

12-5-2022

## Fluid Resuscitation Optimization in Surgical Trauma Patients Utilizing Pulse Pressure Variation and Stroke Volume Variation: An educational module

Maritza J. Beza  
*Florida International University*

Follow this and additional works at: <https://digitalcommons.fiu.edu/cnhs-studentprojects>



Part of the [Medicine and Health Sciences Commons](#)

---

### Recommended Citation

Beza, Maritza J., "Fluid Resuscitation Optimization in Surgical Trauma Patients Utilizing Pulse Pressure Variation and Stroke Volume Variation: An educational module" (2022). *Nicole Wertheim College of Nursing Student Projects*. 137.

<https://digitalcommons.fiu.edu/cnhs-studentprojects/137>

This work is brought to you for free and open access by the Nicole Wertheim College of Nursing and Health Sciences at FIU Digital Commons. It has been accepted for inclusion in Nicole Wertheim College of Nursing Student Projects by an authorized administrator of FIU Digital Commons. For more information, please contact [dcc@fiu.edu](mailto:dcc@fiu.edu).

**Fluid Resuscitation Optimization in Surgical Trauma Patients Utilizing Pulse Pressure Variation and Stroke Volume Variation: An educational module**

A DNP Project Presented to the Faculty of the  
Nicole Wertheim College of Nursing and Health Sciences

Florida International University

In partial fulfillment of the requirements for  
the Degree of Doctor of Nursing Practice

By

Maritza J. Beza MSN, RN

Supervised By

Dr. Vincente Gonzalez DNP, CRNA, APRN

Katherine LaVilla MSN, CRNA, APRN

Approval Acknowledged: DocuSigned by:  
Jorge Valdes  
F0E0FDAF17314D5..., DNA Program Chair

Approval Acknowledged: Date: \_\_\_\_\_  
DocuSigned by:  
Charles Buscemi  
5D65DFEB12C74F7..., DNP Program Director

Date: \_\_\_\_\_

## Table of Contents

<b>I.</b>	<b>Introduction</b>	
	Problem Identification.....	6
	Background.....	7
	Scope of the Problem.....	9
	Consequences of the Problem.....	10
	Knowledge Gaps.....	11
	Proposal Solution.....	12
	Rational.....	13
	Objective.....	14
<b>II.</b>	<b>Literature Review</b>	
	Eligibility Criteria.....	14
	Information Sources.....	15
	Keywords.....	16
	Search Strategy.....	16
	Characteristics and Results of Individual Studies.....	17
	Discussion and Summary of Evidence.....	24
	Conclusions.....	25
<b>III.</b>	<b>Purpose and PICO Clinical Question</b>	
	Purpose.....	26
	PICO Clinical Question.....	26
<b>IV.</b>	<b>Conceptual Underpinning of the Project</b>	
	Primary DNP Project	
	Goal.....	27

Goals and Outcomes.....	28
Project Structure.....	29
Organizational Assessment.....	30
<b>V. Methodology</b>	
Setting and Participants.....	32
Intervention and Procedures.....	33
Protection of Human Rights.....	34
Data Collection.....	35
Data Management and Analysis Plan.....	35
<b>VI. Results</b>	
Demographics.....	36
Pre-test and Post-test Sample.....	37
Pre-test Knowledge.....	38
Post-Test Knowledge .....	38
Post-Test Attitudes Related to Clinical Utility .....	39
<b>VII. Discussion</b>	
Limitations.....	40
Future Implications to Advanced Nursing Practice.....	42
Conclusions.....	44
<b>VIII. Appendix</b>	
Appendix A: Letter of Support.....	47
Appendix B: IRB Approval.....	48
Appendix C: Invitation to Participants.....	49
Appendix D: Informed Consent.....	50

Appendix E: Data Collection Instrument (Pre-and Post-Test Survey) .....	51
Appendix F: Educational Module PowerPoint Presentation.....	52

## **Abstract**

This quality improvement project seeks to evaluate the knowledge, beliefs, and attitudes of anesthesia physicians on the need of fluid resuscitation and optimization using pulse pressure variation (PPV) or stroke volume variation (SVV) in surgical trauma patients. The intervention will be administered to certified registered nurse anesthetists (CRNAs) and physician anesthesiologists. The sample will consist of roughly ten individuals. A pre-test survey, a virtual educational intervention, and a post-test survey will comprise the project. Utilizing pre- and post-test surveys, the consequences of the intervention will be measured. Additionally, statistical analysis will be used to evaluate the efficacy of the educational intervention. It is anticipated that anesthesia provider education on the efficacy and safety of PPV/SVV-guided fluid resuscitation will provide them with the knowledge necessary to facilitate better surgical trauma patient treatment. As a result, they will be more skilled and effective in assisting patients with surgical trauma to attain euvolemia, hence enhancing the results of perioperative treatment.

*Keywords:* dynamic parameters, pulse pressure variation, fluid responsiveness, trauma, hemorrhage, stroke volume variation, shock, hypovolemia, hypervolemia

## **Fluid Resuscitation Optimization in Surgical Trauma Patients Utilizing Pulse Pressure**

### **Variation and Stroke Volume Variation: An educational module**

#### **Problem Identification**

Evaluation and treatment of intravascular volume status is a typical challenge in the anesthetic care of severely sick surgical trauma patients. In accordance with treatment recommendations for a variety of shock states, intravenous crystalloid fluid is routinely administered to patients with hypotension. The objective of fluid administration is to improve preload and stroke output, and consequently cardiac output. However, investigations of critically ill, hypotensive patients in the operating room reveal that approximately fifty percent of fluid boluses do not have the desired effect of increasing cardiac output.<sup>1,2</sup> In addition, accumulating data suggests that excessive fluid administration may be harmful and is associated with a greater mortality rate.<sup>3,4</sup> Large-volume resuscitation exacerbates tissue edema, extravasation of fluid, and endothelial injury.<sup>3,4</sup> Increases in interstitial fluid and extravascular lung water are therefore associated with progressive organ failure and death.

A sufficient level of analgesia and anesthetic depth must be maintained by the anesthetist while resuscitative measures are being taken in order to prevent tissue hypoxia, inflammation, and organ dysfunction. These objectives require the use of blood transfusion, vasopressors, and fluid resuscitation. Mean arterial pressure, cardiac filling pressures, including central venous pressure and pulmonary artery occlusion wedge pressure, and volumes, including left enddiastolic and right ventricular volume, are traditionally measured to determine management.

The poor predictability of these static markers for fluid responsiveness has been demonstrated, though.<sup>1,2,3</sup> In contrast, recent research indicates that stroke volume can be optimized to reduce

hospital length of stay and morbidity.<sup>5,6</sup> It is a predictor of blood loss and fluid responsiveness. Multiple studies have demonstrated that the magnitude of respiratory variation of surrogates of stroke volume can accurately predict fluid responsiveness.<sup>1,2,3,4</sup> Pulse pressure variation (PPV) is the most commonly employed index because it only requires an arterial catheter and numerous bedside monitors can calculate and display its value in real time. PPV has been shown to accurately predict fluid responsiveness in ICU patients when calculated from a simple arterial catheter or automatically calculated by simple bedside monitors such as the IntelliVue (Philips, USA) [5], the PiCCO (PULSION Medical Systems SE, Germany), and the LiDCOplus. Noninvasive finger pressure monitors like the ClearSight (Edwards Lifesciences Corporation, United States) also permit the calculation of PPV. The abundance of data supporting their utility cannot be disregarded; therefore, research into alternative methods for fluid resuscitation in surgical trauma patients is necessary.

