Von Willebrand Disease and Anesthesia

Jordan Idso, SRNA

Von Willebrand Disease: A Historical Perspective

- First introduced in 1962 by Dr. Erik von Willebrand
- Originated in the Baltic Sea, discovered with the onset of menarche in females
- Initially termed pseudohemophilia as bleeding times were prolonged in the absence of thrombocytopenia
- vWD was identified to affect both males and females in contrast to hemophilia
- Continues to be the most common inherited coagulopathy occurring in 1% – 2% of the world’s population

(Pagon, Adam & Ardinger, 2014)

Pathophysiology of vWF

- Characterized by a malfunctioning clotting factor specifically von Willebrand factor (vWF)
  - vWF is a large glycoprotein produced in the plasma, platelets, endothelial cells, and megakaryocytes
- vWF assists in platelet adhesion via 3 functions:
  - Attracting platelets to the site of injury
  - Initiating the transport of factor VIII to form fibrin clots
  - Protecting factor VIII from in vivo proteolysis (an internal degradation process)
- Patients with von Willebrand disease (vWD) also have abnormal communication with glycoprotein Ib receptors

(Mannucci et al., 2002)

Presentation & Classification

Clinical Presentation
- Depends on classification
- Typically mucocutaneous bleeding
- Delayed hemostasis post-injury
- Menorrhagia in females
- Prolonged epistaxis
- GI/GU bleeding
- Often asymptomatic

Classification
- vWD variants
  - Type 1
  - Type 2A, 2B, 2M, 2N
  - Type 3
- Most severe forms
  - Type 2N and type 3
- As a general rule, severity of vWD increases with number (i.e. Type 3 is more severe than type 1)

(Pagon, Adam, & Ardinger, 2014)

Prevalence of vWD

- Demographics
  - Females more susceptible than males, prevalence is roughly 2:1
  - Data appears to be controversial
- Population
  - Affects roughly 1% - 2% of the world’s population
  - Roughly 75% of patients are Caucasian
  - However, no one population is predisposed to vWD
  - The other 25% is represented by people of Middle East, Far East, and Native American descent

(Lillicrap, 2013)
Case Information

- Surgical Procedure
  - Robotic hysterectomy
  - Removal of malignant ovarian mass secondary to Cowden’s syndrome

- Pertinent Patient Information
  - 31 year old, female
  - 138 kg, 63 in
  - ASA 3
  - No known allergies

Pre-operative Evaluation

- Past Medical Hx
  - Hypertension, hyperlipidemia, anemia, Cowden’s syndrome, colon/liver CA, GERD, von Willebrand disease type 2, and an uncorrected hiatal hernia

- Surgical hx
  - Tonsillectomy and adenoidectomy
  - Lap appendectomy/cholecystectomy
  - Hemicolectomy

- Pre-op VS
  - BP: 158/105, HR: 88, RR: 16, Oxy. sat. 98%, and temp. 98.1

- Pertinent labs
  - H: H 10.2/29, plt 180, K 3.3, creatinine 1.3, all other labs WNL

- Airway evaluation
  - Mallampati IV, short thyromental distance, limited neck ROM, and previous documentation of difficult airway

Anesthetic Course

- Induction
  - Versed 2 mg
  - Fentanyl 150 mcg
  - Rocuronium 5 mg
  - Propofol 200 mg
  - Succinylcholine 200 mg

- Technique
  - Rapid sequence performed, airway secured with a video laryngoscope and 7.0 endotracheal tube
  - +BBS, +EtCo2 noted

- Vent Settings
  - PCV, imp pressure 23, rate 14
  - PEEP, tidal volumes 520 – 560 cc’s achieved

- Maintenance
  - Desflurane 7% – 8%
  - Fentanyl 25 – 50 mcg prn
  - Rocuronium 10 – 20 mg prn
  - Once twitches returned
  - Offmex 1 gram pre incision
  - VWF concentrate 6900 IU pre incision over 10 minutes

- Anti-emetics
  - Zofran 4 mg
  - Decadron 5 mg

- Reversal
  - Neostigmine 5 mg
  - Glyc 0.8 mg

Intraoperative Issues

- Surgical course proceeded uneventfully
  - VSS throughout

- Total Anesthesia Time
  - 3 hours 3 minutes

- I/O
  - 2300 cc’s of crystalloid
  - 200 cc’s of urine output

- Estimated Blood Loss (EBL)
  - 150 cc’s

PACU

- An awake extubation was performed uneventfully in the operating room
- Patient was initially placed on a non-rebreather at 10 liters per minute and once in the PACU converted to Bipap for roughly 2 hours
- Bipap was planned and not due to distress or hypercapnia
- Pain level of 2/10
- Treated with fentanyl and morphine PCA per PACU staff
- No PONV or intraoperative awareness reported
- Transferred to general floor after an uneventful PACU stay
- Discharged to home 3 days later with no complications noted

Preoperative Evaluation for vWD

Laboratory Analysis

- vWF:Ag. levels (50 – 200 IU/dl)
- Factor VIII:C levels (50 – 150 IU/dl)
  - Most specific
- Others
  - CBC, aPTT, platelet function assays, vWF multimer analysis, ristocetin-induced platelet agglutination, and collagen binding assays

- Obtain T/S for all procedures along with H/H and Coag’s

Preoperative Screening

- Investigate level of bleeding risk via frequency of the previously mentioned symptoms
- Type of vWD is not often available related to the expense of testing
  - Severity is more often determined by frequency and duration of bleeding events
# Treatment options for vWD

- Desmopressin
- vWF concentrates
- Cryoprecipitate
- Tranexamic Acid
- Estrogen Derivatives

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## Desmopressin (DDAVP)

- Introduced as a treatment option for vWD in 1977
- Derivative of ADH
- Mechanism of action works to raise intrinsic vWF levels through agonistic activity on V2 vasopressin receptors
  - vWF along with factor VIII levels subsequently increase 2 to 3 times normal
  - Clinical results have demonstrated variability in patient outcomes related to short acting multimers
- Standard Dosing
  - 0.3 mcg/kg IV given over 30 minutes
  - 150 mcg to 300 mcg intranasal

(Meff & Silenio, 2014)

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## vWF Concentrates

- Considered the gold standard treatment for vWD
- Useful in treating all variants of vWD
- Used under the trade names Alphanate, Humate-P, Haemate-P, and Wilate
- Each medication contains varying concentrations of vWF and factor VIII

- Standard dosing
  - 60 IU/kg bolus followed by 40 IU/kg doses as needed
- Favorable side effect profile
  - Anaphylactic reactions, hyperthermia, vWF inhibitory antibodies, hemolysis, thromboembolic complications (less than 1%), and hypervolemia

(Mannucci et al., 2002)

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### vWF concentrate

**Mannucci et al. (2002)**
- 5 year, prospective study
- 87 patients
  - All subtypes represented
- Used for 71 cases of surgical prophylaxis and 87 situations involving acute hemorrhage
  - Skin bleeding time used for analysis
- Standard dosing applied
  - 60 IU/kg bolus, 30 IU/kg redose
- Acute bleeding episodes controlled with one bolus dose
- Surgical bleeding was controlled with vWF concentrate
  - Measured via expected surgical blood loss vs. actual blood loss
- No incidences of hemorrhage or side effects reported

