Induction of Labor: Past, Present, and Future

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Women & Infants Hospital of Rhode Island
Purpose/Goal(s) of this Education Activity
The purpose of this activity is to enable the learner to expand their knowledge with new information related to labor induction.

1.0 Contact Hour
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Induction of Labor

Past
Present
Future

National Perinatal Information Center
January 23, 2019
I have no disclosures
Objectives

• Identify origins and evolution of modern labor inductions
• Describe current indications and methods of labor inductions
• Examine the findings and assess the implications of the ARRIVE trial
History of Induction
Earliest Reports

• Hippocrates (2BC) - descriptions of mammary stimulation and mechanical dilation of the cx
• 1810 – first reference of membrane sweeping
• 1861 – Barnes use of rubber water filled balloon
• 1909 – first report on use of posterior pituitary extract for PP hemorrhage by Bell
  – As use expanded to IOL complications noted due to large dose and impurities with method discredited due to uterine rupture
• Mechanical cx dilation used in 1930’s to expedite VD in emergencies.
  – As safety improved used for IOLs
1940’s – 1950’s

- Use of post-pituitary extract in physiologic amounts in OB – BMJ 1948
  - IOL method using quinine followed by ‘pituitrin’ drip – safe and successful in 50 to 60% of cases at term

  - Chronicles first synthesis of polypeptide hormone
  - Same potency as ‘natural oxytocin’
1960’s onwards

• Foley catheter use for IOL in 1967
  – 26Fr Foley w 50mL balloon; ambulation allowed; AROM after expulsion
  *Embrey RT, Mollison P. BMJ 1967*

• Prostaglandin use began in 1960’s
  – Growing literature in the 1970’s with use of IV, vaginal and oral PGE2 and PGF2a.
  – PGE2 insert FDA approved in 1995

• Use of laminaria and hygroscopic mechanical dilators in 1980’s
  – Laminaria with increased infectious morbidity
Increase in IOL Rates

Rate of IOL doubled between 1989 and 1997 with further 40% increase in last 20 years

National Vital Statistics, CDC
Increase in IOL Rates

National vs. WIH IOL Rates

National vs. WIH IOL Rates

National Vital Statistics, CDC
Cervical Ripening

Cx Assessment/Bishop score

- Original publication in 1964 amidst intense controversy regarding EIOL
- Felt differing results were based on patient selection & proposed method as a tool
- Felt IOL was only to be used as elective intervention and any factor that increased risk to the PG was contraindication

• Required multiparity & recommended no EIOL until PG within 3 weeks of term
• Eligible pts had cx exam in last wk of PG as ‘guide to determining proximity to spontaneous labor’
• Favorable score ≥ 9
• Method could be used to more accurately date for EIOL & ERCS
Cervical Ripening
Cx Assessment/Scoring Systems

- Alternatives proposed
  - Cervical length vs % effacement
  - 10 point system of Burnett (1966) scoring all 5 elements 0 to 2

- 3 element system with doubled weighting to cx dilation (Lange et al. 1982)
  - Prediction of inducibility
    - Latency time
    - Duration of labor
  - Ability for AROM, not parity, key factor to success

<table>
<thead>
<tr>
<th>STATION In relation to the spines</th>
<th>-3 cm</th>
<th>-2 cm</th>
<th>-1 to 0 cm</th>
<th>1 to 2 cm</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DILATATION Of the cervix</th>
<th>0 cm</th>
<th>1 to 2 cm</th>
<th>3 to 4 cm</th>
<th>&gt;4 cm</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>2</td>
<td>4</td>
<td>6</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>LENGTH Of the cervix</th>
<th>0 cm</th>
<th>2 cm</th>
<th>1 cm</th>
<th>0 cm</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

Cervical Ripening
Cx Assessment/Simplified Bishop score

• Attempt to determine if simplified 3-element score would have same or increased predictive value for VD

• Original Bishop score created on empiric basis & logistic regression applied

• Dilation, station & effacement had statistical significance and 3 highest regression coefficients

• WIH now uses simplified Bishop score
  – Scores of $\geq 5$ (nullip): $\geq 3$ (multip) with cx dilation of $\geq 3$cm for EIOL

<table>
<thead>
<tr>
<th>Component</th>
<th>Regression Coefficient*</th>
<th>$P$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dilation (cm)</td>
<td>.45</td>
<td>$&lt;.001$</td>
</tr>
<tr>
<td>Station</td>
<td>.32</td>
<td>$&lt;.009$</td>
</tr>
<tr>
<td>Effacement (%)</td>
<td>.15</td>
<td>$&lt;.001$</td>
</tr>
<tr>
<td>Consistency</td>
<td>.13</td>
<td>.07</td>
</tr>
<tr>
<td>Position</td>
<td>.01</td>
<td>.06</td>
</tr>
</tbody>
</table>