## **Background**

Development of an anesthetic strategy and subsequent monitoring of trauma patients while they are undergoing emergency surgery, presents unique difficulties to the anesthetist. In the context of hemorrhagic and hypovolemic shock, hemodynamic compromise frequently occurs, which disrupts the maintenance of an adequate depth of anesthesia and analgesia. Monitoring of the patient's hemodynamic state, even at its most fundamental level, may not provide reliable results under these conditions. The goals of resuscitative efforts for each patient will be different depending on the specifics of the patient's situation as well as the nature of the trauma. To prevent adverse outcomes and increased morbidity and mortality from abdominal compartment syndrome, congestive heart failure, pulmonary edema, and airway edema, achieving euvolemia and avoiding excessive fluid resuscitation is a goal that is shared among all trauma patients. Euvolemia refers to a state in which the patient's blood volume is normal. Oxygenation, ventilation, circulation, and temperature should all be continuously monitored,

according to the essential monitoring guidelines for anesthesiologists. In addition, invasive monitoring devices are frequently recommended for and used with trauma patients. When deciding which monitor to use, it is important to take into account the generated data's precision, clinical relevance, impact on outcome, and the possibility of data generation-related complications.

The ability of frequently used monitors to forecast fluid responsiveness or "recruitable" cardiac output varies. Is there a chance that intravascular volume expansion will improve or increase the patient's cardiac output (stroke volume)? This is a crucial question that can help direct fluid resuscitation. Unfortunately, recent studies indicate that the answer is no in up to 50% of critically ill patients.<sup>2</sup> Patients who are non-responders to intravascular volume expansion are at risk for fluid overload and may be more appropriately managed with intravenous vasopressor or inotropic therapy.<sup>2,3,4</sup> Regardless of the method employed, the physiological phenomenon of fluid responsiveness should not automatically result in fluid administration.<sup>4</sup> In reality, three distinct circumstances must be distinguished. In the early phase of shock, fluid administration should not be initiated based on fluid responsiveness indices, particularly in cases of shock, active bleeding, or obvious fluid losses.<sup>5,6</sup>

Except in cases of active bleeding or persistent fluid losses, the decision to continue fluid infusion after initial fluid resuscitation is a separate issue. Due to the fact that not all patients are fluid responsive, predictors of fluid responsiveness are only one component of the decisionmaking process. The abundance of data pointing to pulse pressure change and/or stroke volume variation as more precise indicators of fluid responsiveness calls for additional study and intraoperative application of dynamic indices.



## Scope of the Problem

Traditional "static" indicators such as mean arterial pressure, cardiac filling pressures (i.e., central venous pressure, pulmonary artery occlusion wedge pressure), and volumes (left end-diastolic and right ventricular volume) are not particularly useful for predicting fluid responsiveness; however, they remain the most commonly used in clinical practice.<sup>1,2,3,4</sup>

"Dynamic" metrics, such as systolic pressure variation (SPV), pulse pressure variation (PPV), and stroke volume variation (SVV), are more accurate indicators of volume status and fluid responsiveness.<sup>3,4,5</sup> These parameters quantify the cyclic variations in left ventricle stroke volume caused by positive pressure ventilation. These indices can be displayed on modern hemodynamic monitors in the operating room for mechanically ventilated patients with an arterial catheter who also meet a few additional criteria.

The evaluation of a patient's volume status and their ability to respond to fluid administration can help prevent inappropriate fluid resuscitation in trauma patients.<sup>5,6</sup> This can help reduce the risk of fluid overload, dilutional coagulopathy, and further bleeding while also improving end-organ perfusion. There is a significant amount of support for the implementation of dynamic markers into trauma resuscitation strategies. Anesthetists are uniquely positioned to implement this evidence into practice and positively influence a patient's progression while optimizing outcomes.

## Consequences of the Problem

The rationale for fluid resuscitation during bleeding and hypovolemia is to increase stroke volume, thus cardiac output (CO) and eventually oxygen delivery (DO<sub>2</sub>). Traditionally, mean arterial pressure and invasive cardiac filling pressures (i.e., central venous pressure,

pulmonary artery occlusion wedge pressure) have been most frequently used to guide fluid management. Several publications show that neither mean arterial pressure, central venous pressure, or pulmonary artery occlusion pressure are reliable predictors of fluid responsiveness.<sup>2,3,4</sup>

Instead, growing evidence shows mean arterial pressure (MAP) is a wrong parameter to detect changes in either stroke volume or cardiac output. Data from recent studies concluded that MAP could remain stable despite broad changes in stroke volume or cardiac output. Ovegas et al. demonstrated that during resuscitation, stroke volume and the cardiac index returned to their respective baseline values with pulse pressure variation (PPV) and stroke volume variation (SVV) while MAP was still lower than target range. This led to a continuation of fluid therapy and, more notably, excess fluid required to stabilize MAP during their experiment. The results indicated that resuscitation could have safely finished much earlier when targeted to PPV or SVV rather than MAP, which led to overt fluid administration.<sup>6</sup>

Despite this body of evidence, mean arterial pressure is still the most frequently used parameter to guide fluid management in operating rooms and intensive care units.<sup>7</sup> Pursuing this narrow target gives false information about fluid status, fluid responsiveness and can lead to over resuscitation and exacerbate the complex physiologic picture of the surgical trauma patient.<sup>8,9</sup> Providing safe and effective anesthesia for the trauma surgical patient requires a fundamental understanding of pathophysiological sequelae of injury as well as aspects of assessment and resuscitation that are unique to this population.<sup>10,11</sup> The objective of the development of an educational intervention is to reexamine traditional practices and replace them with evidencebased interventions to improve outcomes and reduce morbidity and mortality.

## **Knowledge Gaps**

Both inadequate and excessive fluid doses are strongly associated with an increased incidence of postoperative problems in surgical trauma patients.<sup>11,12</sup> Individualization of fluid administration is recommended.<sup>12</sup> Maintaining patients at the inflection point of the Frank-Starling curve (i.e., maintaining PPV within the range of 10–15%) should protect against both hypovolemia and fluid overload. Using PPV or SVV to guide fluid management during and/or immediately after surgery was associated with a considerable reduction in postoperative morbidity, according to a meta-analysis of 14 randomized controlled trials.<sup>13</sup> However, due to the variability of the evaluated research, more validation is required.

## **Proposal solution**

Understanding the impact of over resuscitation on postoperative surgical outcomes is imperative for enhancing perioperative patient care and experiences in special surgical populations, specifically trauma patients. Further, knowledge of the crucial relation of perioperatively administered fluids to postoperative adverse complications is vital for preventing harmful fluid-induced health outcomes and expediting surgical recovery in this vulnerable population.

