Determining the Optimal Route of Hysterectomy for Benign Indications: a Clinical Decision Tree Algorithm

John B. Gebhart, MD, MS

May 17, 2019
Disclosures

• UroCure – Advisory Board
• UpToDate – Royalties
• Elsevier - Royalties
"TOMORROW
HOPES WE HAVE LEARNED
SOMETHING FROM
YESTERDAY"
Objectives

- Background
- Retrospective Algorithm
- Design and Preparation of Prospective Algorithm
  - Deviations and exclusion criteria
  - Optimizing documentation
  - 3-D pelvic models
- Prospective Algorithm Results
Background of Project

- ACOG
  - Vaginal route preferred
  - ≤12 week size
  - Nulliparity not a contraindication

- Surgical approach is non-standardized

- Surgical trends

- Dr. Kovac algorithms
Phase I: Retrospective Algorithm
Objectives

• Primary Aims
  • Create clinical algorithm to determine optimal route of hysterectomy
  • Retrospectively apply the algorithm to a cohort who underwent hysterectomy
  • Outcomes when algorithm was followed vs deviated

• Secondary Aims
  • Evaluate effect of robotic surgery on practice patterns
  • Identify cost implications
Methods

• Modified existing algorithm*
  • Vaginal access to uterus
  • Uterine size
<table>
<thead>
<tr>
<th>Exclusion Criteria</th>
<th>Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adnexal disease as primary indication</td>
<td>Mesh-related surgery or excision</td>
</tr>
<tr>
<td>Adnexal torsion</td>
<td>Müllerian or uterine anomalies</td>
</tr>
<tr>
<td>Age &lt; 18 years old</td>
<td>Ovarian, fallopian tube, or peritoneal cancer</td>
</tr>
<tr>
<td>Cervical cancer &gt; stage 1A1</td>
<td>Pelvic kidney</td>
</tr>
<tr>
<td>Cesarean hysterectomy</td>
<td>Planned umbilical hernia repair affecting route</td>
</tr>
<tr>
<td>Concomitant anti-incontinence procedures</td>
<td>Planned appendectomy, cholecystectomy or bowel surgery</td>
</tr>
<tr>
<td>Did not consent for research</td>
<td>Radical hysterectomy</td>
</tr>
<tr>
<td>Emergent hysterectomy</td>
<td>Risk-reducing surgery (ie BRCA+)</td>
</tr>
<tr>
<td>Endometrial hyperplasia &gt; complex</td>
<td>Tubo-ovarian abscess</td>
</tr>
<tr>
<td>Multiple cone excisions, no available cervical tissue</td>
<td>Uterine cancer or suspicion for sarcoma</td>
</tr>
</tbody>
</table>
Benign Disease

- **Yes**: Uterus accessible transvaginally
  - **Yes**: Uterine size <12 weeks
    - **Yes**: Vaginal hysterectomy
    - **No**: Uterine size <18 weeks
      - **Yes**: Laparoscopic or robotic hysterectomy
      - **No**: Abdominal Hysterectomy
  - **No**: Uterine size <18 weeks
    - **Yes**: Uterine size <12 weeks
      - **Yes**: Vaginal hysterectomy
      - **No**: Abdominal Hysterectomy
    - **No**: Abdominal Hysterectomy

- **No**: Algorithm not appropriate

Uterus accessible transvaginally

Uterine size <18 weeks

Abdominal Hysterectomy

Laparoscopic or robotic hysterectomy
Benign Disease

Yes

Uterus accessible transvaginally

No

Uterine size <18 weeks

No

Abdominal Hysterectomy

Yes

Laparoscopic or robotic hysterectomy

Algorithm not appropriate

Uterine size <12 weeks

Yes

Vaginal hysterectomy

No

Uterine size <18 weeks

No

Abdominal Hysterectomy

Yes

Laparoscopic or robotic hysterectomy
Benign Disease

- Yes: Uterus accessible transvaginally
- No: Uterine size <18 weeks

- No: Abdominal Hysterectomy
  - Yes: Uterine size <12 weeks
    - Yes: Vaginal hysterectomy
    - No: Uterine size <18 weeks
      - Yes: Laparoscopic or robotic hysterectomy
      - No: Abdominal Hysterectomy
  - No: Laparoscopic or robotic hysterectomy
Benign Disease

