Orthopedic Surgery for Adults with Cerebral Palsy - Medical Considerations

American Academy for Cerebral Palsy and Developmental Medicine, 2014, IC 2

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Disclosures

In the past 12 months, I have not had a significant financial interest or other relationship with the manufacturer(s) of the product(s) or provider(s) of the service(s) that will be discussed in my presentation.

This presentation will include discussion of

• thromboembolic prophylaxis regimens

• Pain control options

that have not been approved by the FDA (US)
Objectives

At the end of this presentation, the attendees will be able to

1. Plan Preoperative Assessment for Adults with Cerebral Palsy who will undergo orthopedic procedures.
2. Choose Prophylaxis (if appropriate) against Deep Vein Thrombosis
3. Plan postoperative control of pain
Adults with Cerebral Palsy

Reid, 2012
Principles of Preoperative Assessment

- Assessment is a *stratification* of risk, not “clearance”
- Pediatric Preoperative Assessment: data is limited.

- In adults, most attention has been paid to trying to minimize risk of perioperative cardiac complications, but pulmonary complications are equally prevalent, and contribute at least as much morbidity, mortality, and increased Length of Stay (Qaseem, 2006)
- 74% of deaths in the Australian cohort were attributed to respiratory causes (Reid 2012)
### Table. American Society of Anesthesiologists Classification*

<table>
<thead>
<tr>
<th>ASA Class</th>
<th>Class Definition</th>
<th>Rates of PPCs by Class, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>A normally healthy patient</td>
<td>1.2</td>
</tr>
<tr>
<td>II</td>
<td>A patient with mild systemic disease</td>
<td>5.4</td>
</tr>
<tr>
<td>III</td>
<td>A patient with systemic disease that is not incapacitating</td>
<td>11.4</td>
</tr>
<tr>
<td>IV</td>
<td>A patient with an incapacitating systemic disease that is a constant threat to life</td>
<td>10.9</td>
</tr>
<tr>
<td>V</td>
<td>A moribund patient who is not expected to survive for 24 hours with or without operation</td>
<td>NA</td>
</tr>
</tbody>
</table>

* Information is from reference 9. ASA = American Society of Anesthesiologists; NA = not applicable; PPC = postoperative pulmonary complication.
Preoperative Pulmonary Evaluation

Potential Postoperative Pulmonary Complications Include:

• Atelectasis
• Pneumonia
• Respiratory Failure
• Exacerbation of Chronic Lung Disease

• Postdischarge Death due to unrecognized/exacerbated sleep apnea
Preoperative Pulmonary Evaluation

Risk Factor for Pulmonary Complications Include:

- Age >60
- Chronic Lung Disease
- Tobacco Use
- Congestive Heart Failure
- Functional Dependence
- ASA Classification
- Obesity
- Obstructive Sleep Apnea
- Albumin <3.5 g/ dL
- Duration of Surgery >3 hours
Chronic Lung Disease

Patients with CP could have unrecognized chronic lung disease or obstructive sleep apnea

- Scoliosis and other chest wall deformities
- Impaired cough or gag
- Unrecognized silent aspirations
- Long-term complications of Prematurity
- Impaired neurological control of breathing
Chronic Lung Disease

Clues

• Baseline Tachypnea or Bradypnea
• Abdominal Breathing
• Elevated Bicarbonate or Hematocrit
• Abnormal Chest X-ray

Interventions

• Incentive Spirometry (if able); Blowing Bubbles
• Postural Drainage, Percussion, Vibration
Strategies to Reduce Perioperative Pulmonary Complications

- Tobacco Cessation
- Lung Expansion Modalities
- Preoperative CPAP/ BiPAP training
- Avoidance of Long-acting Neuromuscular Blockade (Pancuronium)
- Addition of regional anesthesia.
The STOP-BANG (Snoring, Tiredness during daytime, Observed apnea, high blood Pressure, Body mass index, Age, Neck circumference, Gender) questionnaire. A high risk of sleep apnea is defined as a score of 3 or more; low risk of sleep apnea, a score of less than 3.