## **Rationale**

Fluids are medications and should be managed accordingly. Resuscitating trauma patients with fluids in a timely manner is a difficult task. Care should be taken in selecting both the type and volume of fluid to promote appropriate perfusion and oxygen delivery, thereby avoiding the adverse effects that can result from administering too little or too much. Whenever possible, ongoing fluid strategies following resuscitation should incorporate dynamic volume status

markers.<sup>11</sup> In daily fluid plans, all aspects of fluid administration, including feeding and medication infusions, should be accounted for.<sup>12</sup> All practitioners providing care for trauma patients must have a thorough understanding of the differences and physiological consequences of specific trauma groups.<sup>12</sup> This review includes studies that evaluate the efficacy of using dynamic metrics for guiding fluid resuscitation in adult surgical trauma patient population. Additional studies selected for review demonstrate their superiority in comparison to standard traditional metrics that are still mostly used throughout care settings.

### **Objective**

This literature review aims to gather data that supports the use of dynamic indices, specifically pulse pressure variation and stroke volume variation, to approach fluid resuscitation, owing to the wealth of data that supports their validity in assessing fluid volume status.

## **II. Literature Review**

### **Eligibility Criteria**

Studies selected for inclusion in this literature review adhered to specified inclusion and exclusion criteria in order to demonstrate the study topic competently. The inclusion requirements were articles written in English, published in a peer-reviewed publication during the past fifteen years, and available in full-text format. Exclusion criteria were studies in which the whole study population was comprised of participants younger than 18 years of age. This study also eliminated studies that focused on dynamic indices other than pulse pressure change and stroke volume variation. The focus of the literature search was on pulse pressure variation and stroke volume variation, as well as their ability to predict fluid responsiveness in adult surgical patients and adult trauma patients slated for surgery.

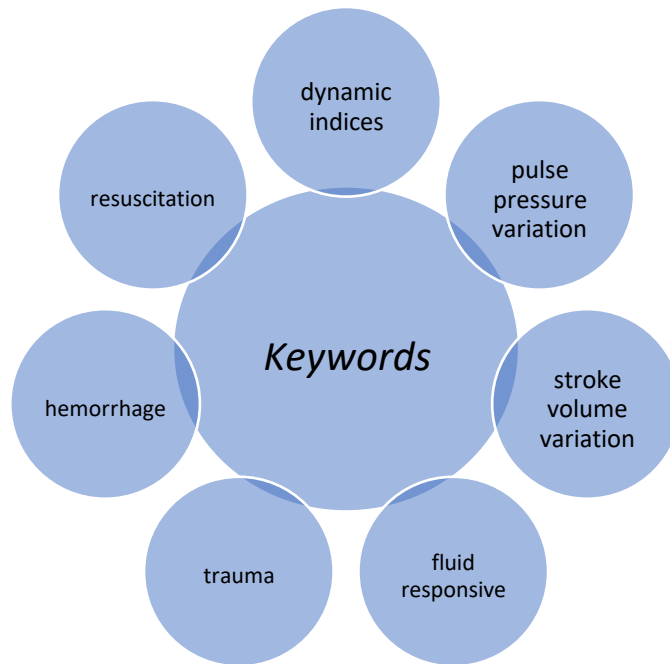
## **Information Sources**

Using the Cochrane, Google Scholar, and Cumulative Index to Nursing and Allied Health Literature (CINAHL) databases, a comprehensive literature search was conducted to identify research studies that evaluated the value of dynamic indices such as pulse pressure variation and stroke volume variation for guiding fluid resuscitation and improved perioperative outcomes in trauma patients scheduled for surgery. The literature review was heavily influenced by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) and the Johns Hopkins Nursing Evidence-Based Nursing Practice Guidelines.<sup>13,14</sup>

## **Keywords**

The following keywords were used to aid retrieval of the most relevant research findings to the clinical issue using the requisite Boolean operators and search symbols: dynamic indices, pulse pressure variation, fluid responsiveness, trauma, hemorrhage, stroke volume variation and resuscitation.

## **Diagram 1. Keywords**



### **Search strategy**

18 research publications were selected for abstract evaluation after a study of the broad body of relevant academic research and the application of predetermined inclusion and exclusion criteria. Studies that did not discuss the efficacy of PPV or SVV or its use in adults were excluded from the review. For the literature review, a total of eight papers deemed to be of adequate quality and relevance to the clinical problem in question were chosen.

### **Characteristics and Results of Individual Studies**

The purpose of the literature search was to identify data about the usefulness of pulse pressure variation and stroke volume variation as a test of fluid responsiveness and its clinical utility in trauma patients scheduled for surgery. There were many research reports examining the efficacy of PPV and SVV and its beneficial use in diverse healthcare populations; however, there were few studies that focused primarily on trauma surgical patients; thus, eight studies met the inclusion criteria established for this systematic literature review. Included in the evaluation were studies that investigated the clinical value of PPV and SVV and its role in enhancing surgical patient outcomes. The safety profile of employing these dynamic indices was also evaluated

based on research supporting its health advantages and consequences. To qualify the evidence supporting the use of dynamic indices to guide fluid resuscitation in trauma surgery patient populations, the deleterious effect of overt fluid resuscitation was also evaluated. Despite the consideration of numerous themes, the data provided by the eight included publications supports PPV and SVV as an alternate technique to optimize fluid resuscitation in surgical patients.

Below is a summary of the eight studies' primary themes:

### **Efficacy of dynamic parameters (PPV &SVV) as indicators of volume tolerance and fluid responsiveness**

Positive pressure ventilation affects the pulse pressure (i.e., the difference between systolic and diastolic arterial blood pressure). Variation in pulse pressure is believed to be an indicator of a patient's position on the Frank-Starling Curve, which represents a patient's response to pre-load (i.e. fluid responsiveness).<sup>15</sup> Patients operating on the flat portion of the curve are insensitive to changes in preload generated by mechanical ventilation; hence, their pulse pressure variation is modest, showing a lack of fluid responsiveness. In contrast, individuals operating on the steep section of the curve are sensitive to cyclic variations in preload generated by mechanical ventilation and hence demonstrate higher variation in pulse pressure (ie, fluid responsive).<sup>16</sup>

PPV is normally computed as the ratio of the highest pulse pressure (systolic blood pressure minus diastolic blood pressure; PPmax) minus the minimum pulse pressure (PPmin) to the mean pulse pressure (PPmean), which is often averaged across three or more breaths. Despite the fact that it may be estimated from pressures generated from manual cuff-inflation, arterial catheter measurements are often more accurate and recommended.