Yes

Uterus accessible transvaginally

No

Abdominal Hysterectomy

No

Uterine size <18 weeks

Yes

Laparoscopic or robotic hysterectomy

No

Algorithm not appropriate

No

Uterine size <18 weeks

Yes

Vaginal hysterectomy

No

Uterine size <12 weeks

Yes

Laparoscopic or robotic hysterectomy

No

Abdominal Hysterectomy

Vaginal hysterectomy

Uterine size <18 weeks
Methods

• Cohorts
  • 2009-2013 (Cohort A)
  • 2004-2005 (Cohort B)

• Expected surgical route determined by applying algorithm
Methods

• Statistical analysis
  • Categorical: $\chi^2$ or Fisher exact test
  • Ordinal: Wilcoxon rank sum test
  • Continuous: 2-sample $t$ test
  • Postoperative health: Logistic Regression models
    • UTI
    • SSI
    • Accordion Classification grade $\geq 3$

• Cost estimates

Results – Practice Patterns

• Expected Vaginal Route
  • Cohort B (2004-2005), N = 305
    • 15.1% deviation
  • Cohort A (2009-2013), N = 743
    • 25.8% deviation
### Expected Vaginal Route

<table>
<thead>
<tr>
<th>Actual Route Performed</th>
<th>Vaginal (N = 551)</th>
<th>Robotic (N = 154)</th>
<th>Abdominal (N = 38)</th>
<th>P value (VH vs RH)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vaginal parity</td>
<td>500/550 (90.9)</td>
<td>65/153 (42.5)</td>
<td>20/38 (52.6)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Cesarean Delivery</td>
<td>72/550 (13.1)</td>
<td>60/153 (39.2)</td>
<td>13 (34.2)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>OR time, median (IQR)</td>
<td>59 (43, 82)</td>
<td>141 (106, 168)</td>
<td>70 (60, 95)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>UTI</td>
<td>22/531 (4.1)</td>
<td>12/149 (8.1)</td>
<td>3/36 (8.3)</td>
<td>0.05</td>
</tr>
<tr>
<td>SSI</td>
<td>1/531 (0.2)</td>
<td>7/149 (4.7)</td>
<td>0/36 (0.0)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Intraoperative route conversion</td>
<td>5 (0.9)</td>
<td>2 (1.3)</td>
<td>---</td>
<td>---</td>
</tr>
</tbody>
</table>

No significant difference in: postoperative blood transfusion, ASA score, overall postoperative complications, Accordion grade 3+ complications, hospital readmission.
## Multivariable Analysis: SSI

<table>
<thead>
<tr>
<th></th>
<th>Adjusted OR (95% CI)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operative time</td>
<td>1.51 (1.02-2.24)</td>
<td>0.04</td>
</tr>
<tr>
<td>Route of Hysterectomy</td>
<td></td>
<td>0.006</td>
</tr>
<tr>
<td>Vaginal</td>
<td>Reference</td>
<td></td>
</tr>
<tr>
<td>Abdominal</td>
<td>13.6 (2.77-66.74)</td>
<td></td>
</tr>
<tr>
<td>Robotic</td>
<td>7.50 (1.52-37.06)</td>
<td></td>
</tr>
</tbody>
</table>

UTI: No independent predictors identified
Multivariable Analysis: Accordion Grade 3+ Complications