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### vWF concentrate

**Berntorp (2009)**
- Systematic review investigating patients non-responsive to desmopressin treated with vWF concentrate
- Found 90% of patients had corrected bleeding times with a single bolus dose of vWF concentrate
- Concluded:
  - Effectively reduced the risk of bleeding complications in vWD patients undergoing elective surgery

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### vWF concentrate

**Auerswald and Kreuz (2009):**
- Suggested to following dosing regimens:
  - for major bleeding and trauma
    - loading dose of 40 – 60 IU/kg be given intravenously followed by a maintenance dose of 40 – 50 IU/kg for 3 days keeping vWF levels greater than 50%
  - For minor bleeding
    - a dose of 40 – 50 IU/kg be given intravenously for either 1 or 2 doses depending on individual response
### Tranexamic Acid (TXA)

- Lysine derivative, anti-fibrinolytic agent  
  - Opposes the disintegration of thrombus formation  
  - Typically used as an adjunct with desmopressin for vWD patients  
  - Used in minor surgery and dental procedures  
  - Combats natural proteolytic enzymes in the oral cavity  
- Standard dosing  
  - 650mg orally for surgical prophylaxis  
  - 1300mg orally every 8 hours for 5 days for menorrhagia  
  - 10mg/kg IV bolus over 15 minutes (typically 1 gram given)

(Neff & Sidonio, 2014)

### Cryoprecipitate

- Plasma derived blood product  
  - Contains vWF, factor I, VIII, XIII, and fibrinogen  
  - 80 – 100 units of factor VIII  
- Reserved for when vWF concentrates unavailable  
  - Falling out of favor related to acute viral pathology post-infusion

(Neff & Sidonio, 2014)

### Estrogen Derivatives

- Increase vWF production from endothelial cells  
  - Reserved for vWD affected women of childbearing age  
  - Effective in type 1 vWD  
  - Not for use in the acute, hemorrhagic scenario  
  - Not typically seen as an effective treatment option

(Neff & Sidonio, 2014)

### Genetic Testing

- Recommended in first degree relatives of a vWD patient with or without a history of spontaneous bleeding episodes  
  - The International Society on Thrombosis and Haemostasis (ISTH) recommends all type 3 vWD patients undergo phenotypic analysis prior to conceiving children

### Practice Recommendations

#### Obstetrics

- Pregnancy tends to place vWD in remission making neuraxial anesthesia safe  
  - Choi and Brull (2009) performed a case review involving 10 research studies with 74 vWD patients undergoing spinal/epidural anesthesia for labor analgesia and found no complications reported  
- However, vWF levels should be drawn prior to neuraxial anesthesia and should not proceed if levels are less than 30% to 40% of normal  
  - Removing the epidural catheter immediately in the postpartum period is recommended  
- Typically, even in the most severe forms of vWD, inherent vWF are increased to 40% to 50% of normal in the pregnant patient

(Choi & Brull, 2009)

#### Regional Anesthesia

- Generally considered safe and efficacious  
  - Especially if inherent vWF levels greater than 50% of normal  
    - Bleeding risk is nullified at this level  
- Either desmopressin or vWF concentrates are the preferred pre-treatment prior to regional anesthesia if deemed clinically necessary  
  - If catheters are placed, removal of the catheter is recommended as soon as clinically possible to prevent bleeding diathesis from occurring or worsening if already present

(Oseeford & Pittman, 2000)
Synopsis of vWD Treatment

- Desmopressin useful in the treatment of vWD
  - Type 1
  - Type 2A, 2M, and 2N
- vWF concentrates are the GOLD standard
  - Efficacious in the treatment of all vWD variants
- Adjuncts
  - TXA
  - Cryoprecipitate (falling out of favor)
  - Estrogen derivatives not commonly used

References


References

Introduction—
What is Charcot Marie Tooth disease?

- Charcot Marie Tooth disease (CMTD)
  - Chronic and progressive neurological disease
  - Affects both motor and sensory nerves
  - Prevalence: 1 in 2,500 people (0.04%) 
  - Diagnosis: genetic testing
  - Over 25 genes associated with CMTD
  - Most common gene affected
    - Peripheral myelin protein 22
  - Autosomal dominant is most common
  - Onset: first or second decade

Two major classifications of CMTD

- 1. Axonal degeneration of peripheral nerve fibers
  - Reduced muscle action potentials
  - Normal or subnormal nerve conduction velocity (NCV)
  - Type 1A: Can affect intercostal and phrenic nerves
    - Respiratory function abnormalities

- 2. Segmental demyelination of peripheral nerve fibers
  - Slower-than-normal nerve conduction velocity (NCV)
  - Nerve conduction speed < 38 meters/second

Symptoms of CMTD

- Peripheral muscle weakness
  - Hands, feet and diaphragm
- Motor deficits
  - Wasting of the feet
  - Bone deformities
    - High-arched feet, hammertoes
- Sensory loss of extremities
  - Numbness & tingling in the hand and feet
  - Loss of vibration and joint position
  - Decreased pain and temperature sensation

Case Information

- 38 year old
- 58 kg
- 165 cm
- Male
- BMI: 21.3
- NKDA
- Procedure
  - Extracorporeal shock wave lithotripsy (ESWL)
- Location
  - Same-day surgery facility

Case Information cont’d

Past Medical History
- CMTD type 1A
- HTN
- Melanoma
- Decreased lung capacity
- Osteopenia
- Leukoerythroblastemia
- GERD
- Migraine headaches
- Nonischemic cardiomyopathy
- Sleep-related hypoventilation
- Sleep apnea
- Kidney disease
- Nephrolithiasis

Surgical History
- Spinal fusion
- ESWL
- Ureteroscopy

- Wheel-chair dependent
- No previous anesthetic complications with GA
Pre-operative Evaluation

- **ASA:** 3
- Mallampati Class II
- **BP:** 125/87
- **HR:** 94
- **RR:** 16
- **O2 Sats:** 98% on RA
- **Temp:** 98.4 degrees F
- Lungs clear, bilaterally
- Heart: RRR
- **Current Medications**
  - Percocet
  - Ciprofloxacin
  - Fioricet
  - Metoprolol Succinate
  - Vitamin D

Anesthetic Course

- **Holding Room:**
  - 1 mg Midazolam IV
  - 50 mcg Fentanyl IV
- **Induction:**
  - RSI
  - 2 mg Midazolam IV
  - 100 mcg Fentanyl IV
  - 40 mg Lidocaine IV
  - 200 mg Propofol IV
  - MILS
  - Cricoid pressure
  - GlideScope 4
- **2nd Attempt:**
  - 200 mg Propofol IV
  - MILS
  - Cricoid pressure
  - GlideScope 3
  - 6.0 cuff ET
  - Sevoflurane 1.2 – 2.1
- **Additional Drugs:**
  - 2 g Ancef IV
  - 4 mg Dexamethasone IV
  - 4 mg Zofran IV
  - 300 mcg Phenylephrine IV
  - 10 mg Ephedrine IV
  - 1200 ml LR

Emergence & PACU

- **Emergence**
  - Sevoflurane discontinued
  - 100% FIO2
  - Quickly met extubation criteria
  - 4 LPM O2 via nasal cannula
- **PACU**
  - Denied pain, n/v
  - No complications
  - Discharged home later that day