Several studies have shown that a PPV between 13 and 15 percent is highly associated with volume responsiveness.<sup>123</sup> As an illustration, one systematic review of 29 studies revealed a

greater area under the receiver operating characteristic curve (AUROC) for PPV than for CVP (0.94 versus 0.55) as a measure of fluid responsiveness (sensitivity and specificity were 0.88 each). Another study adds to this evidence by testing the following parameters in twelve trials: (1) static indicators of cardiac preload (right atrial pressure [RAP], pulmonary artery occlusion pressure [PAOP], right ventricular end-diastolic volume [RVEDV], and left ventricular enddiastolic area [LVEDA]); and (2) dynamic parameters (inspiratory decrease in RAP [Delta RAP], expiratory decrease in arterial systolic pressure [Delta down], respiratory changes in pulse pressure [Delta PP], and respiratory changes in aortic blood velocity [Delta Vpeak]). RAP, PAOP, RVEDV, and LVEDA were not substantially lower in responders than in nonresponders in three of five studies, seven of nine studies, four of six studies, and one of three studies, respectively, prior to fluid infusion. When a substantial difference was discovered, no threshold value could be used to distinguish between responders and nonresponders. Delta RAP, Delta down, Delta PP, and Delta Vpeak were considerably greater in responders before to fluid infusion, and a threshold value predicted fluid response with high positive (77–95%) and negative (81–100%) predictive values.<sup>15</sup>

### **Effects on outcomes of PPV and SVV guided fluid resuscitation**

In studies using PPV or SVV to guide fluid therapy in patients undergoing high-risk surgery, improved outcomes were found. One such trial comprised 33 patients, 17 of whom were allocated to an intervention group in which PPV was continuously evaluated throughout surgery and boluses containing 6% hydroxyethylstarch were delivered to lower PPV and keep it below 10%.<sup>9</sup> The remaining 16 patients were allocated to a control group in which intraoperative fluid was administered at the anesthesiologist's discretion. Complications occurred in significantly fewer patients in the intervention group than in the control group, with seven (41%) versus 13 (75%), respectively.<sup>9</sup> Furthermore, the intervention group had a shorter median duration of mechanical ventilation and a lower number of per-patient complications than the control group.



Another analysis, included 60 high-risk patients scheduled for major abdominal surgery, randomly assigned 30 to a control group that received standard monitoring (electrocardiographic, arterial blood pressure, CVP, pulse oximetry, temperature, and inspiratory and expiratory gas concentration data) and 30 to an intervention group that received standard monitoring supplemented with enhanced hemodynamic monitoring, including SVV, to determine whether patients required fluids or other support with vasopressor or inotropes. There were 17 complications in the intervention group versus 49 in the control group. Furthermore, fewer patients in the intervention group suffered complications—six (20%) versus 15 (50%) and the intervention group's median hospital length of stay was significantly shorter: 15 days versus 19 days.<sup>10</sup>

A third meta-analysis examined 14 randomized controlled studies to determine the efficacy of goal-directed fluid treatment (GDFT) based on dynamic parameters (GDFT<sub>dyn</sub>) in enhancing postoperative outcome. The meta-analysis demonstrated that GDFT<sub>dyn</sub> is related with a significant reduction in post-surgical morbidity, which is the proportion of patients who have at least one problem. This drop in post-surgical morbidity was attributable to a considerable reduction in infections, cardiovascular, and gastrointestinal problems, as well as a shorter period of stay in the intensive care unit (ICU).<sup>11</sup>

### **Adverse effects of fluid overload**

While appropriate fluid resuscitation is essential for optimal results, delivering fluids to individuals who are not fluid responsive raises their risk of complications and poor outcomes.<sup>12</sup> Excess fluid balance was found to be associated with greater postoperative death rate in a multicenter observational analysis of 479 surgical high-risk patients. Patients who received excessive intraoperative fluid balance had a greater risk of postoperative organ dysfunction mainly cardiovascular, respiratory, and neurologic and infection. Patients with excessive fluid balance intraoperatively had a longer ICU stay.<sup>15</sup>

<b>Author(s)</b>	<b>Purpose</b>	<b>Methodology &amp; Research Design</b>	<b>Intervention &amp; Methods</b>	<b>Sampling &amp; Setting</b>	<b>Primary Results</b>	<b>Relevant conclusions</b>
------------------	----------------	--	---------------------------------------	-----------------------------------	----------------------------	---------------------------------

<p>Michard F, Teboul JL, 2002</p>	<p>To identify and critically review the published peerreviewed, Englishlanguage studies investigating predictive factors of fluid responsiveness in ICU patients.</p>	<p>Systematic literature review and meta-analysis</p>	<p>Studies were collected by doing a search in MEDLINE (from 1966) and scanning the reference lists of the articles. Studies were selected according to the following criteria: volume expansion performed in critically ill patients, patients classified in two groups (responders and nonresponders) according to the effects of volume expansion on stroke volume or on cardiac output, and comparison of responder and nonresponder patients' characteristics before volume expansion.</p>	<p>Adult patients, mechanically ventilated in the intensive care unit</p>	<p>Static indicators of cardiac preload (right atrial pressure [RAP], pulmonary artery occlusion pressure [PAOP], right ventricular end-diastolic volume [RVEDV], and left ventricular end-diastolic area [LVEDA]) and dynamic parameters were tested in twelve studies (inspiratory decrease in RAP [Delta RAP], expiratory decrease in arterial systolic pressure [Delta down], respiratory changes in pulse pressure[Delta PP], and respiratory changes in aortic blood velocity [Delta Vpeak]). RAP, PAOP, RVEDV, and LVEDA were not substantially lower in responders than nonresponders before fluid infusion in three of five studies, seven of nine studies, four of six studies, and one of three studies, respectively. When a substantial difference was detected, no threshold value could distinguish responders from nonresponders. Delta RAP, Delta down, Delta PP, and Delta Vpeak were considerably greater in responders before fluid infusion, and a threshold value predicted fluid response with high positive (77 to 95%) and negative (81 to 100%) predictive values.</p>	<p>Dynamic parameters should be used preferentially to static parameters to predict fluid responsiveness in ICU patients.</p>
---	--	---	---	---	--	---

<p>Marik PE, Cavallazzi R, Vasu T, Hirani</p>	<p>A systematic review of the literature to determine the ability of dynamic changes in arterial waveform-derived variables to predict fluid responsiveness and compare these with static indices of fluid responsiveness.</p>	<p>Systematic review and meta-analysis of randomized controlled trials</p>	<p>Clinical studies that evaluated the association between stroke volume variation, pulse pressure variation, and/or stroke volume variation and the change in stroke volume/cardiac index after a fluid or positive end-expiratory pressure challenge.</p>	<p>Adult patients. Nine studies were performed in ICU patients and 20 studies were conducted in the OR or immediately after surgery</p>	<p>Meta-analytics summarized the data. We included 29 trials with 685 patients. 56% of patients responded to fluid challenge. Baseline pulse pressure variation, stroke volume variation, systolic pressure variation, and stroke/cardiac index change had pooled correlation values of 0.78, 0.72, and 0.72. The central venous pressure, global end-diastolic volume index, and left ventricular end-diastolic area index were 0.55, 0.56, and 0.64, respectively, while the receiver operating characteristic curves were 0.94, 0.84, and 0.86. The mean pulse pressure variation threshold was 12.5 +/- 1.6% and the stroke volume variation threshold were 11.6 +/- 1.9%. Pulse pressure fluctuation had 0.89, 0.88, and 59.86 sensitivity, specificity, and diagnostic odds ratio, while stroke volume variation had 0.82, 0.86, and 27.34.</p>	<p>Dynamic changes of arterial waveform-derived variables during mechanical ventilation are highly accurate in predicting volume responsiveness in critically ill patients with an accuracy greater than that of traditional static indices of volume responsiveness. This technique, however, is limited to patients who receive controlled ventilation and who are not breathing spontaneously.</p>
<p>Lopes, M.R., Oliveira, M.A., Pereira, V.O.S. et al., 2007</p>	<p>To investigate whether monitoring and minimizing ΔPP by volume loading during high-risk surgery may improve postoperative outcome.</p>	<p>Single center RCT</p>	<p>Thirty-three patients undergoing high-risk surgery were randomized either to a control group (group C, n = 16) or to an intervention group (group I, n = 17). In group I, ΔPP was continuously monitored during surgery by a multiparameter bedside monitor and minimized to 10% or less by volume loading.</p>	<p>Adult patients undergoing high-risk surgery, in a single center</p>	<p>Study shows that monitoring and minimizing ΔPP by volume loading during high-risk surgery decreases the number of postoperative complications and also the duration of mechanical ventilation, stay in the ICU, and stay in hospital. Thus, ΔPP may serve as a simple tool for improving the outcome of patients undergoing high-risk surgery. Further studies are required to confirm the results of our pilot study on a larger scale, as well as in different settings.</p>	<p>Monitoring and minimizing ΔPP by volume loading during high-risk surgery improves postoperative outcome and decreases the length of stay in hospital.</p>