IOL Process
Pre-requisite Bishop scores for EIOL

- Impact of development and implementation of guidelines for EIOL
- Pre-requisite Bishop score of ≥ 8 (nullip) & ≥ 6 (multip) for EIOL
- Results
  - Decrease in overall IOL rate (24.9 to 16.6%, p<.001)
  - Decrease in EIOL rate (9.1 to 6.4%, p<.001)
  - Decrease in CS nullip EIOLs (34.5 to 13.8%, p = .01)
- Significant cost and LOS reductions noted as result of guideline changes

Comparison of accuracy of transvaginal US vs Bishop score in prediction of VD within 24h of IOL

- Best cut-off point for prediction of successful IOL was 28mm (Bishop score of 3)

- Cx length < 19 mm deliver within 24h; > 31 mm have 84% chance of remaining undelivered
- Cx length a better predictor than Bishop score

- Sensitivity 0.87 vs 0.58; specificity 0.71 vs 0.77
## Induction Process
### Triage/Priority of Indications

<table>
<thead>
<tr>
<th>Level 1 – Highest Priority</th>
<th>Level 2</th>
<th>Level 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eclampsia</td>
<td>PEC</td>
<td>Significant pain <em>(requiring narcotic)</em></td>
</tr>
<tr>
<td>NR Fetal Testing</td>
<td>Oligohydramnios</td>
<td>ITP</td>
</tr>
<tr>
<td>Abruptio Placenta</td>
<td>Cholestasis</td>
<td>Polyhydramnios</td>
</tr>
<tr>
<td>Chorioamnionitis</td>
<td>Seizures – poor control</td>
<td>Prolonged latent phase</td>
</tr>
<tr>
<td>FGR – AEDF/REDF</td>
<td>Renal disease</td>
<td>Prior shoulder dystocia</td>
</tr>
<tr>
<td>DM – poorly controlled</td>
<td>FGR</td>
<td>Distance from hospital/risk of rapid labor</td>
</tr>
<tr>
<td>PEC w severe features</td>
<td>DM – T1,T2, GDMA1</td>
<td>Elective/Social</td>
</tr>
<tr>
<td>Isoimmunization</td>
<td>Antiphospholipid syndrome</td>
<td></td>
</tr>
<tr>
<td>Fetal Demise</td>
<td>GHTN</td>
<td></td>
</tr>
<tr>
<td>PROM</td>
<td>CHTN</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mono-di twins</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Di-di twins</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Late Term</td>
<td></td>
</tr>
<tr>
<td></td>
<td>GDM, diet</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Chronic pulmonary disease</td>
<td></td>
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<tr>
<td></td>
<td>Receiving anticoagulants</td>
<td></td>
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<tr>
<td></td>
<td>Gestational thrombocytopenia</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fetal anomaly</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Prior stillbirth</td>
<td></td>
</tr>
</tbody>
</table>
Membrane Sweeping/Stripping

• Cochrane Review (2005) included 22 trials (2,797 women)
  – Associated with reduced frequency of PG continuing beyond 41 wks (RR 0.59, CI 0.46 to 0.74) an 42 wks (RR 0.28, CI 0.15 to 0.50)
  – To avoid 1 formal IOL membrane sweeping must be performed in 8 patients
  – Routine sweeping from 38 wks does not seem to produce clinical important benefits
  – One study evaluated GBS with no additional risk found, but study too small to rule out effect

Cervical Ripening
Mechanical Methods – Foley Balloon

• Balloon expulsion in 90% of pts w/i 12 hrs
  – Average time for expulsion = 6.1 hrs
• Mean duration of labor to delivery time = 12.8hrs
  – Balloon insertion to delivery interval = 21.2 hrs
  – 94% of pts delivered within 36 hrs of insertion
• Most studies show Foley with **better cx change** & **shorter time interval to delivery than PG**
• Some studies remove Foley at pre-designated time; others wait for it to dislodge

Cervical Ripening
Mechanical Methods

- Inflation effect on cx dilation (3 cm) – **81.6%** with **80 mL** vs **57.7%** with **30 mL**
  - Shorter IOL to delivery interval in primips
  - Increased deliveries within 24 h in primips
  - Decreased oxytocin requirements in primips

- Foley catheter use with TOLAC
  - No specific ACOG recommendations; SOGC may use
  - Uterine rupture rates – SL 0.45%; **Foley 0.76%**; IOL without cx ripening 0.74%; PGE2 gel 2.9%
  - OR for rupture with cx ripening 3.92; miso OR = 25; Foley OR = 6.5