Discussion—Risks with Administering Neuromuscular Blockers

- **CMTD neurological dysfunction:** Degeneration of nerve fibers
- Depolarizing NMB: Succinylcholine
  - Up-regulation of acetylcholine receptors
  - Hyperkalemia
- Non-depolarizing NMB
  - Concern for respiratory dysfunction is present
  - Prolonged muscle weakness
  - Weakness upon emergence
  - Poor tidal volumes
  - Risk for a prolonged intubation
  - Recurarization

Cases Where NMB Safely Used

- 5 children: 0.2 mg/kg mivacurium IV
  - Normal recovery
- 5 adults: 0.2 mg/kg mivacurium IV
  - Normal recovery
- 16 yr female: 0.1 mg/kg vecuronium IV
  - Redosed several times, total of 13 mg vecuronium IV
  - Reversed with atropine and neostigmine
  - Normal recovery
- 6 yr male: vecuronium for an RSI
  - Reversed with glycopyrrolate and neostigmine
  - Normal recovery

Cases Where NMB Safely Used

- **Retrospective review**
  - 7 pts under the age of 16 had 9 procedures
  - Both depolarizing and non-depolarizing NMB were used
  - No complications
- **Chart review**
  - 86 pts underwent 139 procedures
  - Succinylcholine was used in 56 cases
  - Non-depolarizing agents were used in 50 pts
    - 26/50 pts were reversed
    - 19 pts complained of weakness
    - “No complications occurred as a result of muscle relaxants, i.e objective weakness, prolonged intubation or reintubation”

(References: Greenberg & Parker, 1992; Heller & Marn, 2015; Antognini, 1992; Schmi, Wick & Munster, 2006)
Prolonged Neuromuscular Blockade

- 59 yr old male
- Fractured fibula and tibia
- Induction
  - 10 mg morphine IV
  - 350 mg thiopental IV
  - 0.11 mg/kg vecuronium IV
- Peripheral nerve stimulator was not used
- 115 min. case
- Reversal
  - 2.5 mg neostigmine & 0.5 mg glycopyrrolate
- PACU
  - Twitching of his limbs, uncoordinated movements
  - 1 twitch, 2.5 mg neostigmine, 4 twitches

Case Where NMB Avoided

- 15 yr old male
- Emergent laparoscopic appendectomy
- RSI
  - 0.2 mg glycopyrrolate IV
  - 3 mg/kg propofol IV
  - 5 mcg/kg remifentanil IV
- TIVA
  - Propofol infusion: 175 mcg/kg/min
  - Remifentanil infusion: 0.2 – 0.4 mcg/kg/min
  - “Laparoscopic surgical conditions were identical to standard management with neuromuscular blockade”

Research Findings

- The use of succinylcholine and non-depolarizing NMB can be safely used in patients with CMTD
  - Suggested to avoid succinylcholine
    - Risk of hyperkalemia
  - If need to use succinylcholine, use a defasiculating dose
    - May lessen the release of K from diseased muscle
  - Limited research: anesthetic complications are rare

Recommendations for Patients with CMTD

- Thorough pre-op exam
  - Respiratory dysfunction: 0 – 30%
- Document patient’s baseline deficits
- Review previous anesthesia records and dates
- TOF monitoring of the facial nerve
- Undergo GA at a higher frequency
- Higher risk of falling
  - Lower extremity and foot abnormalities
- Avoid nerve compression with positioning

Recommendations Cont’d

- Minimally invasive surgical plan
- Avoid prolonged periods of immobility
  - Difficult to rehabilitate damaged/atrophied muscles
- Extubation awake with extubation criteria met
  - Hemodynamically stable
  - 4 strong twitches with sustained tetany
  - Achieve adequate tidal volumes
  - Sustained head lift
  - Follow verbal commands
- Educate PACU: monitor respiratory status

Conclusion

- More research must be done regarding the anesthetic management of CMTD patients
- Children & adults with CMTD recover within the normal, expected time frame when given a standard intubating dose of a NMB
- Use caution with patients of advanced disease
- Evaluate the use of a NMB on a case-by-case basis
Management of the Pediatric Patient with Emergence Agitation

Jessica McDonnell, SRNA

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**Introduction**

- **Emergence Agitation/Emergence Delirium:**
  - A state of hyperecstasia that includes disorientation, inconsolable crying and/or screaming, and violent movements such as flailing kicking and rolling (Neustadt, 2011)

- **Incidence:** 10-80% with Sevoflurane

- **Etiology:** Children ages 1-12, ages 2 to 5 years are at the highest risk

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**References**

Introduction

- The exact causes of EA/ED are still unknown, possible factors include:
  - Untreated pain
  - Preoperative anxiety
  - Volatile anesthetics (sevoflurane specifically)
  - Patients’ temperament

Case Information

- Dental restorations
- 7-year-old
- 20kg
- Female
- ASA I

Pre-operative Evaluation

- Past Medical History
  - Anxiety
  - Gingivitis
  - Dental caries
- Surgical History
  - No previous history
- Pre-op VS
  - HR: 117
  - BP: 113/67
  - RR: 16
  - Temp: 36.6
  - SaO2: 97%
- Allergies
  - NKA
- Medications
  - No home medications
- Airway evaluation
  - Mallampati: 2
  - Neck: Full ROM
  - Dentition: Intact
- Labs/Tests
  - None taken

Anesthetic Course

- Induction
  - Inhalation mask induction
  - 70/30 Nitrous & Oxygen mixture
  - Sevoflurane added to 8%
  - 22 gauge IV was placed
  - Propofol 40 mg IV
  - Fentanyl 20 mcg IV
  - Phenylephrine 0.25% in each nare
  - intubation with grade I view
  - direct visualization with 4.5 mmuffed nasal RAE ETT
- Maintenance
  - Dexamethasone 4mg
  - Ondansetron 4 mg
  - Fentanyl 30 mcg
  - IV fluids: LR 350 mL
- Induction, maintenance, and surgery were uneventful

Post Induction

- GA maintained with:
  - MAC of 1.5% Sevoflurane
  - Fresh gas flows:
    - 1.5 L/min oxygen
    - 1.5 L/min air
- Emergence
  - Sevoflurane was discontinued
  - A total of 40 mg of propofol was administered
  - Extubated with little to no MAC of Sevoflurane
  - Oral airway placed with simple facemask, oxygen at 6 L/min
  - Patient was then transferred to PACU

Intraoperative Issues

- No intraoperative issues
  - Hemodynamically stable throughout the case
  - Spontaneously breathing
  - Case length: approximately 45 minutes
PACU

- Report was given with vital signs stable
- PACU nurses were informed of the anesthetic
- Post-operative evaluation was unable to be performed
- PACU nurses reported wakeup being very pleasant as if “she woke up from a nap”

Discussion

- **Emergence agitation (EA):**
  - Characterized by self-limiting aggressive agitation that develops in the early phase of awakening from anesthesia at the end of surgery
  - EA can be self-limiting or even last for up to 45 minutes
- Network meta-analysis study by Fang et al. (2015), found propofol, ketamine, fentanyl, dexmedetomidine, and preoperative analgesia good adjuncts to prevent episodes of EA in children
- Another meta-analysis study by Dahmani et al. (2010), found beneficial effects of propofol, ketamine, and fentanyl for prophylactic use in preventing EA, while midazolam and 5HT₃ inhibitors did not have any protective effects

Discussion

- **Preoperative Anxiety Factors:**
  - Preoperative anxiety
  - Postoperative behavior
  - Parental participation in the child’s health care experience
- Administration of fentanyl, dexmedetomidine, propofol, or ketamine would help reduce the incidence of EA if given preoperative or during maintenance of anesthesia.
- Benefits of measuring preoperative anxiety
  - Evidence has suggests children who are anxious in the holding area and during the induction period of anesthesia experience an enhanced distress period immediately postoperatively.

