Pleth Variability Index Monitoring to Guide Fluid Management in Patients Undergoing Major Abdominal Surgery

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Introduction / Background & Significance

- Current intraoperative fluid management for patients undergoing abdominal surgery are subjective, relying on calculations such as the "4-2-1 method" to *estimate* fluid requirements; or unreliable indicators such as HR, BP, Urine output etc.
- Goal of intraop fluid administration is to maintain end organ perfusion and *prevent* organ dysfunction
- Perioperative morbidity and volume of fluid therapy described as a U-shaped curve with increased mortality associated with very high or very low volumes administered
- Use of noninvasive monitors, such as Masimo PVI Monitor, for *objective* assessment of fluid status has shown improved outcomes, especially in combination with Goal Directed Therapy (GDT)
- Intraop IV fluid administration is based on the Frank-Starling mechanism (*Figure 1.)*
- GDT via use of objective endpoint monitoring results in optimization of SV on the Frank-Starling Curve
  - GDT associated with reduced length of stay, fewer ICU admissions, reduced PONV incidence, faster return of bowel function and reduction in morbidity

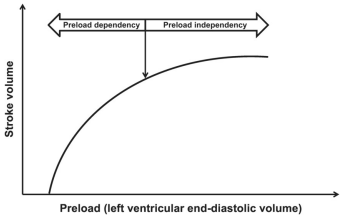


Figure 1. shows Frank-Starling Curve

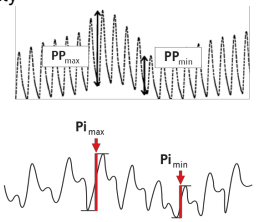


Figure 2. illustrates PVI assessment of pulse variation over time

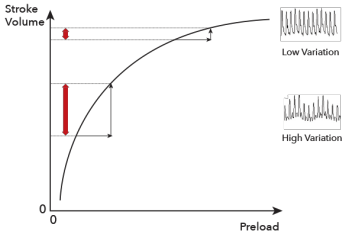


Figure 3. Depicts variation and associated position on Frank-Starling Curve. Note low variation associated with higher position on curve ≈ reduced fluid responsiveness.

- Masimo's Pleth Variability Index Monitoring (PVI) provides an indirect measure of blood volume or pulsatile strength under the sensor to assess fluid responsiveness (*Figure 2 & 3*).
- PVI monitoring is the most widely studied noninvasive device. Minimal equipment & ease of interpretation make it an ideal adjunct for fluid management.
- PVI relies on the "cyclic variation in preload and SV caused by the inspiration-expiration cycle…with the assumption that higher preload is associated with less variation" (Meng & Heerdt, 2016)
- 93.75% Sensitivity and 87% specificity in identifying responders
- FDA approval (August 2020) for use of PVI for GDT in patients undergoing major abdominal surgery!

Methodology

- Study occurred in a 665-bed teaching hospital in Newark, NJ during the fall of 2021 with a sample of 30 participants including MDA's, CRNA's and RRNA's.
- Primary outcome: Change in PVI monitor usage, following CPG implementation (See Figure 5 for QR embedded CPG): Assessed indirectly via changes in inventory supply & ordering
- Secondary outcome: QR code CPG access trends time
- Quasi-Experimental design utilizing an initial presentation and hands on session followed by a reinforcement presentation at 4 weeks. Weekly inventory assessment occurring over the 8 week study period (See *Figure 4.* for adapted theoretical framework)
- Analysis: Quantitative evaluation (t-test)

Figure 4. Masimo PVI monitor with QR embedded CPG attached

Figure 5. PVI CPG embedded QR Code

Results

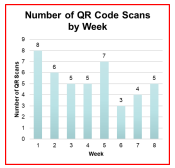
- Anesthesia providers adopted the CPG and used PVI monitors to guide fluid management in major abdominal surgery cases
- Increased usage of PVI monitoring device, evidenced by increased inventory ordering post implementation.
  - **Reduction in days between probe ordering (p=0.004)**
    - Pre-intervention 73.5 days, post-intervention 27.6 days
  - **Reduction in weeks between probe ordering (p=0.002)**
    - Pre-intervention 10.5 weeks, post-intervention 3.94 weeks
  - **Increase in average weekly probe use (p=0.03)**
    - Pre-intervention 2.4 probes, post-intervention 6.7 probes

Date Ordered	Quantity Ordered	Days Between Inventory Order	Weeks Between Inventory Orders	Average Number of Probes Used Per Week
9-Feb	25	NA	NA	NA
15-Apr	25	65	9.286	2.692
30-Jun	25	76	10.857	2.303
9-Sep	25	71	10.143	2.465
13-Oct	25	34	4.857	5.147
1-Nov	25	19	2.714	9.211
12/1/21	25	30	4.286	5.833

Results

QR code access negatively correlated with time

- Weeks 1-4 strong negative correlation **(rho=-0.913)**
- Weeks 5-8 negative correlation **(rho= -0.378)**



Week	Dates	Number of QR Code Scans
1	October 17 to October 23	8
2	October 24 to October 30	6
3	October 31 to November 6	5
4	November 7 to November 13	5
5	November 14 to November 20	7
6	November 21 to November 27	3
7	November 28 to December 4	4
8	December 5 to December 11	5

**Educational sessions occurred Week 1 & 5*

- CPG embedded QR code was scanned a total of 43 times during the 8-week study period.
- Data indicated that fewer scans occurred over time **(rho = -0.931, -0.378)**
- Possible explanations include:
  - Increased provider comfort with monitors and algorithm
  - Providers may have saved a copy / screenshot to their device

Discussion / Implications

- Easy access to a CPG will increase PVI usage as a tool for GDT.
- GDT has already been proven to offer postop benefits: Decreases in ICU admission and reductions in LOS will increase facility revenue. Decreased incidence of PONV, faster return of bowel function, and decreased mortality will improve patient outcomes and experience.
- Future projects may incorporate development and implementation of GDT / PVI as part of an ERAS bundles.
- Cost of increased probe usage will be offset by decreased LOS and ICU admissions.
- Some providers preferred hardcopy of CPG vs. QR code embedded reference

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References