Cervical Ripening
Mechanical Methods – Foley Balloon

• Randomized trial w 18F Foley inflated to either 30 mL (95 pts) or 60 mL (100 pts)

<table>
<thead>
<tr>
<th></th>
<th>30-mL Balloon</th>
<th>60-mL Balloon</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Labor and delivery</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time to expulsion of FB* (h)</td>
<td>3.1 (1.9–5.8)</td>
<td>3.9 (2.4–6.5)</td>
<td>.068</td>
</tr>
<tr>
<td>Dilation after expulsion (cm)*</td>
<td>3 (3–4)</td>
<td>4 (3–4)</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>Time to active labor (h)*</td>
<td>10.4 (6.5–19.3)</td>
<td>10.5 (5.3–16.3)</td>
<td>.44</td>
</tr>
<tr>
<td>Delivery time (h)*</td>
<td>20.0 (13.9–30.0)</td>
<td>18.8 (12.0–27.1)</td>
<td>.37</td>
</tr>
<tr>
<td><strong>Delivery within 12 h</strong></td>
<td>13 (14)</td>
<td>25 (26)</td>
<td>.04</td>
</tr>
<tr>
<td>Delivery within 24 h</td>
<td>60 (64)</td>
<td>65 (66)</td>
<td>.72</td>
</tr>
<tr>
<td>Delivery method</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SVD</td>
<td>62 (66)</td>
<td>62 (63)</td>
<td>.71</td>
</tr>
<tr>
<td>Vacuum-assisted vaginal</td>
<td>3 (3)</td>
<td>3 (6)</td>
<td></td>
</tr>
<tr>
<td>Forceps-assisted vaginal</td>
<td>9 (10)</td>
<td>7 (7)</td>
<td></td>
</tr>
<tr>
<td>Cesarean</td>
<td>20 (21)</td>
<td>23 (23)</td>
<td></td>
</tr>
</tbody>
</table>

– Higher rates of delivery within 12h especially with nulliparous women (p = .04) and greater dilation at removal (3 vs. 4 cm, p < .01)
– No difference in median time to delivery, deliveries within 24h and frequency of CD

Delaney S, Shaffer BL, Cheng YW, Vargas J, Sparks TN, Paul K, Caughey AB. Labor Induction with a Foley Balloon Inflated to 30 mL Compared with 60 mL. Obstet Gynecol 2010;115:1239-45
Prospective randomized trial using single- (145 pts) vs double-balloon (148 pts) catheters

- Both single-balloon & double-balloon devices equally efficacious for IOL (insertion to del time 19.4 & 19.1h)

- Spontaneously expulsion of catheter had shorter time to delivery & lower proportion of operative deliveries

Cervical Ripening
Mechanical Methods + Other Agents

• Mixed results in trials of Foley with concurrent oxytocin
  – No impact on time to delivery
  – Change in Bishop score from 2.4 to 10.1 in 4h
    • 77.8% expulsion rate by 4h and 83.3% VD rate


• Mixed results with Foley and extra-amniotic saline infusion (EASI)

Cervical Ripening
Prostaglandins

- Extensively studies with different agents, doses and routes of administration without consensus as to optimal approach
- PGs should effect physical and biochemical changes in cervix without excessive uterine activity
  - Dissociation of collagen fibers with increase and alteration in glycosaminoglycans
  - PGE2 may result in enhanced myometrial sensitivity to oxytocin
Cervical Ripening
Prostaglandins – Dinoprostone (PGE2)

• Current vehicles – gel and insert
  – Historical routes – oral and suppository
• Ripening with PGE2 suppository vs. oxytocin vs. placebo with patients with PROM
  – Lower rate of CD with PGE2 followed by oxytocin vs oxytocin alone
  – Time to delivery 13.9h (PGE2) vs 16.3h (oxytocin) with both regimens shorter than placebo
  – No improvement in outcome was noted with delay of IOL

Cervical Ripening
Prostaglandins – Dinoprostone (PGE2)

• RCT of PGE2 Pessary vs. placebo
  – More likely to increase Bishop score by ≥ 3, change Bishop score to ≥ 6 and trigger active labor (68% v 15%, p < .001)


• Trial of PGE2 an PGF2a for IOL
  – Insufficient data to make conclusions


• PGE2 insert by FDA approved in 1995
Cervical Ripening
Prostaglandins – Misoprostol (PGE1)

- Meta-analysis review of misoprostol for cervical ripening *(8 trials, 966 pts)* compared with other PGs, oxytocin or placebo
  - *Lower CD rates* (OR 0.67)(15% vs 21.5%, p=.02)
  - *Higher rate of vaginal delivery* within 24h (OR 2.64)
  - Higher incidence of tachysystole (OR 2.70)
  - Reduced number of patients requiring oxytocin
  - Mean interval from start of IOL to delivery 4.6h less
  - *50 mcg dose* with *shorter insertion to delivery* and VD times of 5 and 7h compared to 25 mcg dose with increased tachysystole but similar NN outcomes

