Early term	37 weeks 0 day–38 weeks 6 days
Full term	39 weeks 0 day–40 weeks 6 days
Late term	41 weeks 0 day–41 weeks 6 days
Post term	≥42 weeks

**Table 1.**  
*Definitions and gestational ages (GAs).*

If women are in spontaneous labor, in general, 96% will enter active phase of labor by 15 hours from the onset of contractions. If the duration of latent phase is prolonged, the rate of cesarean section (C/S) increases, as does the complication rate (e.g., postpartum hemorrhage, chorioamnionitis). However, >40% of patients with latent phase  $\geq 18$  hours will deliver vaginally [3].

If labor is induced, the vast majority of women will deliver vaginally. The failed IOL rate is 12–15% especially if the cervix is unripe at the onset of the intervention [4].

IOL should be considered as an appropriate option if it is based upon evidence-based medicine, optimizes maternal and fetal outcomes, and is cost-effective.

2. Timing of IOL

There are no clear recommendations regarding the timing of eIOL in early- and late-term pregnancies.

Awaiting 39 weeks GA is not required if there is a medical indication for IOL. Nonmedically indicated early-term IOL should not occur prior to 39 weeks GA. Because non-respiratory morbidity is also increased, simply documenting fetal lung maturity is inadequate to justify this intervention, even in suboptimally dated pregnancies [5].

Timing the IOL at 39 weeks GA vs. expectantly managing the pregnancy till onset of labor but before 42 weeks GA is a desirable option.

Bailit [6] studied 31,000 expectantly managed primiparas and found that there was a 5% rate of developing maternal hypertension after 39 weeks GA. Increased rates of fetal macrosomia and placental insufficiency also occurred. The risks for fetal death were also increased (Table 2).

Keulen et al. [7] described results of a study wherein IOL at 41 weeks GA was compared to expectant management until 42 weeks GA. Although there were no significant differences in the C/S rates between the two groups (10.8% in both), there were fewer adverse perinatal outcomes (5-minute Apgar score <7, meconium aspiration) in IOL group vs. in the expectant management group (1.7 vs. 3.1%).

Gulmezoglu et al. [8] reported on 9383 patients from 22 trials and found that expectant management, until onset of labor up to 42 weeks GA, resulted in a higher C/S rate (180/1000 women) vs. 160/1000 women with IOL and an increase in all-cause perinatal deaths [9] vs. 1 in the IOL group. The number needed to treat to benefit (NNTB) with IOL in order to prevent 1 perinatal death was 410 (95% CI 322–1492).

Sinkey et al. [10] reported on a Monte Carlo microsimulation model regarding eIOL at 39 weeks or expectant management (EM) with IOL for standard medical or obstetrical indications or at 41 weeks if undelivered. eIOL at 39 weeks resulted in fewer maternal and neonatal risks vs. EM with IOL at 41 weeks among undelivered

	All pregnancies/10,000	Low-risk pregnancies/10,000
GA		
39 weeks	3–4	1
40 weeks	4–5	2
41 weeks	4–7	3
42 weeks	7–12	4

Table 2.  
Risk of fetal death at  $\geq 39$  weeks GA.

patients. C/S rates were statistically significantly higher in the EM arm (35.9 vs. 13.9%). When patients had an unfavorable cervix, eIOL at 39 weeks resulted in fewer C/S vs. EM (8.0 vs. 26.1%;  $p < 0.01$ ). While there were no differences in maternal mortality between the two groups (0% eIOL vs. EM 0.01%,  $p = 0.32$ ), the maternal morbidity in EM was 21.2 vs. 16.5%  $p < 0.01$ . The still birth rate in eIOL was 0 vs. 0.13% in EM ( $p < 0.0003$ ). The neonatal deaths were 0.12% in eIOL vs. 0.25% in EM ( $p < 0.03$ ), and neonatal morbidity was 9.4% in eIOL vs. 12.1% in EM ( $p < 0.01$ ). Thus, preference modeling calculations revealed that 39-week eIOL was the preferred option over EM.