**Sensitivity of 91.7%**

**Specificity of 63.4%**

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**STOP-BANG Questionnaire**

1. **Snoring**
   - Do you snore loudly (louder than talking or loud enough to be heard through closed doors)?
     - Yes
     - No

2. **Tired**
   - Do you often feel tired, fatigued, or sleepy during daytime?
     - Yes
     - No

3. **Observed**
   - Has anyone observed you stop breathing during your sleep?
     - Yes
     - No

4. **Blood pressure**
   - Are you now being or have you been treated for high blood pressure?
     - Yes
     - No

5. **BMI**
   - BMI more than 35 kg/m²?
     - Yes
     - No

6. **Age**
   - Age over 50 years old?
     - Yes
     - No

7. **Neck circumference**
   - Neck circumference greater than 40 cm?
     - Yes
     - No

8. **Gender**
   - Gender male?
     - Yes
     - No
Anesthetic Complications of Obstructive Sleep Apnea

• Anesthesia reduces pharyngeal muscle tone and exacerbates the upper airway anatomic alterations that result in pharyngeal collapse during sleep
• Anesthesia blunts arousal from sleep
• Surgical stress fragments subsequent sleep
• These effects can last several days
Strategies to Reduce Perioperative OSA Complications

• Identify!
• Consider regional anesthesia rather than general if able
• Use shorter acting anesthetic or sedative medications
• In Recovery, patients should have HOB up 30°
• Use CPAP early in case of desaturation
• Use non-opioid analgesia as appropriate (NSAIDs, Ketamine*, Clonidine*, Precedex*)
• Monitor in appropriate unit following surgery
• Be very cautious about planning ambulatory surgery
  • Adesanya, 2010
Figure 1. Cardiac evaluation and care algorithm for noncardiac surgery based on active clinical conditions, known cardiovascular disease, or cardiac risk factors for patients 50 years of age or greater. *See Table 2 for active clinical conditions. †See Clas...
Clinical Risk Factors

• ischemic heart disease
• compensated or prior heart failure
• diabetes mellitus
• renal insufficiency
• cerebrovascular disease
### Revised Cardiac Risk Index

<table>
<thead>
<tr>
<th>How many variables does the patient have?</th>
<th>Risk for major postoperative cardiac complication, %*</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.4</td>
</tr>
<tr>
<td>1</td>
<td>0.9</td>
</tr>
<tr>
<td>2</td>
<td>7.0</td>
</tr>
<tr>
<td>≥3</td>
<td>11.0</td>
</tr>
</tbody>
</table>

Variables are high-risk type of surgery, ischemic heart disease (includes any of the following: history of myocardial infarction, history of a positive exercise test, current report of chest pain that is considered to be secondary to myocardial ischemia, use of nitrate therapy, or electrocardiography with pathologic Q waves), congestive heart failure, and history of cerebrovascular disease, preoperative treatment with insulin, and preoperative serum creatinine >176.8 µmol/L (2.0 mg/dL). Patients with more than 2 variables have a postoperative cardiac complication rate of about 10% and are considered to be high-risk.


*The major cardiac complications included myocardial infarction, pulmonary edema, ventricular fibrillation or primary cardiac arrest, and complete heart block.
<table>
<thead>
<tr>
<th>Test</th>
<th>Indication</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hemoglobin</td>
<td>Anticipated major blood loss or symptoms of anemia</td>
</tr>
<tr>
<td>Leukocyte count</td>
<td>Symptoms suggest infection, myeloproliferative disorder, or myelotoxic medications</td>
</tr>
<tr>
<td>Platelet count</td>
<td>History of bleeding diathesis, myeloproliferative disorder, or myelotoxic medications</td>
</tr>
<tr>
<td>Prothrombin time</td>
<td>History of bleeding diathesis, chronic liver disease, malnutrition, recent or long-term antibiotic use</td>
</tr>
<tr>
<td>Partial thromboplastin time</td>
<td>History of bleeding diathesis</td>
</tr>
<tr>
<td>Electrolytes</td>
<td>Known renal insufficiency, congestive heart failure, medications that affect electrolytes</td>
</tr>
<tr>
<td>Renal function</td>
<td>Age &gt;50 years, hypertension, cardiac disease, major surgery, medications that may affect renal function</td>
</tr>
<tr>
<td>Glucose</td>
<td>Obesity or known diabetes</td>
</tr>
<tr>
<td>Liver function tests</td>
<td>No indication. Consider albumin measurement for major surgery or chronic illness</td>
</tr>
<tr>
<td>Urinalysis</td>
<td>No indication</td>
</tr>
<tr>
<td>Electrocardiography</td>
<td>Men &gt;40 years, women &gt;50 years, or known coronary artery disease, diabetes, or hypertension</td>
</tr>
<tr>
<td>Chest radiography</td>
<td>Age &gt;50 years, known cardiac or pulmonary disease, or symptoms or examination suggest cardiac or pulmonary disease</td>
</tr>
</tbody>
</table>
THE CLOT THICKENS

http://www.radpod.org/2006/12/07/saddle-pulmonary-embolus/
The Joint Commission Says…

Hospitalized patients at high-risk for VTE may develop an asymptomatic deep vein thrombosis (DVT), and die from pulmonary embolism (PE) even before the diagnosis is suspected. Therefore, the best approach is for every patient to be evaluated for primary prophylaxis since preventing DVT is essential to reducing morbidity and mortality associated with PE. There is good evidence that appropriately used thromboprophylaxis has a desirable risk/benefit ratio and is cost-effective. Thromboprophylaxis provides an opportunity to improve patient outcomes and reduce hospital costs. Complications from prophylactic anticoagulation, especially bleeding, have not been supported by the results from many metaanalyses and randomized clinical trials. Uniform uses of electronic alerts or local thromboprophylaxis guidelines are associated with improvements in both prophylaxis provision and patients’ outcomes.
DVT Prophylaxis?