Discussion

- **Risk Factors cont.**
  - Psychological Immaturity
  - The psychological immaturity of a child’s nervous system and the rapid awakening from general anesthesia in an unfamiliar environment may be responsible for the occurrence of EA.
    - GABA_A receptor could be excitatory rather than inhibitory in early infancy as a result of high intracellular chloride ions, thus explaining this paradoxical reaction to anesthesia in young children
    - As child matures, the GABA_A receptor transforms into an inhibitory neurotransmitter, and the reaction no longer occurs, as in the adult.

Discussion

- **Risk Factors cont.**
  - Previous Hospital Experience
    - Children who have had previous negative health care encounters can experience increased anxiety both in the holding area and during separation from parents.
    - By reducing a child’s anxiety during the preoperative period, it may benefit the perioperative process and also decrease anxiety for future anesthesia encounters.
    - Stressful life experiences that take place close to a hospital admission can also affect how a child reacts to anesthesia and the overall surgical experience.

Discussion

- **Risk Factors cont.**
  - Type of Surgical Procedures
    - Banch & Lerman (2014) found several studies had concluded the type of surgery does not increase the risk of postoperative EA.
      - Also found studies with surgical procedures of the genitourinary system and inpatient surgery were associated with an increased risk of postoperative EA.
    - Cho et al. (2014) conducted a RCT that included 90 children between the ages of 1 and 13 years old undergoing strabismus surgery.
      - Suggested that children undergoing ophthalmic surgery may experience a high incidence of EA due to visual disturbances.
    - Conversely, Kanaya et al. (2014) conducted a meta-analysis of RCT and found surgical procedures, specifically, adenotonsillectomy at highest risk for EA.
      - Lower incidence of EA following propofol anesthesia associated with these procedures compared to Sevoflurane anesthesia (Kanaya et al., 2014).
Discussion

Scales used to measure EA/ED

• More than 16 scales can be utilized by the anesthetic professional in order to evaluate EA/ED in the postoperative period.
  – The Pediatric Emergence Anesthesia Delirium (PAED) scale
  – Watcha four-point scale

• Watcha four-point scale
  – More simplified scale
  – Scores ranging from 1-4
    • 1 = calm, quiet
    • 2 = crying, but can be consoled
    • 3 = crying, cannot be consoled
    • 4 = agitated and thrashing (Cos7, 2014)

Discussion

• Pediatric Emergence Anesthesia Delirium (PAED) scale
  – Ranges from a minimum score of 0 to a maximum score of 20.
  – The degree of ED increases directly with the total score.
  – There are five categories that consist of:

<table>
<thead>
<tr>
<th>Score</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Calm, quiet</td>
</tr>
<tr>
<td>1</td>
<td>Crying, can be consoled</td>
</tr>
<tr>
<td>2</td>
<td>Crying, cannot be consoled</td>
</tr>
<tr>
<td>3</td>
<td>Agitated and thrashing</td>
</tr>
<tr>
<td>4</td>
<td>Very agitated and thrashing</td>
</tr>
</tbody>
</table>

(From: G. J. et al., 2013)

Discussion

• Anesthetic Techniques and Management for EA
  – Midazolam
    • The most commonly used and agent for anxiolysis
    • Major appeal: safety profile, effectiveness, synergistic effects when used with propofol
  – Dahmani and colleagues (2010) performed a study to provide a meta-analysis aimed towards the pharmacologic prevention effects of EA in children.
  – Out of thirty-seven articles that included 1685 patients in the intervention group and 1477 in the control group midazolam and 5HT3 inhibitors showed no protective effects on EA

• Concern with midazolam is prolonged emergence time
  – In the RCT study by Cho and colleagues (2012), 81 children undergoing strabismus surgery under general Sevoflurane anesthesia.
  – Results: Significant lower incidence of EA in both midazolam groups 4.7% vs 43.3% in saline group

Discussion

• Ketamine
  – Also proven beneficial effects to reduce the incidence of EA
  – Small RCT by Kim et al. (2015), 68 patients age 1-6 years old
    • Ophthalmic surgery under general Sevoflurane anesthesia
    • Results: Significant decrease in EA Ketamine 24% vs midazolam 52.9%
    • Midazolam required more rescue medication

• Lee and colleagues (2010), different doses of ketamine compared to determine most effective dose
  – 93 children ages 2-14 years old undergoing an adenotonsillectomy.
  – Results: Saline group (54%) vs both ketamine groups (2%) for EA scores
  – Post-op pain control Ketamine 0.25mg/kg (75% median scores of 6/10) vs Ketamine 0.5mg/kg (75% median score of 2/10)

Discussion

• Anesthetic Techniques and Management for EA
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Discussion

**Dexmedetomidine**
- Dexmedetomidine (alpha-2 adrenoreceptor agonists) has not been FDA approved for the use as a sedative, anxiolytic, and analgesic in the pediatric population.
- A RCT by Hauber et al. (2015) examined the hemodynamic effects of a rapid IV bolus injection of DEX on EA.
  - Large sample of 303 children ages 4-10 undergoing tonsillectomy with or without adenoidectomy.
  - **Results:**
    - DEX group (50% EA vs Saline 60%)
    - DEX group = postoperative opioids (77% vs 61%)
    - Slight decrease in heart rate 22% vs 10% in control group.
- A smaller RCT - the effects of dexmedetomidine in 40 children undergoing ambulatory hernioplasty or orchiopexy under general Sevoflurane anesthesia.
  - Significant reduction in EA in DEX vs Saline (5% vs 55%).
  - No differences in post of pain or discharge times (Kim et al., 2014).

**Fentanyl**
- Fentanyl commonly utilized in conjunction with either midazolam or propofol upon emergence to eliminate post-operative pain (suggested factors thought in causing EA).
- In a prospective, randomized, double-blind study, performed by Kim et al. (2012).
  - 222 children 18 months- six-years old underwent ambulatory inguinal hernia repair under general Sevoflurane anesthesia.
  - **Results:**
    - Both fentanyl and propofol PAED scores were significantly lower than the saline group.
    - Incidence of nausea/vomiting in fentanyl group was 26% higher than the propofol group.
  - Propofol and fentanyl groups discharged from PACU after a 10 min wake up vs saline group took >15 minutes for discharge 0%; incidence of EA (Kim et al., 2012).

Discussion

**Anesthetic Techniques and Management for EA**

- **Propofol**
  - Desirable anesthetic due to smooth and rapid recovery with few postoperative side effects (Kanaya et al., 2014).
  - The “propofol technique” has been utilized in cases of the pediatric patient undergoing dental procedures.
  - Messieha, Z. (2013) describes the technique by conducting a Sevoflurane washout in the spontaneously breathing intubated child.
  - Conducted over 300 cases utilizing the technique and noted a significant limitation of EA in over 90% of those cases.