Misoprostol vs. Other Agents

<table>
<thead>
<tr>
<th></th>
<th>Improved</th>
<th>Same</th>
<th>Worse</th>
</tr>
</thead>
<tbody>
<tr>
<td>PGE1/PGE2 gel</td>
<td>✓✓✓</td>
<td>✓✓</td>
<td>✓</td>
</tr>
<tr>
<td>PGE1/PGE2 insert</td>
<td>✓✓✓✓</td>
<td>✓✓</td>
<td>✓</td>
</tr>
<tr>
<td>PGE1/Oxytocin</td>
<td>✓✓✓</td>
<td>✓✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

- Higher rate of tachysystole with misoprostol

Oral vs. vaginal misoprostol
- Shorter time to delivery with vaginal but more abnormal EFM
Bracketed Times from Prostin to LR Transfer

- 106 patients (91%)
- 71 patients (51%)
- 39 pts (28%)

4 to 20 hrs:
- 19

6 to 16 hrs:
- 8
- 12

6 to 8 hrs:
- 19

4 to 20 hrs:
- 18

< 2 hrs:
- 5

2 to 4 hrs:
- 8

4 to 6 hrs:
- 13

6 to 8 hrs:
- 21

8 to 12 hrs:
- 16

10 to 12 hrs:
- 7

12 to 16 hrs:
- 12

> 24 hrs:
- 7

16 to 20 hrs:
- 7

20 to 24 hrs:
- 7

> 24 hrs:
- 7

Total:
- 106

Percentage:
- 91%
- 51%
- 28%
Cervical Ripening

“We like to try all of our options before using drugs to induce labor.”
Cervical Ripening
Outpatient

- RCT with PGE2 gel vs placebo for 5 consecutive days
  - Median 4 days to delivery in PGE2 group vs 10 days with placebo

- Outpatient vs. Inpatient Foley
  - 9.6h reduction in LOS
  - No difference in Bishop score, duration of IOL, oxytocin dose, Apgars, UA cord pH


Ongoing debate as to optimal regimen, but no debating costs

- Misoprostol 50 mcg tablet - $0.49 (74.4%)
- Misoprostol 100 mcg tablet - $0.98
- Cervidil (PGE2) insert - $385.63 (7.6%)
- Prostin (PGE2) suppository - $2,208.12
- Foley catheter – $11.00 (80.1%)
- Cook double-balloon device - $41.25
- Utah double-balloon device - $42.36
Physiology of Uterine Contractions

- Clinical labor starts when uterine activity reaches between 80 and 120 MVUs
- Typical labor pattern
  - Baseline of 8 to 12 mm Hg
  - Ctx 25 to 50 mm Hg (3 to 5 ctx/10 min)
- Uterine hyperactivity > 250 MVUs
- Baseline hypertonus
  - Weak – 12 to 20 mm Hg
  - Moderate – 20 to 30 mm Hg
  - Strong - > 30 mm Hg

Induction of Labor
Oxytocin Physiology

• Two types of oxytocin receptors – myometrial and decidual
• Myometrial receptors increase with increasing GA
  – Increase slowly between 20 and 30 weeks
  – Stable period from 34 weeks
  – Rapid increase just prior to labor at term
  – Decreased sensitivity after 40 weeks

Induction of Labor
Oxytocin Pharmacokinetics

• Misconception of half-life of 3 to 4 minutes informed early methods of treatment
  – Time to reach steady state generally accepted as approximately 4 half-lives and resulted in dosage intervals of 15 to 20 minutes

• Seitchik et al. found steady state concentration reached at 40 to 60 min (42 min)
  – Also found variations of plasma oxytocin levels to produce effective ctx among patients
  – Seitchik & Castillo proposed dosage intervals of 30 minutes
Induction of Labor
Oxytocin Management Principles

• Uterine activity
  – After reaching maximum efficiency further increases in oxytocin results in slowing or interruption of myometrial blood flow & accumulation of metabolites
  – *Decrease in effective magnitude* of uterine pressure

• Cervical dilation rate
  – Rate of approximately 1cm/h in active labor

• Fetal Response
  – Intermittent decrease or interruption in blood flow to intervillous space impacting fetal oxygen during contractions

Induction of Labor
Oxytocin Fetal Impact

- Study of impact of uterine activity on fetal oxygen status and FHR patterns
  - 56 healthy nullip patients with EIOL evaluated retrospectively over 30 minutes with different levels of uterine activity
  - Assessment of fetal oxygen status using FSpO2 sensor