<p>Mayer J, Boldt J, et. al, 2010</p>	<p>The aim of this study was to perform intraoperative goal-directed therapy with a minimally invasive, easy to use device (FloTrac/Vigileo), and to evaluate possible improvements in patient outcomes determined by the duration of hospital stay and the incidence of complications compared to a standard management protocol.</p>	<p>RCT</p>	<p>In this randomized, controlled trial 60 high-risk patients scheduled for major abdominal surgery were included. Patients were allocated into either an enhanced hemodynamic monitoring group using a cardiac index based intraoperative optimization protocol (FloTrac/Vigileo device, GDT-group, n = 30) or a standard management group (Control-group, n = 30), based on standard monitoring data.</p>	<p>Adult patients in ED, ICU and operative settings.</p>	<p>The median duration of hospital stay was significantly reduced in the GDT-group with 15 (12 - 17.75) days versus 19 (14 - 23.5) days (P = 0.006) and fewer patients developed complications than in the Control-group [6 patients (20%) versus 15 patients (50%), P = 0.03]. The total number of complications was reduced in the GDTgroup (17 versus 49 complications, P = 0.001).</p>	<p>In high-risk patients undergoing major abdominal surgery, implementation of an intraoperative goal-directed hemodynamic optimization protocol using the FloTrac/Vigileo device was associated with a reduced length of hospital stay and a lower incidence of complications compared to a standard management protocol.</p>
<p>Dave C, Shen J, Chaudhuri D, et al., 2020</p>	<p>This study aimed to conduct a systematic review and meta-analysis on the impact of dynamic assessment of fluid responsiveness in the perioperative care of surgical ICU patients on length of stay in the ICU. As secondary objectives, a cost analysis of FT-DYN and assessed the impact of FT-DYN versus standard care on hospital length of stay and mortality.</p>	<p>Systematic review and meta-analysis</p>	<p>We identified all randomized controlled trials (RCTs) through MEDLINE, EMBASE, and CENTRAL that examined adult patients in the ICU who were randomized to standard care or to FTDYN from inception to September 2017. Two investigators independently reviewed search results, identified appropriate studies, and extracted data using standardized spreadsheets. A random effect meta-analysis was carried out. Eleven RCTs were included with a total of 1015 patients.</p>	<p>Adult surgical ICU patients</p>	<p>The incorporation of FT-DYN through SVV in surgical patients led to shorter ICU length of stay (weighted mean difference [WMD], -1.43d; 95% confidence interval [CI], -2.09 to -0.78), shorter hospital length of stay (WMD, -1.96d; 95% CI, -2.34 to 1.59), and trended toward improved mortality (odds ratio, 0.55; 95% CI, 0.30-1.03). There was a decrease in daily ICU-related costs per patient for those who received FT-DYN in the perioperative period (WMD, US\$ -1619; 95% CI, -2173.68 to 1063.26). Incorporation of FT-DYN through SVV in the perioperative care of surgical ICU patients is associated with decreased ICU length of stay, hospital length of stay, and ICU costs.</p>	<p>This systematic review and metaanalysis found that incorporating FTDYN through SVV in the perioperative care of surgical ICU patients results in a decrease in ICU and hospital LOS, associated ICU costs, and a trend toward decreasing mortality. There was no benefit in overall hospital associated costs. Our findings give support to initiating a new standard in perioperative care through dynamic assessments of fluid responsiveness for surgical ICU patients</p>

<p><b>Benes J, Giglio M, et al., 2014</b></p>	<p>To investigate whether the use of goal-directed fluid therapy is associated with a decrease in post-surgical morbidity.</p>	<p>Systematic review and meta-analysis</p>	<p>A systematic literature review, using MEDLINE, EMBASE, and The Cochrane Library databases through September 2013 was conducted. Data synthesis was obtained by using odds ratio (OR) and weighted mean difference (WMD) with 95% confidence interval (CI) by random-effects model.</p>	<p>Adult surgical ICU patients</p>	<p>In total, 14 RCT met the inclusion criteria (961 participants). Post-operative morbidity was reduced by GDFTdyn (OR 0.51; CI 0.34 to 0.75; P &lt;0.001). This effect was related to a significant reduction in infectious (OR 0.45; CI 0.27 to 0.74; P = 0.002), cardiovascular (OR 0.55; CI 0.36 to 0.82; P = 0.004) and abdominal (OR 0.56; CI 0.37 to 0.86; P = 0.008) complications. It was associated with a significant decrease in ICU length of stay (WMD -0.75 days; CI -1.37 to -0.12; P = 0.02).</p>	<p>Meta-analysis shows that GDFTdyn decreases postsurgical morbidity, the rate of infectious, cardiac and abdominal complications, as well as ICU length of stay.</p>
<p><b>Bednarczyk JM, Fridfinnson JA, Kumar A, et al., 2017</b></p>	<p>A systematic review and meta-analysis to evaluate whether fluid therapy guided by dynamic assessment of fluid responsiveness compared with standard care improves clinically relevant outcomes in adults admitted to the ICU.</p>	<p>Systematic review and meta-analysis</p>	<p>Two reviewers independently identified randomized controlled trials comparing dynamic assessment of fluid responsiveness with standard care for acute volume resuscitation in adults admitted to the ICU.</p>	<p>Adult surgical ICU patients enrolling 1,652 patients</p>	<p>Methods used to assess fluid responsiveness included stroke volume variation (nine trials), pulse pressure variation (one trial), and stroke volume change with passive leg raise/fluid challenge (three trials). In 12 trials reporting mortality, the risk ratio for death associated with dynamic assessment of fluid responsiveness was 0.59 (95% CI, 0.42-0.83; I = 0%; n = 1,586). The absolute risk reduction in mortality associated with dynamic assessment of fluid responsiveness was -2.9% (95% CI, -5.6% to -0.2%). Dynamic assessment of fluid responsiveness was associated with reduced duration of ICU length of stay (weighted mean difference, -1.16 d [95% CI, 1.97 to -0.36]; I = 74%; n = 394, six trials) and mechanical ventilation (weighted mean difference, -2.98 hr [95% CI, 5.08 to -0.89]; I = 34%; n = 334, five trials).</p>	<p>In adult patients admitted to intensive care who required acute volume resuscitation, goal-directed therapy guided by assessment of fluid responsiveness appears to be associated with reduced mortality, ICU length of stay, and duration of mechanical ventilation.</p>