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<tr>
<th>Route of Hysterectomy</th>
<th>Adjusted OR (95% CI)</th>
<th>P Value</th>
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<tbody>
<tr>
<td>Vaginal</td>
<td>Reference</td>
<td></td>
</tr>
<tr>
<td>Abdominal</td>
<td>4.58 (1.58-13.33)</td>
<td></td>
</tr>
<tr>
<td>Robotic</td>
<td>3.41 (1.39-8.36)</td>
<td>0.009</td>
</tr>
</tbody>
</table>
Results – cost implications

- Unadjusted mean cost*
  - Vaginal: $10,318
  - Robotic: $14,402
  - Abdominal: $15,079

- Expected vaginal route, Cohort A (2009-2013)
  - 30 hysterectomies abdominal
  - 154 hysterectomies robotically

- Total cost savings if followed algorithm ~ $800,000

Strengths and Limitations

• Strengths
  • Large cohort
  • 13 surgeons
  • Historical data from Cohort B (2004-2005)

• Limitations
  • Retrospective
  • Fellowship trained surgeons
Conclusion

• Robotic surgery initiation:
  • 20% absolute reduction of laparotomy
  • 10% absolute reduction of VH

• Using algorithm, VH associated with lower infection rates, operative times and costs

• Utilize vaginal route when feasible
Original Research

Determining Optimal Route of Hysterectomy for Benign Indications

Clinical Decision Tree Algorithm

Jennifer J. Schmitt, DO, Daniel A. Carranza Leon, MD, John A. Occhino, MD, Amy L. Weaver, MS, Sean C. Dowdy, MD, Jamie N. Bakkum-Gamez, MD, Kalyan S. Pasupathy, PhD, and John B. Gebhart, MD

Phase II: Design and Implementation of Prospective Algorithm
Deviations

• Pathology uterine size > estimated size
• Endometriosis
• Laparotomies
• Nulliparity

• Adnexal cyst >4 cm
• Gender confirming surgery
<table>
<thead>
<tr>
<th>Exclusion Criteria</th>
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<tr>
<td>Primarily adnexal indication or benign adnexal mass &gt;4 cm</td>
</tr>
<tr>
<td>Adnexal torsion</td>
</tr>
<tr>
<td>Age &lt; 18 years old</td>
</tr>
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<tr>
<td>Endometriosis</td>
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- Mesh-related surgery or excision
- Müllerian or uterine anomalies
- Ovarian, fallopian tube, or peritoneal cancer
- Pelvic kidney
- Planned umbilical hernia repair affecting route
- Planned appendectomy, cholecystectomy or bowel surgery
- Radical hysterectomy
- Risk-reducing surgery (ie BRCA+)
- Tubo-ovarian abscess
- Uterine cancer or suspicion for sarcoma
Hysterectomy indicated for Benign Disease

- Uterine size ≤12 w (280 g)
  - And
  - ≤1 C-section/laparotomy
  - And
  - Adequate vaginal caliber, mobility and descent in office

  Vaginal Hysterectomy

- Uterine size 13-16 w
  - Or
  - ≥2 C-section/laparotomy
  - Or
  - Inadequate vaginal caliber, mobility and descent in office

  Exam Under Anesthesia

  - Uterus descends to halfway down vagina and adequate vaginal caliber
  - Yes
  - No

  Laparoscopic or Robotic Hysterectomy

- Uterine size ≥17 w

  Laparoscopic, Robotic, or Abdominal Hysterectomy
Hysterectomy indicated for Benign Disease

Uterine size $\leq 12$ w (280 g)
And
$\leq 1$ C-section/laparotomy
And
Adequate vaginal caliber, mobility and descent in office

Vaginal Hysterectomy

Uterine size 13-16 w
Or
$\geq 2$ C-section/laparotomy
Or
Inadequate vaginal caliber, mobility and descent in office

Exam Under Anesthesia

Uterus descends to halfway down vagina and adequate vaginal caliber

Yes

No

Laparoscopic or Robotic Hysterectomy

Uterine size $\geq 17$ w

Laparoscopic, Robotic, or Abdominal Hysterectomy
Hysterectomy indicated for Benign Disease