Grobman et al. [4] studied the perinatal consequences of IOL at 39 weeks GA among 6106 low-risk nulliparous women from 412 hospitals in an RCT parallel group, unmasked trial. Neonatal death or severe neonatal complications occurred in 4.3% in IOL group vs. 5.4% in the EM group (RR 0.80; 95% CI 0.64–1.00). The IOL group had an 18.6% C/S rate vs. 22.2% in EM group (RR 0.84; 95% CI 0.76–0.93). The rate of hypertension/preeclampsia was 9.1% in the IOL group vs. 14.1% in the EM group. They concluded that 1 C/S may be avoided for every 28 deliveries among low-risk nulliparas who undergo elective IOL at 39 weeks GA. They recommended that if eIOL option is not used, the patients should be informed of the higher likelihoods of developing hypertension/preeclampsia and of requiring a C/S when EM option is pursued.

### 3. Bishop score

The Bishop score is the most commonly used method for evaluating the ripeness of the cervix, which in turn helps predict the likelihood of a successful IOL, i.e., vaginal birth. This calculation was originally intended to help predict the likelihood of going into labor for multiparous women who were at term. Currently, the Bishop score is used to assess the likelihood of a successful vaginal delivery in both nulliparas and multiparas who are at term. The score includes assessment of cervical dilation, effacement, consistency, position, and station of the presenting part. A low score  $\leq 5$  suggested that spontaneous labor would not ensue within the next 2–3 weeks. A higher score ( $\geq 6$ –7) indicated a likelihood of labor occurring within the next 7–10 days. In the setting of a low Bishop score, the likelihood of a failed induction (i.e., need for C/S) is 25%. Thus, when an IOL is planned, every attempt should be made to first “ripen” the cervix, i.e., increase the Bishop score to a value  $\geq 7$ .

### 4. Techniques

Misoprostol, Cervidil, Foley balloon (with or without oxytocin), amniotomy, and stripping membranes are all accepted techniques for IOL. Each of those options has inherent risks and complications.

Misoprostol is cheap, is stable at room temperature, and can be used both orally and rectally even in resource poor settings. Although it is not FDA approved for this indication, it is a commonly chosen option. Wallstrom et al. [11] studied 4002 pts who received liquid misoprostol every 2 hours vs. receiving a rectal or oral tablet. The C/S rate was 17 vs. 26% with tablets, and there were no adverse perinatal outcomes (low Apgar scores, pH values, PPH). This option can be used when more rapid and reliable absorption of the agent is desired.

Cervidil (dinoprostone) is the only FDA-approved intervention for cervical ripening but is more costly than misoprostol. Tsikouris et al. [12] compared 50  $\mu$ g misoprostol vs. 3 mg dinoprostone in two vaginal doses 6 hours apart, followed as needed,

with oxytocin for labor induction in low-risk post term (>40 weeks GA) with unfavorable cervix (Bishop score  $\leq 6$ ). They found that women in the dinoprostone group were more likely to need a second vaginal dose in order to proceed to labor (43.4 vs. 21.5% in miso group,  $p = 0.01$ ). Both groups had equivalent rates of successful IOL (91.6% with miso vs. 85.8% with dinoprostone). Although, there was a shorter time to delivery with misoprostol vs. with dinoprostone (11 vs. 14.1 hours,  $p < 0.001$ ), this group demonstrated a higher rate of tachysystole miso (16.8 vs. 4.0%,  $p = 0.007$ ).

Bauer et al. [9] reported that in an RCT in 180 multiparas randomized to simultaneous use of Foley balloon with oxytocin vs. sequential use of oxytocin given after the Foley balloon was removed, there was a statistically increased likelihood of delivery within 24 hours with simultaneous use (87.8% in simultaneous group vs. 73.3% in sequential group;  $p = 0.02$ ). This group also had a significantly shorter induction to delivery interval and greater cervical dilation at balloon expulsion. The mode of delivery and intra-amniotic infection rates were similar. Thus, the simultaneous option is preferable.