- **Propofol cont.**
  - A prospective RCT conducted by Costi et al. (2014), was to determine whether transition to propofol over three minutes at the end of Sevoflurane anesthesia would reduce the incidence of EA in children.
    - Trial consisted of 230 children ages 1-12 years who underwent MRI scans.
    - **Result:** Incidence of EA and severity was lower in the propofol group on both PAED (29% vs 7%) and Watcha scale (15% vs 7%).
  - Inconsistent results among studies and whether propofol is the preferred method and lowers the incidence of EA thus necessitates further research and studies.

Recommendations

1. **Standardized Rating System:**
   - Standardizing one particular scale: i.e. PAED, Watcha Scale
   - Scales and standard scores for future studies
2. **Anesthetic Technique:**
   - Many anesthetic options available with no single medication showing significant positive or negative outcomes in EA
   - Utilize strategies: induction, maintenance, emergence (combo)
   - Limit (or eliminate) the amount of volatile agents used during the case
   - Agent on emergence is thought to be most convenient and applicable
   - *Most important* → Patient specific plan

Conclusion

- Pediatric patient ages 2 to 5 years of age remain at highest risk for developing emergence agitation
- Reducing or eliminating EA can decrease the risk of injury to the child or surgical site such as removal of dressings or IV catheters
- EA in the PACU requires extra nursing staff and unsatisfied caregivers
- Supplemental sedatives and/or analgesic medications lead to longer recovery times, delay patient discharge, and increased costs
### References


### Introduction

**A Venous Air Embolism (VAE) is a potentially fatal complication where air enters the vasculature causing obstruction of blood flow (gas lock).**

**Severity is related to:**
- Volume of air entrained
- Air entrainment rate


**Incidence:**
- Neurosurgery (Sitting Position): 10-80%
- Laparoscopic Surgeries: Up to 69%
- Orthopedic Surgeries: Up to 57%
- Cervical Laminectomies: Approximately 10%
- Mortality: Up to 28%

Case Information

- Total Laparoscopic Hysterectomy
- 45 year-old
- 70 Kg
- 168 cm
- Female
- ASA 2
- No Known Allergies

Pre-operative Evaluation

- Past Medical History:
  - Migraine headaches, dyslipidemia, uterine fibroids, intrauterine fetal death related to placental abruption, and disseminated intravascular coagulation (DIC) related to placental abruption
- Surgical History:
  - Cesarean section X 3 and umbilical hernia repair X 2

Pre-operative Evaluation Cont’d

- Pre-op VS:
  - Heart rate 64, blood pressure 122/81, respirations 12, pulse oximetry 97%, and temperature 36.8° Celsius
- Mallampati class II

Anesthetic Course

- Holding Room Drugs:
  - 2 mg Midazolam IV
- Induction Drugs:
  - 50 mcg Fentanyl IV, 50 mg Lidocaine IV, 180 mg Propofol IV, 5 mg Rocuronium IV, 140 mg Succinylcholine IV
- Other Drugs:
  - 4 mg Ondansetron IV, 8 mg of Dexamethasone IV, 2 g Cefazolin IV
- Airway:
  - 7.0 mm cuffed endotracheal tube
- Ventilation:
  - Synchronized intermittent mechanical ventilation, respiratory rate of 10, tidal volume of 500 mL, and 4 centimeters of water of positive end-expiratory pressure (PEEP)
- Sevoflurane end-tidal concentrations of 1.7 to 2.6 throughout the case
- Lithotomy Position
  - Prior to Incision:
    - 50 mcg Fentanyl IV and 30 mg of Rocuronium IV

Intraoperative Issues

- Pneumoperitoneum Established:
  - VS: ETCO₂ from 32 mmHg to 15 mmHg and then to 0 mmHg, heart rate 32, blood pressure 44/40, oxygen saturation 76%
- Abdomen evacuated, manual ventilation, 25 mg Ephedrine IV given
- Code Blue:
  - EKG: bradycardia - wide complex ventricular tachycardia - asystole
  - Drugs: 2 mg Epinephrine IV in 0.5 mg doses, 2 mg Atropine IV in 0.5 mg doses, 1 g Calcium Chloride IV, and 50 mEq Sodium Bicarbonate IV
- Return of Spontaneous Circulation:
  - VS: Blood pressure 158/102, heart rate 135

Intraoperative Issues Cont’d

- Perineal blood found (300 mL) - decision to open:
  - 2 mg Midazolam IV, 20 mg Rocuronium IV
  - 2 IV catheters, arterial line, and central line placed
- Labs: pH 7.05, potassium 3.5 mmol/L, Hgb 9.0 g/dL
- Treatment: 3 units PRBCs, 1 unit FFP, 150 mEq Sodium Bicarbonate IV in 50 mEq doses, 20 mEq Potassium IV
- Repeat Labs: pH 7.3, Hgb 11.5
- Pulmonary edema treated with 40 mg furosemide IV
- Blood pressure supported with Phenylephrine drip
Intraoperative Issues Cont’d

• 3 Hour Surgery:
  – Patient remained in atrial fibrillation
  – BIS: 0
  – ETCO₂ remained in the mid 20’s
  – Oxygen saturation in the low 90’s
  – 5,600 mL of intravenous fluids
  – 500 mL of 5% albumin
  – EBL 900 mL

Intensive Care Unit

• Transfer to ICU:
  – Fixed Pupils
  – Ventilatory dependent
  – Not following commands

36 Hours Later:

– Weaned from ventilator and extubated
– Left-sided weakness due to a CVA

Discharged home 6 Days Later

Detection

• Transesophageal Echocardiogram (TEE):
  – Most sensitive method of detection (0.02 ml/kg of air)
• Precordial Doppler Ultrasound:
  – Most sensitive noninvasive method of detection (0.05 ml/kg of air)
  – Versatile with both adults and children
  – Questionable effectiveness
• Pulmonary Artery Catheter:
  – Considered insensitive for detecting air entrainment (0.25 ml/kg or greater)
  – Best used for a patient who would benefit from its use as a monitoring tool due to their physical status

Detection Cont’d

• ETCO₂ Monitoring:
  – A change of 2 mmHg can be an indicator of VAE
  – A decrease in ETCO₂ is the initial response to a VAE
  – Most cases will show a decreased value with VAE; however, an increased value may also indicate VAE
• Precordial Stethoscope:
  – Used to auscultate a "mill-wheel" murmur
  – Effectiveness is controversial

Prevention

• Prevention is Key!
• Identify high risk patients:
  – Sitting Position:
    • Surgical site above the level of the heart
    • If used, increase right atrial pressure by elevating the patient’s legs
  – Left Uterine Displacement Position:
    • If used, place patient in a 5° reverse Trendelenburg’s position with left uterine displacement

Prevention Cont’d

• Adequate Hydration:
  – Patients with decreased central venous pressure (CVP) have increased risk of VAE
  – CVP Goal: 10-15 mmHg
• Use of PEEP:
  – Controversial, recommended to use PEEP to improve oxygenation, not for VAE risk reduction
• Avoid Nitrous Oxide:
  – 34 times more soluble
  – Expands the volume of a VAE
Management

- Goals: Prevent Further Air Entry, Reduce the Volume of Air Entrained, and Provide Hemodynamic Support:
  - Stop insufflation
  - Cover any suspected site with saline soaked gauze
  - Rapid fluid volume expansion
  - Cease the use of any nitrous oxide
  - Left lateral decubitus position (Durant Maneuver)