It is the standard of care in adult orthopedics

- THA/TKA/ Hip Fracture-> 10-14 days of prophylaxis
- Lower leg injury or knee arthroscopy-> no prophylaxis
- What about children? Perioperative recommendations focus on children with pre-existing risk factors (cancer, rheumatologic disease, known thrombophilia)
  
  Jackson, 2008

- What about patients with CP?
  - PubMed search last week:
    - Fatal DVT in a 9 year old following VDRO (Sabharwal, 2013)
    - DVT in a postpartum woman with CP (Phillips, 2012)
    - DVT following repair of a baclofen pump (Murphy, 2002)
  
- In 91% of children admitted with femoral or pelvic fracture to Johns Hopkins, thromboprophylaxis was not used. No clinically significant DVT or PE was found. (Greenwald, 2012)
DVTs in Adult Orthopedic Patients

Falck-Ytter, 2012
Risk factors for deep venous thrombosis in
tetraparesic mentally retarded patients

M. C. ROUSSEAU and B. GUILLOTEL
Hôpital San Salvadour, Assistance Publique Hôpitaux de Paris, France
(Received 1 January 2001; accepted 24 July 2001)

Conclusion: Spasticity probably plays a role in preventing deep venous thrombosis in paralysed patients, but it does not fully explain the absence of deep venous thrombosis in this population.
Deep Vein Thrombosis in Patients with Severe Motor and Intellectual Disabilities

Hiromitsu Ohmori, MD, PhD,† Fumihiro Ochi, MD,‡ Naoyuki Tanuma, MD, PhD,§ Eiichi Ohnuki, MD,¶ Masami Yamasaki, MD,¶ Hiroko Takesue,¶ Miki Kan,¶ Nobuo Matsumoto, MD,¶ Ryo Sumimoto, MD, PhD,¶ and Akira Harada, MD¶

• 8/23 patients in a long-term hospital in Japan were found to have DVT. All were asymptomatic.
• Mean age 43.5 years
• This may be associated with the “sudden death rate of 4.2% that has been reported among the causes of death in patients with SMID, after pneumonia, respiratory failure, heart failure, and asphyxia.
Gestational Age and Risk of Venous Thromboembolism From Birth Through Young Adulthood

Bengt Zöller, Xinjun Li, Jan Sundquist, Kristina Sundquist and Casey Crump

*Pediatrics*; originally published online July 28, 2014;

DOI: 10.1542/peds.2013-3856
Options for Prophylaxis

- Heparin
- LMWH
- Warfarin
- Aspirin? (not labeled in the US for DVT prophylaxis)
- Compression Devices (alone or in combination)
- Factor Xa Inhibitors
  - Fondaparinux (contraindicated <50 kg)
  - Apixiban
  - Rivaroxaban (OK down to 37 kg!)
- Direct Thrombin Inhibitor (Dabigatran)- not labeled in the US for DVT prophylaxis (is labeled for DVT treatment)