Fruhman et al. [13] conducted an RCT on 140 women with Bishop score  $\leq 6$ , receiving either tension in 30 minutes increments on the Foley balloon catheter or no tension. The outcomes (vaginal delivery within 24 hours and C/S rates) were similar in the two groups, thus concluding that this intervention was not needed.

Smyth et al. [14] reported the results of a Cochrane review regarding the effectiveness and safety of amniotomy. Although amniotomy resulted in a 20-minute decrease in the first stage of labor and a lower rate of C/S, these were not statistically significant. Thus, amniotomy should not be a routine part of labor management but should only be considered if clinical indications exist, such as the need for internal fetal scalp electrode in order to obtain reliable fetal heart tracings.

Amniotic membrane stripping results in release of prostaglandins and is a safe, effective and inexpensive method to induce labor [15]. When performed at 38–40 weeks GA, it increases the likelihood of spontaneous labor, reduces the need for additional induction methods, and decreases the likelihood of pregnancies going post term. GBS prophylaxis is not indicated for this intervention. However, there is no data regarding hepatitis B or HIV transmission to fetus with this option, and patients should be informed accordingly.

## 5. Requirements for IOL

All patients should have accurate dating, ideally performed by reliance on last menstrual period (LMP) which has >90% accuracy if regular periods or by an early first trimester ultrasound, which has >99% accuracy. If there is a discrepancy between the two options, the best GA estimate should be utilized (**Table 3**).

## 6. Complications

The use of Foley balloon is associated with increased likelihood of infections and injury to the cervix and vagina. Additionally, malpresentations have occurred after vertex presentation at insertion of the Foley balloon. Injury to fetus (bruising/necrosis of ear, face, arm) have also been reported.

Oxytocin can be administered by low-dose, intermediate-dose, or high-dose protocols. Low dose is 3 mu/min, intermediate dose is 4–6 mu/min, and high dose is >6 mu/min. The low-dose option results in longer duration of IOL. High dose results in increased rates of tachysystole with or without FHR abnormalities. Intermediate-dose protocol is preferred because it results in lower C/S rates vs. the



GA	Discrepancy	Action
First trimester (using CRL)		
<8 weeks 6 days	>5 days	Use u/s calculated dates
9 weeks 0 day–13 weeks 6 days	>7 days	Use u/s calculated dates
Second trimester (using BPD, HC, AC, FL)		
14 weeks 0 day–15 weeks 6 days	>7 days	Use u/s calculated dates
16 weeks 0 day–21 weeks 6 days	>10 days	Use u/s calculated dates
22 weeks 0 day–27 weeks 6 days	>14 days	Use u/s calculated dates
Third trimester (using BPD, HC, AC, FL)		
≥28 weeks 0 day	>21 days	Use u/s calculated dates*

\*Least accurate for redating, considering IUGR.

**Table 3.**  
*Dating of pregnancy using LMP and ultrasound.*

		Autism/ASD+	Autism/ASD–
		49	104
No exposure	12%	28%	NS
Yes exposure	88%	72%	NS

**Table 4.**  
*Exposure to L&D drugs (oxytocics, epidural).*

other two protocols and there is no associated increase in the induction to delivery time. Complications are hyperstimulation/tachysystole and can result in fetal compromise or uterine rupture. Water intoxication (low urine output and fluid retention) has also been reported. AF embolism although rare can occur in the third stage of labor, after placental separation.

Concerns about autism in neonates after maternal oxytocin use have not been proven. Current evidence does not identify a causal relationship between oxytocin for IOL and autism. The ACOG recommends against any changes in current practices regarding the use of this agent [16].