Induction of Labor
Oxytocin Protocols

- Optimal initial oxytocin dose, interval and frequency of dosage increase, and methods of infusion are subject of considerable debate
- Meta-analysis of 11 trials with 1,699 patients (840 low-dose/859 high-dose)
  - Low-dose - fewer episodes of tachysystole (OR 0.41, CI 0.33-0.52)
  - Low-dose – higher rate of SVD (OR 1.67, CI 1.27-2.20)
  - Low-dose – fewer OVDs (OR 0.58, CI 0.40-0.83)
  - Low-dose – trend toward lower CD rate (OR 0.78, CI 0.60-1.02)
  - Also lower rates of PP maternal infection and PPH in low-dose group
- **Conclusion:** Although ideal regimen not known, IOL with **minimal dose of oxytocin** to achieve active labor and increasing intervals no more frequently than **30 minutes**, is appropriate

Induction of Labor
Oxytocin Protocols

• Randomized, double-masked comparison of oxytocin dosage in IOL. Merrill DC, Zlatnik FJ. Obstet Gynecol 1999;94:455-63.
  – Low-dose -1.5mU/m increased by 1.5mU/m every 30m
  – High-dose – 4.5mU/m increased by 4.5mU/m every 30m
  – Time to full dilation and delivery decreased in high-dose group by approx 2h with decreased cost of care

  – 2 regimens with oxytocin increased every 60m or 20m
  – Lower incidence of CD in low-dose group (13.1% vs 30.7%, p = .02)
  – Shorter time to active labor, full dilation and delivery for VDs in high-dose group (4.5h vs 6.9h, 10.7h vs 12.2h, 11.4h vs 13.2h)
  – Overall time from admission to delivery shorter in low-dose group (13.2h vs 20.5h)
Induction of Labor Oxytocin Protocols

  - **No statistically significant differences** for duration of any stage of labor, quantitative assessment of uterine activity, incidence of hyperstimulation or NN outcome

  - Prospective study of low-dose (1mU/m increments) vs high-dose (6mU/m increments) in singleton cephalic PGs
  - Labor stimulation > 3h lower in high-dose (p<.0001)
  - Reduction in NN sepsis in high-dose (0.2 vs 1.3%, p<.01)
  - Failed IOL less frequent
  - Shorter time in LR

**Conclusion:** high-dose oxytocin for IOL is potentially problematic but in contrast for augmentation may reduce rate of CD for dystocia
Induction of Labor
Oxytocin Checklist

- Conservative oxytocin checklist develop and introduced at HCA hospitals
- **Max oxytocin dose decreased** 13.8 to 11.4mU/m (p=.003)
- No change in time to delivery
- **CD rate decreased** from 23.6 to 21.0% system-wide
- Every index of NN outcome improved but did not reach statistical significance

# Induction of Labor

## IOL Times vs. Spontaneous Labor

<table>
<thead>
<tr>
<th>Type of Delivery</th>
<th>Mean LOS (days)</th>
<th>Median LOS (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>IOLs</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cesarean Deliveries</td>
<td>4.73</td>
<td>4.2</td>
</tr>
<tr>
<td>Vaginal Deliveries</td>
<td>3.18</td>
<td>2.82</td>
</tr>
<tr>
<td><strong>Non-IOLs</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cesarean Deliveries</td>
<td>4.02</td>
<td>3.23</td>
</tr>
<tr>
<td>Vaginal Deliveries</td>
<td>2.45</td>
<td>2.3</td>
</tr>
<tr>
<td><strong>Differences</strong></td>
<td></td>
<td></td>
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<tr>
<td>Cesarean Deliveries</td>
<td>0.71</td>
<td>0.97</td>
</tr>
<tr>
<td>Vaginal Deliveries</td>
<td>0.73</td>
<td>0.52</td>
</tr>
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</table>
## Induction of Labor
### IOL Times vs. Spontaneous Labor