<p>Silva JM Jr, de Oliveira AM, Nogueira FA, et al., 2013</p>	<p>The aim of this study was to evaluate the impact of intraoperative fluid balance on the postoperative organ dysfunction, infection and mortality rate.</p>	<p>Observational prospective cohort study</p>	<p>a prospective cohort study during one year in four ICUs from three tertiary hospitals, which included patients aged 18 years or more who required postoperative ICU after undergoing major surgery. The calculation of fluid balance was based on preoperative fasting, insensible losses from surgeries and urine output minus fluid replacement intraoperatively.</p>	<p>Patients aged <math>\geq 18</math> years undergoing surgery that required postoperative ICU.</p>	<p>The study included 479 patients. Mean age was <math>61.2 \pm 17.0</math> years and 8.8% of patients died at the hospital during the study. The median duration of surgery was 4.0 (3.2 to 5.5) h and the value of the Simplified Acute Physiology Score (SAPS) 3 score was <math>41.8 \pm 14.5</math>. Comparing survivors and non-survivors, the intraoperative fluid balance from nonsurvivors was higher (1,950 (1,400 to 3,400) mL vs. 1,400 (1,000 to 1,600) mL, <math>P &lt; 0.001</math>). Patients with fluid balance above 2,000 mL intraoperatively had a longer ICU stay (4.0 (3.0 to 8.0) vs. 3.0 (2.0 to 6.0), <math>P &lt; 0.001</math>) and higher incidence of infectious (41.9% vs. 25.9%, <math>P = 0.001</math>), neurological (46.2% vs. 13.2%, <math>P &lt; 0.001</math>), cardiovascular (63.2% vs. 39.6%, <math>P &lt; 0.001</math>) and respiratory complications (34.3% vs. 11.6%, <math>P &lt; 0.001</math>). In multivariate analysis, the fluid balance was an independent factor for death (OR per 100 mL = 1.024; <math>P = 0.006</math>; 95% CI 1.007 to 1.041).</p>	<p>Patie exces intrao fluid have ICU com and hos mortal</p>
---	---	---	--	---	--	---

## **Discussion and summary of evidence**

A total of eight publications were chosen for review because they were of appropriate quality and relevance to the clinical topic under investigation. The efficacy of pulse pressure variation and stroke volume variation as a test of fluid responsiveness and its clinical relevance in trauma patients undergoing surgery was one of the primary topics addressed in this literature review. Three of the eight selected studies assessed PPV and SVV by comparing them to conventional approaches of hemodynamic monitoring in perioperative situations, thereby assessing PPV and SVV. These systematic analyses compared traditional static indicators of cardiac preload to the relationship between stroke volume variation, pulse pressure variation, and/or stroke volume variation and the change in stroke volume/cardiac index after a fluid or positive end-expiratory pressure challenge. The studies suggested that dynamic parameters, rather than static parameters, should be used to predict fluid responsiveness in critically ill patients.<sup>1,2,3,4</sup>

The remaining four publications chosen for inclusion in this literature review offered additional support for the efficacy of employing dynamic parameters to determine fluid responsiveness and investigated whether outcomes improved. One single-center, randomized control trial concluded that monitoring and limiting increases in PPV by volume loading during high-risk surgery reduces the number of postoperative problems, as well as the duration of mechanical breathing, ICU stay, and hospital stay. Thus, PPV may serve as a straightforward technique for improving the outcome of high-risk surgical patients. The final two systematic reviews and meta-analyses looked at whether fluid therapy guided by dynamic assessment of fluid responsiveness improves clinically meaningful outcomes in post-surgical patients admitted to the ICU when compared to routine care. The researchers concluded that among adult patients



admitted to intensive care who required intraoperative volume resuscitation, goal-directed therapy guided by fluid responsiveness evaluation appears to be related with lower mortality, ICU length of stay, and mechanical ventilation duration.<sup>3</sup>

The prevention of fluid volume excess is an equally important notion in guiding fluid therapy in trauma patients. Volume overload impairs microcirculation, disrupts endothelial function, and increases capillary leakage, all of which contribute to multiple organ failure and higher mortality.<sup>4</sup> One observational prospective cohort study's finding supported this. The oneyear study took place in four ICUs and comprised 479 patients who required postoperative ICU after major surgery. The fluid balance was computed by subtracting preoperative fasting, insensible procedure losses, and urine output from intraoperative fluid replenishment. In patients with an excessive intraoperative fluid balance, the incidence of ICU problems and inpatient mortality is increased. The analysis revealed that the frequency of ICU complications and inpatient mortality is elevated in individuals with an excessive intraoperative fluid balance.<sup>4</sup>

## **Conclusions**

Research comparing the utility of dynamic parameters PPV and SVV to traditional hemodynamic variables suggests that dynamic parameters are a reliable technique for measuring volume tolerance and fluid responsiveness.<sup>1,3,4</sup> Moreover, dynamic parameter guided fluid resuscitation is promoted as a viable strategy for enhancing postoperative outcomes in patients undergoing high-risk operations.<sup>5,6</sup> Whether selecting whether to deliver or terminate fluid therapy and when to pursue alternative support, functional hemodynamic markers are helpful. It should be emphasized, when assessing functional hemodynamic signs, that fluid responsiveness does not always indicate the requirement for a fluid bolus. Fluid therapy should only be delivered in response to indicators of hypoperfusion, and the risk of volume overload must be evaluated against the potential benefit. Indicators of functional hemodynamics may be incorporated into a

simple fluid resuscitation technique, according to expert opinion obtained from a review of relevant research. PPV and SVV measurements frequently necessitate the use of an arterial catheter and are limited to patients who have sinus rhythm, mechanical ventilation, and not spontaneously breathing. Patients must be intubated and mechanically ventilated in order to compute dynamic markers. Four key factors influence the use and interpretation of these markers: limited tidal volume or spontaneous breathing, open chest, and persistent arrhythmias.<sup>3,4</sup> Future research is needed to 1) clinically corroborate the findings of these studies 2) develop unique approaches to customize the use of dynamic indices, and 3) develop innovative approaches to use dynamic indices in guiding trauma resuscitation.

### **III. Purpose and PICO Clinical Question**

#### **Purpose**

To improve anesthesia provider knowledge and perception regarding pulse pressure variation (PPV) and/or stroke volume variation (SVV)-based goal-directed resuscitation in trauma surgical patients.

#### **PICO Clinical Question**

In trauma patients scheduled for surgery, what are the effects of pulse pressure variation and/or stroke volume variation guided fluid resuscitation compared to traditional hemodynamic monitoring on improving postoperative outcomes?

