How close are we to predicting trauma

Professor Ian Milsom, M.B., Ch.B. Hons, Ph.D

Gothenburg Continence Research Center
Sahlgrenska Academy at Gothenburg University,
Gothenburg, Sweden

Trauma associated with vaginal delivery.
Where are we circa 2017?
Funding

- National LUA/ALF grant nr 11315 Region of Västra Götaland, Sweden
- The Göteborg Medical Society
- Hjalmar Svensssons Fund

Disclosures
No conflict of interests
Pelvic Floor Disorders (PFDs)

Pelvic Organ Prolapse (5-10%)
Urinary incontinence (30-60%)
Anal incontinence (11-15%)

Any form of pelvic floor disorder 46%

Common problems affecting millions of women throughout the world

Negative effect on:
Quality of life and Working ability
Sporting activities and Sexual activity

Global costs high

Life-time risk of POP surgery

The lifetime risk of undergoing POP surgery alone has been reported to vary between 5 and 19%. The highest life time risk for POP surgery, 19%, has been reported from Western Australia.

De Boer et al. estimated that 20.2% of Dutch women would undergo POP or continence surgery before 85 years of age.

Wu et al. estimated a similar rate of intervention in the United States.

Numerous risk factors for PFDs have been identified:

Age  Parity  Pregnancy
Hereditary factors  Delivery mode
Hysterectomy  Anal sphincter rupture
Obesity  Postmenopausal
Irritable Bowel syndrome  Multiple sclerosis
Ethnicity  Parkinsons illness
Dementia  Urinary tract infections
Physical activity  Diabetes mellitus
Neurological illnesses

For ethical and practical reasons, randomised controlled trials to evaluate the causal effects of vaginal and caesarean delivery on the pelvic floor will never be performed.

We therefore have to rely on:

- Objective Pathophysiological data
- Epidemiological data
Objective Pathophysiological data

Magnetic resonance imaging
Ultrasound
Electrophysiological data
MRI Levator ani injury postpartum

6-10% after spontaneous vaginal delivery
17-33% after vacuum extraction
67-71% after forceps delivery

but was not identified in nulliparous women or after caesarean section


Epidemiological data
Urinary Incontinence after Vaginal Delivery or Caesarean Section


EPINCONT study - community based cohort (n = 15 307), younger than 65 years

Prevalence of UI
Nulliparous  10.1%
Vaginal delivery group 21.0%
Cesarean section group 15.9%

Odds ratio UI
Nulliparous - CS 1.5 (95% CI 1.2-1.9)
VD - CS  1.7 (95% CI 1.3-2.1)
Rate of pelvic organ prolapse surgery in relation to mode of delivery and time from first childbirth

(Leijonhufvud et al. Am J Obstet Gynecol 2011;204(1):70.e1-7)
Effect of delivery history on pelvic organ prolapse

<table>
<thead>
<tr>
<th>Mode of delivery (N)</th>
<th>% with prolapse ≥ 2b</th>
<th>OR [95% CI]</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Only SVD (343)</td>
<td>29%</td>
<td>Reference</td>
<td></td>
</tr>
<tr>
<td>Only CS (53)</td>
<td>6%</td>
<td>0.12 [0.04 to 0.41]</td>
<td>0.001</td>
</tr>
<tr>
<td>SVD + CS (52)</td>
<td>21%</td>
<td>0.51 [0.25 to 1.05]</td>
<td>0.067</td>
</tr>
</tbody>
</table>

* OR adjusted for age at first child, parity and BMI at index birth

The risk increase after VD compared to CS was 67% for UI and 275% for UI>10 years.

The prevalence of sPOP was 14.6% after vaginal delivery and 6.3% after caesarean section and the risk increase associated with VD was 255% compared to CS.

Vaginally delivered women had a more than tripled prevalence and risk of having the combination sPOP and UI compared to CS.

The prevalence of UI, UI>10 years and sPOP did not differ between elective CS and acute CS.

Gyhagen et al. BJOG. 2013 Jan;120(2):144-51.
Gyhagen et al. BJOG. 2013 Jan;120(2):152-60.
Prevalence of sPOP in relation to mode of delivery stratified for BMI and infant birth weight

<table>
<thead>
<tr>
<th>BMI</th>
<th>VD (%)</th>
<th>CS (%)</th>
<th>OR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 25</td>
<td>12.1</td>
<td>5.1</td>
<td>2.57 (1.73-3.83)</td>
</tr>
<tr>
<td>25-29</td>
<td>15.5</td>
<td>7.8</td>
<td>2.18 (1.44-3.30)</td>
</tr>
<tr>
<td>≥ 30</td>
<td>19.4</td>
<td>7.4</td>
<td>3.04 (1.82-5.08)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Birth weight</th>
<th>VD (%)</th>
<th>CS (%)</th>
<th>OR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;3000</td>
<td>11.8</td>
<td>7.9</td>
<td>1.57 (0.97-2.56)</td>
</tr>
<tr>
<td>3000-3499</td>
<td>14.2</td>
<td>5.0</td>
<td>3.17 (1.95-5.15)</td>
</tr>
<tr>
<td>3500-3999</td>
<td>14.6</td>
<td>5.9</td>
<td>2.73 (1.55-4.80)</td>
</tr>
<tr>
<td>4000-4499</td>
<td>15.8</td>
<td>3.7</td>
<td>4.85 (2.10-11.17)</td>
</tr>
<tr>
<td>≥ 4500</td>
<td>23.8</td>
<td>7.8</td>
<td>3.67 (1.22-11.03)</td>
</tr>
</tbody>
</table>