  *Controversial

Recommendations

- TEE is the most sensitive method of detection
- Precordial doppler ultrasound is the most sensitive noninvasive form of VAE detection
  - Reliability is questionable
- Initial response of a VAE is a decrease in ETCO₂

Management Cont’d

- Goals: Prevent Further Air Entry, Reduce the Volume of Air Entrained, and Provide Hemodynamic Support:
  - Air retrieval through a central venous catheter
  - Swan-Ganz: 6-16% Success
  - Bunegin-Albin multilumen catheter: 30-60% success
  - Not a first line treatment!
  - Cardiopulmonary resuscitation and positive inotropic agents
  - Proven to relieve gas lock

Recommendations Cont’d

- Management begins with prevention:
  - Avoid the sitting position if possible
  - Provide adequate hydration to increase right atrial pressure
  - Avoid PEEP
  - Avoid using nitrous oxide
- Treatment includes:
  - Administering vasopressors, 100% oxygen, and fluid volume expanding agents
  - Positive inotropic agents and closed cardiac massage will support forward flow of blood
  - Durant maneuver and air removal through a central venous catheter remains controversial

Conclusion

- Many recommended interventions for the detection, prevention, and management of a VAE are supported by evidence. When used, good patient outcomes may result.

References

- Donnelly, T. R., O’Dwyer, P. J., & O’Dwyer, P. J. (2002). Long-term outcome of patients undergoing two or more surgical procedures. Anaesthesia and Intensive Care, 30(02), 129-133.
- Donnelly, T. R., & O’Dwyer, P. J. (2002). Long-term outcome of patients undergoing two or more surgical procedures. Anaesthesia and Intensive Care, 30(02), 129-133.
- Donnelly, T. R., & O’Dwyer, P. J. (2002). Long-term outcome of patients undergoing two or more surgical procedures. Anaesthesia and Intensive Care, 30(02), 129-133.
- Donnelly, T. R., & O’Dwyer, P. J. (2002). Long-term outcome of patients undergoing two or more surgical procedures. Anaesthesia and Intensive Care, 30(02), 129-133.
- Donnelly, T. R., & O’Dwyer, P. J. (2002). Long-term outcome of patients undergoing two or more surgical procedures. Anaesthesia and Intensive Care, 30(02), 129-133.
- Donnelly, T. R., & O’Dwyer, P. J. (2002). Long-term outcome of patients undergoing two or more surgical procedures. Anaesthesia and Intensive Care, 30(02), 129-133.
- Donnelly, T. R., & O’Dwyer, P. J. (2002). Long-term outcome of patients undergoing two or more surgical procedures. Anaesthesia and Intensive Care, 30(02), 129-133.
- Donnelly, T. R., & O’Dwyer, P. J. (2002). Long-term outcome of patients undergoing two or more surgical procedures. Anaesthesia and Intensive Care, 30(02), 129-133.
- Donnelly, T. R., & O’Dwyer, P. J. (2002). Long-term outcome of patients undergoing two or more surgical procedures. Anaesthesia and Intensive Care, 30(02), 129-133.
- Donnelly, T. R., & O’Dwyer, P. J. (2002). Long-term outcome of patients undergoing two or more surgical procedures. Anaesthesia and Intensive Care, 30(02), 129-133.
- Donnelly, T. R., & O’Dwyer, P. J. (2002). Long-term outcome of patients undergoing two or more surgical procedures. Anaesthesia and Intensive Care, 30(02), 129-133.
- Donnelly, T. R., & O’Dwyer, P. J. (2002). Long-term outcome of patients undergoing two or more surgical procedures. Anaesthesia and Intensive Care, 30(02), 129-133.
- Donnelly, T. R., & O’Dwyer, P. J. (2002). Long-term outcome of patients undergoing two or more surgical procedures. Anaesthesia and Intensive Care, 30(02), 129-133.
- Donnelly, T. R., & O’Dwyer, P. J. (2002). Long-term outcome of patients undergoing two or more surgical procedures. Anaesthesia and Intensive Care, 30(02), 129-133.
- Donnelly, T. R., & O’Dwyer, P. J. (2002). Long-term outcome of patients undergoing two or more surgical procedures. Anaesthesia and Intensive Care, 30(02), 129-133.
- Donnelly, T. R., & O’Dwyer, P. J. (2002). Long-term outcome of patients undergoing two or more surgical procedures. Anaesthesia and Intensive Care, 30(02), 129-133.
- Donnelly, T. R., & O’Dwyer, P. J. (2002). Long-term outcome of patients undergoing two or more surgical procedures. Anaesthesia and Intensive Care, 30(02), 129-133.
- Donnelly, T. R., & O’Dwyer, P. J. (2002). Long-term outcome of patients undergoing two or more surgical procedures. Anaesthesia and Intensive Care, 30(02), 129-133.
- Donnelly, T. R., & O’Dwyer, P. J. (2002). Long-term outcome of patients undergoing two or more surgical procedures. Anaesthesia and Intensive Care, 30(02), 129-133.
Introduction

- Post operative nausea and vomiting can occur at a rate of 25% despite the use of traditional antiemetics

- Complications can include:
  - Dehiscence of sutures
  - Venous hypertension
  - Bleeding
  - Aspiration
  - Pneumothorax
  - Dehydration and electrolyte imbalances
  - Prolonged PACU stays
  - Increased hospital cost

(Ertebø et al., 2015)

References Cont’d


Thank You Are There Any Questions?

Management of Post-Operative Nausea and Vomiting Through Stimulation of the Pericardium-6 Acupoint

Nathan Roehrich, SRNA

Risk Factors for PONV

- Patient Specific
  - Female gender
  - Age less than 50
  - Nonsmoker
  - Hx of PONV/motion sickness
- Anesthetic Related
  - Use of volatile anesthetics & Nitrous Oxide
  - High dose of opioids
- Surgery Related
  - Duration greater than 1 hour
  - Laparoscopic, strabismus, craniotomy, breast, etc.
  - Inexperienced surgeon
    - Increases length of surgery and unnecessary handling of tissues

(Wagenhauser-Fieß, 2014)
Etiology of PONV

- N/V are coordinated by emetic or vomiting center found in the lateral reticular formation
- Vomiting is caused by direct or indirect noxious stimuli via 1 or more of 4 additional sites
  - Vagus Nerve (eye, oropharynx, GI tract, mediastinum, peritoneum)
  - Cerebral Cortex (emotions, sights, smells)
  - Vestibular Apparatus (ear, movement)
  - Chemoreceptor trigger zone CTZ (blood, CSF)
- Conventional ligands involved: Histamine (H1), Acetylcholine (M1), Serotonin (5-HT3), Dopamine (D2), Neurokinin (NK1), Substance P

(Source: Becker, 2010; Truman, 2011)

Case Information

- Robotic assisted laparoscopic cholecystectomy
- 25 years old
- 72 kg
- Female
- ASA 2

Pre-operative Evaluation

- Pre-op VS
  - BP: 116/71
  - SpO2: 98%
  - HR: 82
  - Temp: 98.6 F
- Pertinent labs
  - Hemoglobin: 13.3
  - Potassium: 4.1
  - Glucose: 98
- Airway evaluation
  - Mallampati: II
  - Thyromental distance: 3 fingerbreadths
  - Full neck ROM