<table>
<thead>
<tr>
<th>Type of Delivery</th>
<th>Mean (hrs)</th>
<th>Median (Hrs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>IOLs - LR</td>
<td>15.89</td>
<td>13.2</td>
</tr>
<tr>
<td>IOLs – ACU</td>
<td>11.5</td>
<td>9.88</td>
</tr>
<tr>
<td>Total IOL Time</td>
<td>27.39</td>
<td>23.08</td>
</tr>
<tr>
<td>Labor – VDs</td>
<td>10.77</td>
<td>9.77</td>
</tr>
<tr>
<td><strong>Difference - LR Bed Time</strong></td>
<td><strong>5.12</strong></td>
<td><strong>3.43</strong></td>
</tr>
<tr>
<td><strong>Difference – Total Bed Time</strong></td>
<td><strong>16.62</strong></td>
<td><strong>13.31</strong></td>
</tr>
<tr>
<td>Labor – PCS</td>
<td>13.08</td>
<td>9.31</td>
</tr>
<tr>
<td><strong>Difference</strong></td>
<td>2.81</td>
<td>3.89</td>
</tr>
<tr>
<td>Labor – RCS</td>
<td>11.84</td>
<td>4.08</td>
</tr>
<tr>
<td><strong>Difference</strong></td>
<td>4.05</td>
<td>9.12</td>
</tr>
</tbody>
</table>
## Time Lines (Mean)

<table>
<thead>
<tr>
<th>Indication</th>
<th>No</th>
<th>CS Rate</th>
<th>ACU (hrs)</th>
<th>LR (hrs)</th>
<th>MBU (hrs)</th>
<th>LOS (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HTN</td>
<td>50</td>
<td>24%</td>
<td>35.85</td>
<td>18.43</td>
<td>55.14</td>
<td>4.46</td>
</tr>
<tr>
<td>HTN*</td>
<td>46</td>
<td>24%</td>
<td>18.93</td>
<td>18.44</td>
<td>53.85</td>
<td>3.78</td>
</tr>
<tr>
<td>Late Term</td>
<td>46</td>
<td>23.9%</td>
<td>11.79</td>
<td>14.06</td>
<td>50.18</td>
<td>3.12</td>
</tr>
<tr>
<td>PROM</td>
<td>32</td>
<td>18.8%</td>
<td>9.18</td>
<td>15.26</td>
<td>49.57</td>
<td>3.35</td>
</tr>
<tr>
<td>DM</td>
<td>19</td>
<td>15.8%</td>
<td>17.99</td>
<td>14.23</td>
<td>44.68</td>
<td>3.01</td>
</tr>
<tr>
<td>Oligo</td>
<td>16</td>
<td>6.3%</td>
<td>19.0</td>
<td>16.46</td>
<td>42.06</td>
<td>3.36</td>
</tr>
<tr>
<td>NRFT</td>
<td>13</td>
<td>30.8%</td>
<td>9.79</td>
<td>14.16</td>
<td>51.39</td>
<td>3.22</td>
</tr>
<tr>
<td>Elective</td>
<td>11</td>
<td>9.1%</td>
<td>-----</td>
<td>27.97</td>
<td>40.28</td>
<td>2.31</td>
</tr>
<tr>
<td>FGR</td>
<td>11</td>
<td>27.3%</td>
<td>19.31</td>
<td>17.2</td>
<td>57.01</td>
<td>3.79</td>
</tr>
<tr>
<td>Chol</td>
<td>5</td>
<td>20%</td>
<td>22.1</td>
<td>20.6</td>
<td>49.47</td>
<td>3.89</td>
</tr>
<tr>
<td>Misc</td>
<td>8</td>
<td>12.5%</td>
<td>16.18</td>
<td>16.02</td>
<td>48.36</td>
<td>3.2</td>
</tr>
<tr>
<td><strong>All IOLs</strong></td>
<td></td>
<td></td>
<td><strong>16.04</strong></td>
<td><strong>15.89</strong></td>
<td></td>
<td><strong>3.35</strong></td>
</tr>
</tbody>
</table>

* Removal of 3 outliers with long antepartum stay prior to IOL
Cost differential for IOL by method of delivery

- 2013 and 2017 cost analyses

<table>
<thead>
<tr>
<th>Year</th>
<th>VD</th>
<th>CS</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>+ $1,468</td>
<td>+ $3,521</td>
</tr>
<tr>
<td>2017</td>
<td>+ $2,068</td>
<td>+ $4,187</td>
</tr>
</tbody>
</table>
Induction Outcomes

Recent Studies
EIOL vs EM

  - Retrospective cohort all deliveries in CA in 2006
  - Odds of CD lower with EIOL vs EM across all GAs from 37 through 40 weeks
  - Retrospective cross-sectional study from Consortium for Safe Labor (12 US institutions – 19 hospitals) 2002 through 2008 healthy TSV PGs 37 through 41 weeks
  - Same results as Darney study
  - Suggested entry criteria for ARRIVE trial be revised to include lower GA patients
ARRIVE Trial