- Uterine size ≤12 w (280 g)
  - And
  - ≤1 C-section/laparotomy
  - And
  - Adequate vaginal caliber, mobility and descent in office
  - Vaginal Hysterectomy

- Uterine size 13-16 w
  - Or
  - ≥2 C-section/laparotomy
  - Or
  - Inadequate vaginal caliber, mobility and descent in office

  Exam Under Anesthesia
  - Uterus descends to halfway down vagina and adequate vaginal caliber
    - Yes
    - Laparoscopic, Robotic, or Abdominal Hysterectomy
    - No
      - No

- Uterine size ≥17 w
  - Laparoscopic, Robotic, or Abdominal Hysterectomy
Hysterectomy indicated for Benign Disease

- Uterine size $\leq 12$ w (280 g)  
  And  
  $\leq 1$ C-section/laparotomy  
  And  
  Adequate vaginal caliber, mobility and descent in office

- Uterine size 13-16 w  
  Or  
  $\geq 2$ C-section/laparotomy  
  Or  
  Inadequate vaginal caliber, mobility and descent in office

- Uterine size $\geq 17$ w

  - Laparoscopic, Robotic, or Abdominal Hysterectomy

  - Exam Under Anesthesia

  - Uterus descends to halfway down vagina and adequate vaginal caliber
    - Yes
    - No

  - Laparoscopic or Robotic Hysterectomy
Hysterectomy indicated for Benign Disease

- Uterine size ≤12 w (280 g)
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  **Vaginal Hysterectomy**

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  - Or
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  **Exam Under Anesthesia**

  - Uterus descends to halfway down vagina and adequate vaginal caliber

  **Yes**

  **Laparoscopic or Robotic Hysterectomy**

- Uterine size ≥17 w

  **Laparoscopic, Robotic, or Abdominal Hysterectomy**
Hysterectomy indicated for Benign Disease

- Uterine size $\leq 12$ w (280 g) 
  - And 
  - $\leq 1$ C-section/laparotomy 
  - And 
  - Adequate vaginal caliber, mobility and descent in office

- Uterine size $13-16$ w 
  - Or 
  - $\geq 2$ C-section/laparotomy 
  - Or 
  - Inadequate vaginal caliber, mobility and descent in office

- Exam Under Anesthesia

- Uterus descends to halfway down vagina and adequate vaginal caliber
  - Yes
  - No

- Laparoscopic or Robotic Hysterectomy

- Uterine size $\geq 17$ w

- Laparoscopic, Robotic, or Abdominal Hysterectomy
Standardizing Exam Documentation

• 2004-2005
  • 497 total patients (248.5/year)
    • 24 documentation issues (4.8%)

• 2009-2013
  • 1335 total patients (267/year)
    • 121 documentation issues (9.1%)
Prospective Algorithm

***Consultant performs exam

Office dictation standardization

- Uterine size: weeks of gestation
  (<8 or normal, 10, 12, 14, 16, 18, 20, 22 weeks…)
- Vaginal Caliber:
  - narrow or adequate
- Uterine/cervix location:
  - high or normal/prolapsed
- Uterine mobility:
  - mobile or not mobile
Prospective Algorithm
***Consultant performs exam if EUA

Office dictation standardization

- **Uterine size**: weeks of gestation (<8 or normal, 10, 12, 14, 16, 18, 20, 22 weeks…)
- **Vaginal Caliber**:
  - narrow or adequate
- **Uterine/cervix location**:
  - high or normal/prolapsed
- **Uterine mobility**:
  - mobile or not mobile

EUA dictation standardization

- **Under anesthesia**
  - Bimanual assess caliber and descensus
    - Stirrups
  - If unsure:
    - Weighted speculum
    - 2 tenaculums + traction
- **Dictate in operative note**
  - Uterine size (weeks gestation)
  - Vaginal caliber
  - Uterine descensus/mobility
3-D Models for Uterine Size Estimates