Anesthetic Course

- Medications:
  - Preoperative:
    - 2 mg versed
    - 4 mg ondansetron
  - Induction:
    - 200 mcg fentanyl
    - 50 mg midazolam
    - 30 mg rocuronium
    - 5 mg dexamethasone
- Technique:
  - Total Intravenous Anesthetic
    - Propofol infused starting at 175 mcg/kg/min and titrated to effect
- Rationale
  - Decrease as many emetic stimuli as possible
Intraoperative Issues

- High peak airway pressures with Trendelenburg position and CO2 insufflation
  - Switched from VCV to PCV
    - Rate 12, PIPsp 25, PEEP 4
    - PAP decreased with adequate Tv
- Otherwise uneventful intraoperative course
  - Propofol titrated down towards end of case
  - Additional 50 mcg fentanyl given on emergence
  - 30 mg ketorolac
  - Patient extubated uneventfully after displaying adequate respiratory dynamics

PACU

- Patient transferred to PACU with 4L NC
- Alert, orientated, responding appropriately
- Denied pain, or symptoms of nausea/vomiting
- Given 0.5 mg hydromorphone by PACU nurse
- No rescue antiemetics required

Discussion

- Acus7mula7on is a noninvasive treatment modality applied by delivering transcutaneous signals on specific acupoints on the body’s surface for therapeutic purposes.
- Delivered via means of physical, mechanical, or electrical pressure.
- Historically the Pericardium-6 (P6) acupoint is widely considered to be the “pre-eminent point to treat nausea and vomiting of any etiology.”
  
  (Trueman, 2011, p. 37)

Discussion Cont’d

- The P6 acupoint is located between the tendons of the palmaris longus and flexor carpi radialis muscles, approximately 4 cm or 2 fingerbreadths proximal to the wrist crease

Discussion Cont’d

- P6 acupressure can be delivered by either invasive or non-invasive techniques
  - Invasive: Direct needling, dextrose injections
  - Noninvasive: Pressure bands, electrostimulation, ReliefBand®

Discussion Cont’d

- Mechanism of action is not completely understood
- Impulses are sent through type I & II afferent nerve fibers and median nerve
- The generated signals travel to the body’s central nervous system and the higher emetic center of the brain
  - Resulting in endorphins, enkephalin, adrenocorticotropic hormone release
  - The combination modulate the neural pathways between the brain and the stomach restoring normal gastric rhythm, blocking CTZ signals, and relieving nausea

(Nunley, Wakim, & Guinn, 2008)
Discussion Cont’d

• A multitude of studies have concluded that P6 acupressure reduces PONV compared to placebo treatments.
  
  • Direkvand-Moghadam and Khosravi (2013) performed a RCT of 102 patients undergoing elective cesarean section.
    – 24 hour incidence of PONV was 50% in the control group and 20.58% in the P6 group.
  
  • Gan et al. (2004) performed a RCT of 77 patients undergoing major breast surgery.
    – P6 acupressure decreased the 2 hour incidence of PONV from 79% in the control group to 19% in the P6 group.
    – Also found pain scores and need for additional opioids was decreased.

Discussion Cont’d

• P6 acupressure is also comparable in efficacy to common antiemetics
  
  • In a randomized, prospective, double-blind and placebo-controlled study conducted by Agarwal et al. (2002), 150 patients undergoing elective laparoscopic cholecystectomy were evaluated:
    – The control group was compared to a 4 mg prophylactic dose of ondansetron or P6 acupressure
    – PONV in the first 6 hours following surgery was 44% in the control group, 10% in the acupressure group, and 8% in the ondansetron group.

Discussion Cont’d

• A Cochrane Review completed by Lee and Fan (2011) of 40 RCT’s involving 4,858 participants found:
  
  – There was no difference between P6 acupuncture stimulation and pooled antiemetic drugs in the risk of nausea, vomiting, or need for rescue antiemetics.
  
  – Antiemetics evaluated included ondansetron, metoclopramide, prochlorperazine, cyclizine, and droperidol.
  
  – There was no difference between effectiveness of invasive vs. noninvasive forms of P6 acupuncture stimulation.
  
  – Side effects were minor to nonexistent
  
  – *participants who receive of combination therapy of P6 acupressure and ondansetron have more favorable PONV rates, and a higher quality of recovery than those receiving either intervention alone.

Discussion Cont’d

• P6 with in combination with traditional antiemetics may be the best use for the therapy.
  
  • Coloma et al. (2002) performed a RCT of 268 outpatients receiving ondansetron, P6 acupressure, a placebo, or a combination of both.
    – Concluded that there were no significant differences between the efficacies of ondansetron vs. acupressure when either was used alone.
    – However, when these treatments were compared to combination therapy, “significantly more patients receiving the combination therapy had no complaints of nausea or episodes of vomiting-retching” (p. 1390).
    – Discovered that a higher percentage of patients in the acupressure vs. ondansetron group (70% vs. 33%) also reported a regular sleep pattern 24 hours following surgery.

Discussion Cont’d

• P6 acupressure in the presented case study was equivalent in technique to a prospective, double-blind, RCT in which 264 women underwent laparoscopic hysterectomy.
  
  – P6 acupressure was delivered via several different modes during monitoring neuromuscular blockade of the median nerve with a traditional nerve stimulator.
  
  – Proximal positive electrode was placed between the tendons of the palmaris longus and the flexor carpi radialis 1 cm proximal to the P6 acupressure point.
  
  – The distal negative electrode was placed 2 cm distal to the P6 acupoint.

  * ST at 1-Hz, TOF every 15 seconds, DBS every 20 seconds, and Tetanic stimulation at 50-Hz for 5 seconds every 10 minutes.

Discussion Cont’d

• Results found that the incidence of PONV was significantly lower in the tetanus group than any other for 0-6 hours:
  
  – Control: 53.7%  
  – ST at 1-Hz: 40.4%  
  – TOF: 37.7%  
  – DBS: 26.4%  
  – Tetanus: 15.4%

• Patient in this case study did not experience episodes of nausea or vomiting in her 24 hour stay.
Evidence Based Recommendations

- P6 acupressure may be used as an alternative or adjuvant therapy for prevention of postoperative nausea and vomiting in low to moderate risk patients.

- In high-risk patients (with four or more risk factors), P6 acupressure should be used in conjunction to pharmacological prophylaxis as a multi-modal approach.
  - This combination has shown to be significantly effective in high-risk patients to reduce PONV.

- P6 acupressure should be used in conjunction to pharmacological methods as a multi-modal approach in patients who may suffer from potential catastrophic consequences of PONV.

References


Conclusion

- P6 acupressure may be used as a cost effective and safe adjunct for PONV prophylaxis.

- A multimodal approach in treating PONV remains the most effective technique.

- Further research should be conducted on the optimal application time, duration of therapy, and cost analysis of P6 acupressure.

References cont.

Beach Chair Position

• Beach Chair Position (BCP) is the primary position for shoulder surgery
• Risk of perioperative cranial nerve injury, visual loss, and cerebral infarction increase with the inherent decrease in cerebral perfusion pressures when BCP is utilized
• Review of literature was conducted to examine clinical recommendations for the use of ventilation strategies in this patient population

Does increasing EtCO2 in order to improve cerebral blood flow decrease risk of neurological sequelae from occurring?