A Randomised Trial of Induction versus Expectant Management

Labor Induction versus Expectant Management in Low-Risk Nulliparous Women

The NEW ENGLAND JOURNAL of MEDICINE

Established in 1812
August 9, 2018
Vol. 379 No. 6

Abstract

- **Purpose**: Assess perinatal and maternal consequences of IOL at 39 weeks gestation in low risk nulliparous women
- **Methods**: Random assignment to IOL between 39’0 and 39’4 weeks or EM
  - Primary outcome: composite of perinatal death or severe NN complications
  - Secondary outcome: CS rate
  - 3,062 women to IOL; 3,044 women to EM
• **Results**
  – Primary outcome in 4.3% in IOL group and 5.4% of EM group (RR 0.80, CI 0.64 to 1.00)
  – Secondary outcome in **18.6% of IOL group** and **22.2% of EM group** (**RR 0.84, CI 0.76 to 0.93**)

• **Conclusions**
  – IOL at 39 weeks did not result in lower frequency of composite adverse NN events, but did result in **decreased frequency of CD**
Background & Participants

- Prior conclusions re: CS rates flawed in that spontaneous labor patients were used as control group vs. IOL
- Trial was conducted by the MFMU network as a multicenter RCT at 41 participating hospitals
- Consented women were low-risk NTSV with no C/I to vaginal delivery and reliable dating
Results

• GA at delivery
  – IOL 39.3 weeks (interquartile range 39.1 to 39.6)
  – EM 40.0 weeks (interquartile range 39.3 to 40.7)

• Modified Bishop score at randomization

<table>
<thead>
<tr>
<th>Modified Bishop score at randomization**</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median</td>
</tr>
<tr>
<td>Interquartile range</td>
</tr>
<tr>
<td>Score &lt;5 — no./total no. (%)**</td>
</tr>
</tbody>
</table>
IOL Group Results

- **Significantly less likely** to have HTN disorders of PG
  - (9.1% vs. 14.1%; RR 0.64; CI 0.56 to 0.74); p<0.001)

- IOL patients spent **more time in labor and delivery** unit, but had a **shorter PP LOS**

| Median duration of stay in labor and delivery unit (IQR) — hr$ | 20 (13–28) | 14 (9–20) | <0.001$ |
| Postpartum hospital stay — no. (%) |  |  |  |
| <2 days | 322 (10.5) | 317 (10.4) | 0.01$ |
| 2 days | 2191 (71.6) | 2084 (68.6) |  |
| 3 days | 399 (13.0) | 452 (14.9) |  |
| 4 days | 130 (4.2) | 166 (5.5) |  |
| >4 days | 17 (0.6) | 18 (0.6) |  |
6 additional hours of LR Bed Occupancy for IOL patients

**LOS Total Hours**

<table>
<thead>
<tr>
<th></th>
<th>IOL Group</th>
<th>EM Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 2 days*</td>
<td>553.84</td>
<td>545.24</td>
</tr>
<tr>
<td>2 days</td>
<td>4,382</td>
<td>4,168</td>
</tr>
<tr>
<td>3 days</td>
<td>1,197</td>
<td>1,356</td>
</tr>
<tr>
<td>4 days</td>
<td>520</td>
<td>664</td>
</tr>
<tr>
<td>&gt;4 days</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Total Days</td>
<td>6,652.84</td>
<td>6,733.24</td>
</tr>
<tr>
<td>Average LOS</td>
<td>2.19 days</td>
<td>2.23 days</td>
</tr>
</tbody>
</table>

* applied 1.72 days (mean LOS for WIH admissions < 2 days in IOL and non-IOL patients)

0.04 day difference in LOS (62 minutes)
IOL Group Results

- **No significant difference** in primary PN outcome, **but CD rate** with **unfavorable cx improved** *(modified Bishop score < 5)*

### Cesarean Delivery

<table>
<thead>
<tr>
<th>Modified Bishop score</th>
<th>&lt;5</th>
<th>≥5</th>
<th>1.00</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3868</td>
<td>2226</td>
<td>0.85 (0.76–0.95)</td>
</tr>
<tr>
<td></td>
<td>940</td>
<td>302</td>
<td>0.83 (0.67–1.03)</td>
</tr>
</tbody>
</table>

- Surprising finding considering existing literature with higher CD with unfavorable cx
• 1,471 patients eligible for EIOL  
  (*Undelivered NTSV at 39’0 weeks & no IOL*)

### Potential ARRIVE Projections

#### Potential ARRIVE Admissions

<table>
<thead>
<tr>
<th></th>
<th>FY 19 ^ Deliveries</th>
<th>Inductions (Rate)</th>
<th>Add 20% (294 pts)</th>
<th>Add 40% (588 pts)</th>
<th>Add 60% (883 pts)</th>
<th>Add 80% (1,177 pts)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual</td>
<td>8,425</td>
<td>2,592 (30.8%)</td>
<td>2,886 (34.3%)</td>
<td>3,180 (37.7%)</td>
<td>3,475 (41.2%)</td>
<td>3,769 (44.7%)</td>
</tr>
<tr>
<td>Monthly</td>
<td>702.1</td>
<td>216</td>
<td>239</td>
<td>265</td>
<td>290</td>
<td>314</td>
</tr>
<tr>
<td>Daily</td>
<td>23.1</td>
<td>7.1</td>
<td>7.9</td>
<td>8.7</td>
<td>9.5</td>
<td>10.3</td>
</tr>
</tbody>
</table>