A research group from the SW Autism Research & Resource Center (SARRC) surveyed mothers with affected children and found that the rates were no different in groups that used medications (oxytocin + epidural) in labor vs. those who did not. Thus, the authors concluded that exposure to L&D drugs was not an independent risk factor for autism/autism spectrum disorders (**Table 4**).

7. Setting of IOL

At present, the vast majority of IOL occur within hospital settings. These interventions require the use of significant resources (lab studies, labor rooms, fetal heart rate and contraction monitoring, RN involvement, analgesia). In general, the cervical ripening process (prior to the onset of labor) requires approximately 8–12 hours. This intervention increases the overall duration of the patient’s admission in the hospital. In a Cochrane review of outpatient cervical ripening, 5003 term, low-risk women were pooled from 34 RCTs. IOL, either totally in an outpatient setting or sending the patient home shortly after initial treatment had been initiated in

hospital setting, was deemed safe and satisfactory [17]. The most preferred method for this intervention was nonpharmacologic, i.e., cervical Foley balloon. Patient acceptance and satisfaction were not markedly different with this option.

8. Labor management

Spong et al. [3] recommend that for all obstetrical care, the focus should be to minimize perinatal morbidity and decrease the chance of a C/S. If maternal and fetal condition remains reassuring, nonintervention in the latent phase of labor is paramount. A latent phase up to 24 hours and the use of oxytocin for at least 12–18 hours after rupture of membranes and with adequate contractions should be obtained before declaring that IOL has failed (Table 5).

Failed IOL	Failure to obtain cervical dilation after 24 hours of strong/regular contractions with oxytocin use and rupture of membranes
First-stage arrest	≥6 cm dilation with rupture of membranes
	≥4 hours adequate uterine contractions
Second-stage arrest	No descent/rotation after
	≥4 hours in nullips with epidural
	≥3 hours in nullips without epidural
	≥3 hours in multips with epidural
	≥2 hours in multips without epidural

Table 5.  
Definition/duration of failed inductions and arrest disorders.

9. Cost implications

At present, approximately 25% of the 4 million annual US births undergo IOL. These currently occur at varying GAs and are due to clinically accepted indications. Elective IOL in all low-risk pregnant women would result in a strain on current resources and would take away from the availability of these resources from clinically indicated scenarios (spontaneous labor). Therefore, if this option is chosen, there should be maximum communication and coordination between healthcare providers and hospital personnel along with the patient and her support personnel. Grobman [18] reported that existing opinions regarding increased costs related to IOL may be due to the belief that there is increased resource utilization and possible adverse outcomes such as C/S. When IOL is compared to spontaneous labor, observational studies lean toward increased costs. However, when IOL costs are compared to expectant management, the costs appear to be similar, but there are improved perinatal outcomes. Additionally, there is minimal to no information regarding outpatient costs due to expectant management.

10. Ethics

In a statement about ethical decision-making, the ACOG recommends that the major principles guiding IOL should involve respect for patient’s autonomy,

beneficence, nonmaleficence, and justice [19]. As has been shown in the discussions within this document, at every step of the process of IOL, the clinician must make every effort to respect the patient's autonomy (i.e., self-rule, whereby she can apply her own moral principles) while acknowledging the limitations of her ability to fully understand and therefore participate in such medically complex decision-making for herself and her baby. This concept, along with the other ethical principles stated herein, creates the moral foundation of informed consent, which must be integrated into the fabric of direct patient care.

## 11. Conclusions

Given the option, over 50% of women with uncomplicated pregnancies would elect to be induced [20]. However, IOL is associated with increased utilization of labor and delivery resources. One way to help address these issues is to preferentially choose outpatient settings for some interventions (e.g., membrane sweeping or cervical ripening agents), in order to decrease clogging up inpatient resources. Creating a model similar to a VBAC calculator could be beneficial in identifying the likelihood of success with eIOL and of neonatal morbidity.