Cerebral Perfusion

• Brain uses 15-20% of Cardiac Output
• Under General Anesthesia, MAP at the Circle of Willis is reduced by approximately 2 mm Hg per inch above the heart OR level of measurement
• Typically a 20-24 mm Hg difference

Target MAP shifted from 65 to 85 mm Hg

Intraoperative Strokes

• Risk of perioperative stroke 0.08-0.7% for general operations (non vascular)
• Limited data directly correlating strokes to BCP
  – Under reporting
• “The sitting position and the head position create specific physiological conditions that may be conducive to cerebral and spinal cord ischemia during this type of surgery” (Pohl & Cullen, 2005, p. 463)

Cerebral Blood Flow

Regulation of CBF

- Cerebral perfusion pressures
  - MAP-ICP (or CVP whichever is greater)
  - 80-100 mm Hg
- Cerebral autoregulation
  - 60-150 mm Hg
- Extrinsic Factors
  - Respiratory gas tensions
  - Temperature
  - Blood viscosity
  - Autonomic influences

Factors Affecting CBF

- Patient position
- Anesthetic agents
- Flexion or extension of head/neck
- Mechanical ventilation

Carbon Dioxide

• “Profound vasodilator”
• Homeostatic mechanisms kept intact with PaCO2 tensions 20-80 mm Hg
  – Outside this range blood flow becomes pressure dependent
• Cerebral blood flow changes 1-2ml/100 g/min per mm Hg change in PaCO2
• Crosses blood brain barrier=>immediate effect

Case Study Information

• Right Reverse Total Shoulder Arthroplasty
• 89 year old Female
• 79 kg
• ASA 4
• Allergies: hydrocodone, amoxicillin, diltiazem
Pre-operative Evaluation

- PMH: Dyslipidemia, atrial fibrillation, HTN, CKD, cerebrovascular disease, TIA, GERD, DM type 2, enchondroma, and glaucoma
- Surgical Hx: TKA, cholecystectomy, shoulder arthroscopy, and appendectomy
- Medications: Simvastatin, tramadol, senna, warfarin, metoprolol, aspirin, pantoprazole and gabapentin
- Pre-op vitals: 113/87, HR 89, RR 16, T 36.7, SaO2 94 on RA
- Airway evaluation: MP 2, TM distance >3 FB, limited mouth opening, limited neck ROM and dentures

Laboratory Data

- Hgb- 14.3
- Hct- 43.3
- Plts- 166
- Cr- 1.23
- K- 4.6
- INR- 2.0
- PT- 22.7

Anesthetic Course

- GETA
  - Preoxygenated 10L via facemask
  - 100mcg Fentanyl
  - 50mg Lidocaine
  - 12mg Etomidate
  - mask ventilation
  - 50mg Rocuronium
  - 7.0 ETT via Mac 3
  - Sevoflurane 1.1-1.7%
- Interscalene Block
  - 50mcg Fentanyl
  - 32ml 3:1 ratio 0.25% bupivacaine with epi and 0.5% ropivacaine
- Additional Medications
  - Ondansetron 4mg
  - Decadron 10mg
  - Phenylephrine gtt
  - No additional paralytics or narcotics given

- Left radial arterial line placed
- Left IJ CVC placed due to marginal IV access and difficult venipuncture
- Cerebral Oximetry
- Standard Monitors

Intraoperative Issues

- Hypotension gradually ensued following induction
  - Neo gtt initiated
- Cerebral oximetry values remained low despite return to pre-induction BPs
- Ventilation changes made to increase EtCO2
- Cerebral oxygenation values quickly rose to baseline

Relationship of SSpO2 (SpO2) and EtCO2
### PACU

- Uneventful emergence and PACU stay
  - Vital signs: BP 128/65, HR 78, RR 10, T 97.3, SaO2 97%
- Pt denied any pain postop
- **No evident signs of neurological delays**
- Case totals
  - LR 1500
  - Urine 575
  - EBL 50
  - Anesthesia time: 3 hours 58 minutes

### Discussion

**Beach Chair Positioning**
- Used for greater visualization, decreased neurovascular injury, and ease to open approach
- Autonomic reflexes abolished by GA
- Venous pooling ensues
- CPP decreased proportioning to decrease in MAP

### Regional + General

**Interscalene Block (ISB)**
- ISB typically used
- Sympatholysis further enhances hypotension/hypoperfusion

### Use of Cerebral Oximetry

- **Near-infrared Spectroscopy (NIRS)**
- Primary use in vascular & cardiac arena
- Sparsely used as a standard monitoring tool
  - Used for patients at risk of cerebral desaturation events at facility
- Offers early detection and prevention of cerebral desaturation

### CO2 Management in the BCP

- According to Murphy et al. (2014), an 80% cerebral desaturation rate occurs in pts monitored via NIRS while in BCP
- “Studies in supine awake volunteers and surgical patients have demonstrated that changes in ventilation and EtCO2 tension result in significant alterations in regional cerebral oximetry values” (Murphy et al., 2014, p. 619)

- Randomized controlled trial by Murphy et al. (2014) included 70 patients undergoing shoulder surgery in BCP
  - Control group => EtCO2 30-32 mm Hg
  - Study group => EtCO2 40-42 mm Hg
  - Cerebral desaturation events (CDEs) were 8% in study group compared to 56% in the control group
CO2 Management in the BCP

- Prospective interventional within-group study by Picton et al. (2015) included 56 patients undergoing surgery in the BCP
  - Two anesthetics used (Desflurane vs. TIVA)
  - FiO2 and target EtCO2 adjustments made at 5 set points
  - No significant interactions between the two anesthetics
  - Between the two set points of FiO2 0.3/EtCO2 30 mm Hg and FiO2 1.0/EtCO2 45 mm Hg showed a 14% improvement in cerebral oxygenation

- Prospective controlled study by Picton et al. (2010) included 20 patients undergoing carotid endarterectomy under GA
  - Study revealed 6% increase in cerebral oximetry in the unshunted patients and 3% increase in shunted patients when EtCO2 was kept at 40-45 mm Hg versus 30-35 mm Hg
  - FiO2 was kept at 1.0

- Prospective pilot study by Picton et al. (2010) included 10 patients without vascular disease undergoing surgery under GA
  - Following induction and intubation, FiO2 and minute ventilation adjusted at set points
  - Results showed a 7-8% improvement in regional cerebral oxygenation from set point A (EtCO2 30-35 mm Hg/FiO2 0.3) to set point B (EtCO2 40-45 mm Hg/FiO 1.0)

Deleterious Effects of Increased EtCO2 Values

- Acidosis
  - Typically low end of normal pH
  - Brief
- Bodily functions disrupted from states of hypercapnia
  - Acid-base balance
  - Kidney, nervous system and cardiovascular function
- Stimulus for patient to breath

Recommendations

- Aim to achieve EtCO2 values of approximately 40 mm Hg
  - Use of 1.0 FiO2 also recommended per literature
- Use (or advocate for use of) cerebral oximetry to help closely monitor anesthetic course for pts in BCP
- Maintain adequate MAP
  - Remembering to compensate for level of BP cuff or transducer
- Aggressive fluid resuscitation to replace deficits
- Double check head/neck alignment

Conclusion

- CO2 potent vasodilator
- Induced mild acidosis short lived
- Balancing hemodynamic status with ventilation strategy
- Risk vs. Benefit
- Additional large-scale prospective studies needed
References