- Collaboration with Radiology department at St. Mary’s 3-D printer lab
- Mayo 12 and Eisenberg 4A
- Pelvic girdle with bladder, vagina and abdominal layers
  - Interchangeable uteri: 100 g, 280 g, 500+ g
Phase III: Prospective Algorithm
Introduction and Implementation

• Gynecologic Surgery Division Meetings
  • Reviewed Retrospective Results
  • Introduce Prospective Algorithm
    • Pelvic models
  • Review Prospective Algorithm

• November 23, 2015 – December 31, 2018
Hysterectomy indicated for Benign Disease

55.3%
- Uterine size ≤12 w (280 g)
- And
- ≤1 C-section/laparotomy
- And
- Adequate vaginal caliber, mobility and descent in office

29.9%
- Uterine size 13-16 w
- Or
- ≥2 C-section/laparotomy
- Or
- Inadequate vaginal caliber, mobility and descent in office

14.8%
- Uterine size ≥17 weeks

Vaginal Hysterectomy

Exam Under Anesthesia

15.9%
- Uterus descends to halfway down vagina and adequate vaginal caliber

71.2%
- Yes

14.0%
- No

Laparoscopic, Robotic, or Abdominal Hysterectomy

Laparoscopic or Robotic Hysterectomy
Adherence to algorithm when TVH was expected = 170/202 (84.2%)
Adherence when TVH+ EUA-TVH expected = 211/260 (81.2%)

**Gray**: expected route = actual route

**Red**: Actual route more invasive than expected (deviation)

**Green**: Actual route less invasive than expected (no deviation)

**Blue**: EUA performed and TVH could not be performed

<table>
<thead>
<tr>
<th>Expected Route per Algorithm</th>
<th>Vaginal</th>
<th>Abdominal</th>
<th>Robotic</th>
<th>Total (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vaginal</td>
<td>170</td>
<td>2</td>
<td>30</td>
<td>202 (55.3)</td>
</tr>
<tr>
<td>Abd/Robotic/Lap</td>
<td>1</td>
<td>38</td>
<td>15</td>
<td>54 (14.8)</td>
</tr>
<tr>
<td>EUA then vaginal</td>
<td>41</td>
<td>2</td>
<td>15</td>
<td>58 (15.9)</td>
</tr>
<tr>
<td>EUA then robotic</td>
<td>6</td>
<td>2</td>
<td>43</td>
<td>51 (14.0)</td>
</tr>
<tr>
<td>Total (%)</td>
<td>218 (59.7)</td>
<td>44 (12.0)</td>
<td>103 (28.2)</td>
<td>365 (100)</td>
</tr>
</tbody>
</table>
Vaginal Hysterectomy

• Outcomes
  • 0 route conversion
  • 3 intraop complications (cystotomy, 1.8%)
  • 5 transfusions (2.9%)
  • 10 UTIs (5.9%)
  • 2 Accordion grade 3+ (1.2%)
    • Return to OR
      • Bleeding from gonadal vessels then pelvic abscess requiring IR drain
      • Acute blood loss anemia – found a contained retroperitoneal hematoma
  • Nearly 95% discharged by 24 hours
Deviation when VH Expected

- N = 49 (13.4%)
  - 16 nulliparous (32.7%)
  - 13/48 (27%) 1+ cesarean delivery
  - No route conversions, intraop complications, or transfusions
  - 2 UTI (4.4%), 1 port site cellulitis (2.2%)
  - 1 Accordion grade 3+
    - Return to OR for ureteral injury
  - 86% discharged within 24 hours
Conclusion

• Algorithm increased VH rate from 74 to 84%
• 100% of TVH group were successfully completed vaginally
• 95% of EUA-TVH group were successfully completed vaginally
• Algorithm can be used to identify straight forward vs complex cases
• Algorithm may increase the rate of VH and lower health care costs
Questions & Discussion