Population (P): Trauma patients scheduled for surgery

Intervention (I): PPV/SVV guided fluid resuscitation

Comparison (C): Traditional hemodynamic monitoring

Outcomes (O): Improvement of postoperative outcomes

### **IV. Conceptual Underpinning of the Project**

## Primary DNP Project Goal

Following the securement of the airway, appropriate oxygenation, and ventilation, the focus of the surgical trauma patient's resuscitation switches to controlling hemorrhage and restoring circulation. Severe hypovolemia is immediately followed by cardiovascular decompensation, decreased oxygen delivery, and the development of lactic acidosis. If oxygen delivery is not restored as soon as possible, cell membrane pumps fail irreversibly, resulting in end-organ failure or death.<sup>10</sup> Fluid replacement in the trauma patient therefore seeks to avoid irreparable cell damage by restoring appropriate tissue perfusion and oxygen delivery as soon as possible. Both intravascular volume and oxygen-carrying capacity must be addressed; nevertheless, acute anemia is frequently tolerated better than hypovolemia.

Despite concerns about the choice, amount, and endpoints of resuscitation, it is generally accepted that administering too little leads to hypoperfusion, whereas administering too much leads to glycocalyx dysfunction, tissue edema, coagulopathy, and end-organ damage, resulting in increased morbidity and mortality.<sup>6,7,8</sup> As a result, the goal is to achieve normovolemia while satisfying other resuscitation endpoints; however, it is unclear which parameter(s) should be used to guide fluid therapy during resuscitation.

The goal of fluid resuscitation after bleeding and hypovolemia is to raise stroke volume, which in turn increases cardiac output (CO) and, eventually, oxygen supply (DO<sub>2</sub>). Mean arterial pressure and invasive cardiac filling pressures (i.e., central venous pressure, pulmonary artery occlusion wedge pressure) have traditionally been used to advise fluid management. Several studies have found that mean arterial pressure, central venous pressure, and pulmonary artery occlusion pressure are not accurate indicators of fluid responsiveness.

Growing data suggests that mean arterial pressure (MAP) is an ineffective metric for detecting changes in stroke volume or cardiac output. According to recent research, MAP can stay steady despite large variations in stroke volume or cardiac output.<sup>2,3,4</sup> During resuscitation,

Ovegas et al. revealed that stroke volume and the cardiac index restored to their respective baseline values with pulse pressure variation (PPV) and stroke volume variation (SVV), but MAP remained below the desired range.<sup>3</sup> This resulted in the continuance of fluid therapy and, more importantly, the use of extra fluid to stabilize MAP during their experiment. The findings revealed that resuscitation may have been safely completed much sooner if PPV or SVV were targeted rather than MAP, resulting in overt fluid administration.<sup>6</sup>

Despite this body of evidence, mean arterial pressure is still the most frequently used parameter to guide fluid management in operating rooms and intensive care units. Pursuing this narrow target gives false information about fluid status, fluid responsiveness and can lead to over resuscitation and exacerbate the complex physiologic picture of the surgical trauma patient.<sup>7,8</sup> Providing safe and effective anesthesia for the trauma surgical patient requires a fundamental understanding of pathophysiological sequelae of injury as well as aspects of assessment and resuscitation that are unique to this population. The objective of the development of an educational intervention is to reexamine traditional practices and replace them with evidencebased interventions to improve outcomes and reduce morbidity and mortality.

### **Goals and Outcomes**

The SMART acronym was used to guide the development of target objectives. The abbreviation SMART indicates that the project's objectives should be specific, measurable, achievable, realistic, and time-bound.<sup>17</sup> The goals of this study are to improve understanding of the impacts and outcomes of PPV/SVV guided resuscitation versus traditional approaches in trauma surgery patients, and to assess the efficacy of a virtual PowerPoint teaching intervention to achieve this goal. The project's goal is to expand anesthesia provider knowledge of PPV and SVV as alternatives to established indices for fluid resuscitation in trauma surgery patients. To gather data and assess results related to participants' knowledge, perceptions, and behaviors on

dynamic indices for fluid resuscitation in surgical trauma patients, a virtual pre-test/post-test design will be used.

### **Specific**

Anesthesia providers who participate will receive an email invitation to a 20-minute virtual educational module that includes a pre-test survey, an evidence-based PowerPoint presentation, and a post-test survey. Participants are anticipated to gain a better understanding of the impacts and outcomes of managing fluid resuscitation incorporating dynamic variables in surgical trauma patients as a result of this project. This initiative is also expected to benefit surgical trauma patients by providing a safer therapeutic alternative to improve perioperative outcomes. Collaboration among anesthesia personnel makes the project's specific aims realistic and possible within the term specified by the graduate program.

### **Measurable**

A pre-intervention survey will be distributed to assess anesthesia provider perception and current knowledge regarding the use of PPV/SVV based goal-directed resuscitation. After completion of the educational intervention, a post-intervention survey will be conducted to assess if knowledge and perceptions have changed based on the information provided. Survey creation and data analysis will be facilitated by Qualtrics online software.

### **Achievable**

Following participation in the virtual educational intervention, anesthesia providers will have a greater understanding of the advantages of managing fluid resuscitation using dynamic variables in surgical trauma patients as compared to traditional methods. In addition, it is anticipated that this initiative would result in improved perioperative results and patient satisfaction for surgical trauma patients. The data collected during the evaluation phase of the research will be utilized to

evaluate the effectiveness of the virtual instructional module on dynamic variable guided fluid resuscitation.

### **Realistic**

Using a virtual teaching module provided by the student registered nurse anesthetist, anesthesia providers will be informed on the benefits of managing fluid resuscitation utilizing dynamic variables in surgical trauma patients . A pre- and post-intervention survey will be performed to compare data on anesthesia provider knowledge and create reports on the virtual educational intervention's effectiveness.

### **Timely**

The virtual dynamic variable-guided fluid resuscitation educational module will be finalized and made available for three weeks to participating anesthesia providers. The initiatives of this project will result in the following outcomes: after three weeks, anesthesia physicians will have a better understanding of the efficacy of dynamic variable guided fluid resuscitation as an adjuvant in surgical trauma patients. A virtual pre-test/post-test survey approach will be utilized to examine data and outcomes pertaining to the participants' knowledge and virtual educational intervention about dynamic variable guided fluid resuscitation.

### **Project Structure**

The development of an educational course and procedure for dynamic variable-guided fluid resuscitation will demand a comprehensive organizational evaluation to uncover knowledge gaps and the significance, relevance, value, and linkage of the project to all interested parties. SWOT analysis (strengths, weaknesses, opportunities, and threats) will be utilized to evaluate both internal and external factors and threats to the project's developmental objectives. The quality improvement project intends to highlight anesthesia providers' understanding of the efficacy of dynamic variable-guided fluid resuscitation as an adjunct in surgical trauma patients; consequently, assembling a team of knowledgeable stakeholders is a crucial first step. With their

consent, participants will complete an anonymous virtual pre-test survey to examine their knowledge, perspective, and current clinical practices regarding the use of dynamic variables for postoperative outcome improvement in surgical trauma patients. Participants will next watch a virtual instructional PowerPoint based on the findings of an evidence-based systematic review and fill out a virtual post-test survey questionnaire.