## Author details

Donald Morrish<sup>1</sup> and Iffath Abbasi Hoskins<sup>2\*</sup>

<sup>1</sup> St. John's Episcopal Hospital, Queens, NY, USA

<sup>2</sup> NYU School of Medicine, New York, NY, USA

\*Address all correspondence to: [iffath.hoskins@nyulangone.org](mailto:iffath.hoskins@nyulangone.org)

## IntechOpen

© 2019 The Author(s). Licensee IntechOpen. This chapter is distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/3.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. 



## References

- [1] Bonsack C, Lathrop A, Blackburn M. Induction of labor. Update and review. SMWH. Vol 59#6; November/December 2016
- [2] ACOG Committee Opinion # 579. Definition of term pregnancy; Reaffirmed 2017
- [3] Spong C, Berghella V, Saade GR, et al. Preventing the first cesarean delivery. *Obstetrics and Gynecology*. 2012;**120**(5):1181-1193
- [4] Grobman WA, Bailit Y, et al. Defining failed IOL. *American Journal of Obstetrics and Gynecology*. 2018;**218**:122.e1-122.e8
- [5] ACOG Committee Opinion #561 Nonmedically indicated early-term deliveries; May 2018
- [6] Bailit JL. Ohio perinatal quality collaborative. *American Journal of Obstetrics and Gynecology*. 2010;**203**:e1-e3
- [7] Keulen JKJ, Bruinsma A, Kortekaas JC, et al. *BMJ*. 2019;**364**:1344
- [8] Gulmezoglu AM, Crowther CA, Middleton P, Heatley E. IOL for improving birth outcomes at or beyond term. *Cochrane Database of Systematic Reviews*. 2012;(6):CD004945
- [9] Bauer AM, Lappen JR, Gecsi KS, et al. Cervical ripening balloon with and without oxytocin in multiparas: An RCT. *American Journal of Obstetrics and Gynecology*. 2018;**219**(3):294, e6
- [10] Sinkey RG, Lacevic J, Reljic T, et al. Elective induction of labor at 39 weeks among nulliparous women: The impact on maternal and neonatal risk. *PLoS ONE*. 2018;**13**(4):e0193169
- [11] Wallstrom T, Jambert Pettersson H, Stenson D, et al. Labor induction with orally administered misoprostol: A retrospective cohort study. *BioMed Research International*. 2017:6840592. ePub September 18
- [12] Tsikouris P, Koukouli Z, Manav B, et al. Induction of labor in post term nulliparas and parous women-potential advantages of misoprostol over dinoprostone. *Geburtshilfe und Frauenheilkunde*. 2016;**76**(7):785-792
- [13] Fruhman G, Gavard JA, Amon E, et al. Tension compared to no tension on a Foley transcervical catheter for cervical ripening: RCT. *American Journal of Obstetrics and Gynecology*. 2017;**216**(1):67
- [14] Smyth RM, Markham C, Dowswell T. Amniotomy for shortening spontaneous labor. *Cochrane Database of Systematic Reviews*. 2013;**6**:CD006167
- [15] Hellman E, Sushereba E. Amniotic membrane sweeping. *Seminars in Perinatology*. 2015;**39**(6):466-470
- [16] ACOG. Committee opinion # 597: Labor induction or augmentation and autism. *Obstetrics and Gynecology*. 2014;**123**(5):1140-1142
- [17] Vogel JP, Osoti AO, Kelly AJ, et al. Pharmacological and mechanical interventions for labour induction in outpatient settings. *Cochrane Database of Systematic Reviews*. Sep 2017;(9):CD007701
- [18] Grobman WA. Costs of elective IOL. *Clinical Obstetrics and Gynecology*. 2014;**57**(2):363-368
- [19] ACOG Committee Opinion # 390. 2007. Ethical Decision Making in Obstetrics and Gynecology; Reaffirmed 2019

[20] Out JJ, Vierhout ME, Verhage F,  
et al. Characteristics and motives  
of women choosing eIOL. *Journal*  
*of Psychosomatic Research*.  
1986;**30**:375-380

IntechOpen

IntechOpen