^*based on projected 2% decrease in deliveries from FY18 to FY 19*

#### Additional LR Bed Time

<table>
<thead>
<tr>
<th>Additional Bed Occupancy (hrs)</th>
<th>Add 20% (294 pts)</th>
<th>Add 40% (588 pts)</th>
<th>Add 60% (883 pts)</th>
<th>Add 80% (1,177 pts)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1,764</td>
<td>3,528</td>
<td>5,298</td>
<td>6,702</td>
</tr>
</tbody>
</table>
Management Challenges
Shared Decision Making

• Study used ELICIT – a computerized preference elicitation tool
  – 91% of PG women stated a preference for VD & would accept 59-75% chance of CD before choosing a planned CD
  – Need for oxytocin, antibiotics or OVD resulted in lower scores, comparable to those assigned to uncomplicated CD
  – Shows importance of patient education about process of labor and delivery and IOL

Management Challenges
Shared Decision Making

• Specific survey tool to assess patient’s impression of IOL process using both pre- and post-IOL
  – Women described minimal dialogue with their clinicians and expressed desire for more information re: risk and benefits – cited *Listening to Mothers II and III Surveys*
  – Survey mentioned maternal concerns re: lack of informed decision making and cited opportunities for improvement

Management Challenges
Ensuring an Adequate Trial of Labor

• Evidence shows progressively lower rates of VD with longer duration of latent phase
  – 40% of women who remained in LP after 12h or oxytocin with ROM had VD


• ACOG Care Consensus – Safe Prevention of Primary Cesarean Delivery  March 2014

If the maternal and fetal status allow, cesarean deliveries for failed induction of labor in the latent phase can be avoided by allowing longer durations of the latent phase (up to 24 hours or longer) and requiring that oxytocin be administered for at least 12–18 hours after membrane rupture before deeming the induction a failure.

Strong recommendation, moderate quality evidence
Management Challenges
Ensuring an Adequate Trial of Labor

• Implementation of ACOG recommendations studied with significant decrease in CD rates
  – PCD rate ↓ from 9.4 to 6.9% (OR 0.71, CI 0.59-0.85, p<.01)
  – CD rate for 1\textsuperscript{st} stage arrest ↓ from 1.8 to 0.9% (OR 0.51, CI 0.31-0.81, p<.01) \textit{Significant only for nulliparous women}

  – Median duration of labor significantly longer before PCD(120m), 1\textsuperscript{st} stage CD(180m), 2\textsuperscript{nd} stage CD(120m), failed IOL(300m)

Management Challenges
Use of Directive Tools

- **Labor Progression Study (LaPS), Bernitz et al (2018)**
  - This study looked at the frequency of intrapartum cesarean section (ICS) in active labor using the WHO Partograph vs. Zhang’s guideline
  - 7,277 woman at 14 different obstetrics units
  - **No difference in ICS rate** between groups, but decreased CS rate overall

<table>
<thead>
<tr>
<th></th>
<th>ICS Rate Prior to Study</th>
<th>ICS Rate During Study</th>
</tr>
</thead>
<tbody>
<tr>
<td>WHO Partogram</td>
<td>9.5%</td>
<td>5.9%</td>
</tr>
<tr>
<td>Zhang Guideline</td>
<td>9.3%</td>
<td>6.8%</td>
</tr>
</tbody>
</table>

Bernitz S et al. (2018) The frequency of intrapartum casearean section use with the WHO partograph versus Zhang’s guideline in Labour Progression Study (LaPS): A multicentre, cluster randomised controlled trial. Lancet

- Individual MD has a contributing effect to increased CS risk (OR 1.78)
- May be related to individual MD patient selection or variation in diagnosis of arrest disorder, failed IOL or NR fetal status
Questions
References

References

- Merrill DC, Zlatnik FJ. Randomized, double-masked comparison of oxytocin dosage in induction and augmentation of labor. Obstet Gynecol 1999;94:455–63. (Level I)
References

References

References

References

Participants are encouraged to ask questions and share comments.

- Please submit any questions or comments via the chat box in the lower left corner of your screen
- Questions and comments are visible only to presenters
- Questions will be answered in the order they are received
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- Certificates of attendance and completion will be emailed within 14 business days