Adjusted for current BMI, maternal age, infant birth weight and head circumference.
A hypothesis was proposed that the following physical features of the Mother and the Baby can be scored and used to determine the most suitable route of delivery:

U - Presence or absence of antenatal UI
R - Race/Ethnicity
C - Childbearing started at what age
H - Height of mother
O - Overweight? (mothers BMI)
I - Inheritance (family history)
C - Children (number of children desired)
E - Estimated fetal weight
Predictive Modelling Cooperation

SWEPOP Study Group
Sahlgrenska Academy, Gothenburg
Maria Gyhagen, Jwan Othman, Ida Nilsson, Björn Areskoug, Ian Milsom

PROLONG Study Group
Aberdeen, Glasgow and Otago
Don Wilson, Suzanne Hagen, Andrew Elders

CLEVELAND CLINIC Group
Cleveland
Matt Barber, Eric Jelovsek, Michael Kattan, Kevin Chagin
Study Populations

Data from 2 longitudinal, prospective cohorts

1. Swedish Pregnancy, Obesity and Pelvic Floor Study (SwePOP)
   - Only Primiparous women delivered 1985-1988 (n = 9423)
   - Swedish Medical Birth Register data
   - Follow-up 20 years after delivery

2. ProLong study from UK/New Zealand
   - All deliveries w/in 12 months (1993-94)
   - 7883 participated 3 months after index birth
   - Aberdeen (UK), Birmingham (UK), Dunedin (New Zealand)
   - Followed up 12 years after delivery

Gyhagen M, Bullarbo M, Nielsen T, Milsom I, BJOG 2013
Hypotheses

- Models can be developed to predict the likelihood of developing PFDs (outcomes) 12-20 years after delivery that:
  - Discriminate better than chance (i.e. concordance index=0.5)
  - Reasonable to calibrate and are internally and externally validated
  - Can be used in an on-line calculator to permit prediction on an individual basis
The cohorts were split so that data during the first half of the cohort’s time period were used to fit prediction models and validation was performed using data from the second half (temporal validation).

Multiple logistic models were fit to the data and reduced using backwards elimination.

Model internal validation was assessed using 1000 bootstrap samples generating a bias-corrected concordance index.
Prediction modelling - Results

Models were able to discriminate between women who developed bothersome symptoms or received treatment, at 12 (PROLONG) and 20 years (SWEPOP) respectively, for:

- Pelvic organ prolapse (concordance indices 0.570, 0.627)
- Urinary incontinence (concordance indices 0.653, 0.689)
- Fecal incontinence (concordance indices 0.618, 0.676)
- One or more pelvic floor disorders (concordance indices 0.639, 0.675)
- Two or more pelvic floor disorders (concordance indices 0.635, 0.619)
<table>
<thead>
<tr>
<th>Maternal Age at Delivery*</th>
<th>28</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Previous Births*</td>
<td>0</td>
</tr>
<tr>
<td>Family History of Pelvic Organ Prolapse*</td>
<td>Yes</td>
</tr>
<tr>
<td>Maternal Height (cm)*</td>
<td>170</td>
</tr>
<tr>
<td>Maternal Pre-Pregnancy Weight (kg)*</td>
<td>85</td>
</tr>
<tr>
<td>Estimated Fetal Head Circumference (cm)*</td>
<td>?</td>
</tr>
<tr>
<td>Estimated Fetal Weight (g)*</td>
<td>3500</td>
</tr>
<tr>
<td>Planned Route of Delivery*</td>
<td>Vaginal</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Maternal Age at Delivery*</th>
<th>28</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Previous Births*</td>
<td>0</td>
</tr>
<tr>
<td>Family History of Pelvic Organ Prolapse*</td>
<td>Yes</td>
</tr>
<tr>
<td>Maternal Height (cm)*</td>
<td>150</td>
</tr>
<tr>
<td>Maternal Pre-Pregnancy Weight (kg)*</td>
<td>100</td>
</tr>
<tr>
<td>Estimated Fetal Head Circumference (cm)*</td>
<td>37</td>
</tr>
<tr>
<td>Estimated Fetal Weight (g)*</td>
<td>4500</td>
</tr>
<tr>
<td>Planned Route of Delivery*</td>
<td>Vaginal</td>
</tr>
</tbody>
</table>
### 28 year old primip, family history of POP, low risk

<table>
<thead>
<tr>
<th>Condition</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>POP</td>
<td>5%</td>
</tr>
<tr>
<td>UI</td>
<td>17.8%</td>
</tr>
<tr>
<td>FI</td>
<td>6.7%</td>
</tr>
<tr>
<td>PFD</td>
<td>23.3%</td>
</tr>
<tr>
<td>≥ 2 PFD</td>
<td>4.8%</td>
</tr>
</tbody>
</table>

### 28 year old primip, family history of POP, high risk

<table>
<thead>
<tr>
<th>Condition</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>POP</td>
<td>16.7%</td>
</tr>
<tr>
<td>UI</td>
<td>45.6%</td>
</tr>
<tr>
<td>FI</td>
<td>17.2%</td>
</tr>
<tr>
<td>PFD</td>
<td>52.8%</td>
</tr>
<tr>
<td>≥ 2 PFD</td>
<td>26.3%</td>
</tr>
</tbody>
</table>
Conclusions

• Models provide individualized risk estimates for the development of PFDs 12-20 years after delivery.
• Models provide an opportunity before birth to identify women at low risk of developing pelvic floor disorders and institute prevention strategies for women at higher risk.
• These models provide similar discrimination to predictive models currently used in clinical practice such as the National Cancer Institute Gail model for prediction of Breast Cancer risk (concordance index 0.59) and the Framingham Cardiovascular Risk Model (concordance index 0.72).