- All recommended 10-14 days

Falck-Ytter, 2012
Combination of Compression and Anticoagulation

<table>
<thead>
<tr>
<th>Reference</th>
<th>Combination</th>
<th>Anticoagulation</th>
<th>Weight (%)</th>
<th>Risk ratio</th>
<th>Risk ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abdominal</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cahan et al.</td>
<td>0 of 15</td>
<td>0 of 17</td>
<td>2-9</td>
<td>0-15 (0-02, 1-19)</td>
<td></td>
</tr>
<tr>
<td>Wille-Jørgensen et al.</td>
<td>1 of 86</td>
<td>7 of 90</td>
<td></td>
<td>0-17 (0-04, 0-74)</td>
<td></td>
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<tr>
<td>Wille-Jørgensen et al.</td>
<td>2 of 79</td>
<td>12 of 81</td>
<td>7-0</td>
<td></td>
<td>0-37 (0-10, 1-35)</td>
</tr>
<tr>
<td>Celebi et al.</td>
<td>3 of 92</td>
<td>8 of 91</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subtotal</td>
<td>6 of 272</td>
<td>27 of 279</td>
<td>15-5</td>
<td>0-24 (0-10, 0-57)</td>
<td></td>
</tr>
<tr>
<td>Heterogeneity: $\tau^2 = 0.00; \chi^2 = 0.86, 2$ d.f., $P = 0.65; I^2 = 0%$</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Test for overall effect: $Z = 3-20, P = 0.001$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Orthopaedic</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Cohen et al.</td>
<td>16 of 395</td>
<td>19 of 400</td>
<td>23-2</td>
<td>0-85 (0-45, 1-63)</td>
<td></td>
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<tr>
<td>Edwards et al.</td>
<td>6 of 141</td>
<td>16 of 136</td>
<td>13-4</td>
<td>0-36 (0-15, 0-90)</td>
<td></td>
</tr>
<tr>
<td>Kalodiki et al.</td>
<td>8 of 32</td>
<td>12 of 32</td>
<td>18-5</td>
<td>0-67 (0-32, 1-41)</td>
<td></td>
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<tr>
<td>Patel et al.</td>
<td>7 of 65</td>
<td>11 of 53</td>
<td>14-2</td>
<td>0-52 (0-22, 1-25)</td>
<td></td>
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<tr>
<td>Siragusa et al.</td>
<td>6 of 35</td>
<td>10 of 35</td>
<td>13-6</td>
<td>0-60 (0-24, 1-47)</td>
<td></td>
</tr>
<tr>
<td>Stannard et al.</td>
<td>0 of 25</td>
<td>5 of 25</td>
<td>1-5</td>
<td>0-09 (0-01, 1-56)</td>
<td></td>
</tr>
<tr>
<td>Subtotal</td>
<td>43 of 693</td>
<td>73 of 681</td>
<td>84-5</td>
<td>0-60 (0-42, 0-85)</td>
<td></td>
</tr>
<tr>
<td>Heterogeneity: $\tau^2 = 0.00; \chi^2 = 4-25, 5$ d.f., $P = 0.51; I^2 = 0%$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test for overall effect: $Z = 2.85, P = 0.004$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Total: 49 of 965, 100 of 960, 100-0, 0-51 (0-36, 0-73)

Heterogeneity: $\tau^2 = 0.03; \chi^2 = 8-96, 8$ d.f., $P = 0-35; I^2 = 11\%$
Test for overall effect: $Z = 3-69, P < 0-001$
Test for subgroup differences: $\chi^2 = 3-63, 1$ d.f., $P = 0-06; I^2 = 72-5\%$

British Journal of Surgery

Volume 101, Issue 9, pages 1053-1062, 10 JUN 2014 DOI: 10.1002/bjs.9527
Aspirin

- Aspirin’s effectiveness is similar to anticoagulation for hip & knee arthroplasty with lower bleeding risk
- Aspirin is less effective in hip fracture
  - Drescher, 2014
Review of Newer Anticoagulants

- Fondaparinux (Arixtra)
- Rivoraxaban (Xarelto)
- Dabigatran (Pradaxa) 220 mg
- Dabigatran (Pradaxa) 150 mg
- Apixiban (Eliquis)
- Bemiparin (not available in US)

So Why Not?

• Bleeding Risk
• Interactions with other medications (esp. Warfarin)
• Unknowns of newer medications
• Pain
• Freaking out from compression devices
• Cost
• What is the real risk?
Postoperative Pain Control

• Regional Anesthesia
• Patient/Nurse/Caregiver Controlled Anesthesia
• Opioids, when used in patients with pain, have a low risk of respiratory depression

• For the Love of God, Don’t use Codeine
Codeine

(These Slides from Stefan Friedrichsdorf)

• Overall, codeine is a weaker analgesic than commonly believed: A standard dose of many NSAIDs produces more effective analgesia than 30 to 60 mg of codeine in adults after surgery.  

  Moore A, 1997

• Codeine is a prodrug converted to Morphine in the liver by Cytochrome P450 2D6

• This enzyme is …difficult
Codeine

(1) Poor Metabolizer - Ineffective
• Caucasians 5-10 %
• Africans 2-17 %
• Asians 2-7 %

(2) Intermediate Metabolizer - Poorly Effective

(3) Extensive Metabolizer - ”Normal”

(4) Ultra-rapid Metabolizer - Danger of overdose

CAUTION URGED BY THE FDA!
Conclusions

• Adults with CP deserve a thorough preoperative assessment prior to orthopedic procedures, with special attention to pulmonary status. Engage your colleagues in Anesthesia, Internal Medicine, and Pulmonary Medicine

• Use of DVT Prophylaxis should be individualized according to the surgeon and patient/family’s tolerance of risk

• Postoperative pain control should be vigorous and should not include codeine


Contact Information

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THANK YOU!