### **Strengths**

As an outcome, the goal of this project is to empower anesthesia practitioners with the knowledge and evidence-based data they need to include dynamic variable-guided fluid resuscitation into a standardized treatment regimen for surgical trauma patients in order to enhance their surgical outcomes. The abundance of literature that explains the influence of dynamic parameters on immediate and long-term postoperative surgical outcomes emphasizes the need to incorporate more therapeutic interventions to optimally balance general anesthetic techniques, particularly for certain special surgical populations.

### **Weaknesses**

A careful review of any potential internal difficulties that may jeopardize the project's ability to meet its goals and objectives is critical to its success. The occurrence of research/practice gaps on the appropriate procedures for managing fluid resuscitation in adult surgical trauma patients has been identified as a drawback that may have an impact on the overall quality of this project's outcome. While the negative effects of fluid overload are generally well understood within the anesthesia profession, conflicting research evidence on the efficacy of alternative fluid responsiveness monitors adds to anesthesia providers' reluctance to consider the need for updated therapy guidelines that best meet the needs of surgical trauma patients scheduled for surgery. As a result, another possible obstacle to the project's success is that experienced anesthesia providers are often hesitant to change their anesthetic practices and may rely on previous or conflicting data to defend their approach to caring for surgical trauma

patients. Significant methodological variations in anesthesia providers' patient care approaches bring the evidence-based training module's data and modifications to traditional resuscitation guidelines into question. These provider variations may delay or hinder the implementation of alternative strategies for safely achieving normovolemia in surgical trauma patients.

### **Opportunities**

According to evidence-based literature on dynamic parameter indications, a guided fluid resuscitation technique for surgical trauma patients is recommended.<sup>4,5,6,7</sup> All anesthesia care professionals, including certified registered nurse anesthetists (CRNAs), certified anesthesiologist assistants (CAAs), physician anesthesiologists, and anesthesia students, will collaborate to produce an acceptable care protocol that includes evidence-based recommendations. Collaboration with perioperative nursing workers will also be required to ensure that the protocol's suggestions are widely understood and applied effectively. Memorial Healthcare System, which has more than ten campuses throughout Florida, is a national leader in providing great patient care and satisfaction. Memorial Regional Hospital, the pinnacle of the Memorial system and one of Florida's main hospitals, is noted for its high-quality patient care and influential wide-ranging healthcare services. The project's successful implementation at Memorial Regional Hospital may increase the likelihood of future project promotion and networking opportunities, as well as acceptance and incorporation of the project's established protocol at other Memorial Healthcare facilities and other South Florida hospitals and surgical care facilities.

### **Threats**

External issues that may jeopardize the project's outcomes must be identified and addressed. Threats may include anesthesia practitioners' resistance to including dynamic parameters and their reluctance to depart from traditional hemodynamic monitoring standards.



Unanimous provider compliance is critical to the project's protocol implementation success; thus, evidence-based education in support of the project's recommendations must be strategically presented to all anesthesia care staff to promote a clear understanding of the protocol's intended uses and benefits to patient-care outcomes. A solid understanding of the educational resources supplied should foster a working environment of healthcare practitioners who have a keen interest in improving surgical outcomes in trauma patients.

### **Organizational Assessment**

The adoption of dynamic parameter-guided fluid resuscitation in surgical trauma patients relies substantially on an efficient team-based strategy. The critical processes for developing the presentation and methodology for the educational module will be emphasized. To evaluate the efficacy of the learning intervention, pre- and post-test knowledge questionnaires will be administered, and the evaluation data will be compared to the goals and objectives established during the planning process. The summary evaluation report will include the project description, interventions, statement of purpose, methods and tools used for data collection and analysis, historical context of the targeted clinical issue, significant result findings, outcomes, and conclusions, project limitations, and suggestions for project enhancement. Recommendations for the project should aim to increase its general feasibility and acceptability as a tool for future clinical practice quality improvement.

### **V. Methodology Setting and Participants**

This quality improvement initiative will be implemented at the 797-bed Memorial Regional Hospital (MRH) in South Florida. Anesthesia services are provided throughout MRH by Certified Registered Nurse Anesthetists (CRNAs), Certified Anesthesiologist Assistants (CAAs), and Physician Anesthesiologists. The target audience will consist of roughly ten fulltime, part-time, and per-diem anesthesia providers at Memorial Regional Hospital. The

participants will consist of male and female adults ranging in age from 25 to over 60, with varying levels of education and ethnic backgrounds. This initiative is centered on the expertise of anesthesia professionals, including CRNAs and Physician Anesthesiologists, while the material offered in this educational intervention is applicable to all healthcare disciplines involved in the surgical services care department.

### **Intervention and Procedures**

An email invitation containing an electronic consent form, a virtual PowerPoint educational session, and a URL connection to the pre- and post-intervention questionnaires via the secure online survey platform Qualtrics will be delivered to MRH's anesthesia department specialists. Participants will fill out an anonymous virtual pre-test survey with their permission to assess their knowledge, perceptions, and current clinical practices regarding the use of dynamic parameters as an alternative to traditional hemodynamic monitoring for quality improvement in surgical trauma patients. The participants will then view a virtual instructional PowerPoint presentation based on the findings of linked evidence-based literature. The virtual post-test, which will be similar to the virtual pre-test, will be administered to participants. The virtual pretest and post-test assessments are intended to take about 5 minutes each. The virtual instructional session is scheduled to last 10 minutes. This virtual instructional program will require approximately 20 minutes of participation. The interactive survey will collect demographic information such as gender, age, ethnicity, and job title. The virtual pre-test/post-test survey will also be utilized to collect data on participants' knowledge, perceptions, and practices regarding dynamic parameter guided fluid resuscitation. All data analysis will be done virtually, and no personally identifiable information will be collected.

The following are the primary interventions and procedures of the project: IRB submission and approval of project proposal; development of educational PowerPoint module; emailing important project details, participation requirements, and directions to providers within

MRH's anesthesia group, voluntary participation consent form, PowerPoint-presented educational course, and access link to the pre-and post-intervention questionnaires via online survey portal; statistical analysis of pre-and post-intervention knowledge survey results and evaluation.

### **Protection of Human Subjects**

Investigators will not analyze completed virtual surveys until all pre- and post-test virtual surveys have been gathered. Without collecting identifiable private information, all project data collected from the virtual pre-test and post-test surveys will be tallied anonymously to electronic spreadsheets. Electronic data from this research will be securely maintained on a passwordprotected laptop to which only the lead project investigators will have access. There are no foreseeable scenarios that would necessitate breaching confidentiality. Participation in this study endeavor carries a low level of risk or discomfort. As with any similar form of educational intervention, the physical, psychological, social, legal, and economic dangers associated with this endeavor are modest. This project's low dangers include slight emotional stress or minor physical discomfort from sitting in a chair for an extended period of time, for example.

### **Data Collection**

The attached virtual pre-test/post-test survey form will be used to collect data anonymously. The interactive survey will collect demographic information such as gender, age, ethnicity, and job title. In addition, the virtual pre-test/post-test survey will be used to collect data on participants' lavender oil aromatherapy knowledge, views, and practices. All data analysis will be done virtually, and no personally identifiable information will be collected.

### **Data Management and Analysis Plan**

Electronic data generated for this project will be subjected to statistical analysis to establish the quality of the project's outcomes and the project's overall success. The data management and analysis will be directed by a process flowchart. The summary evaluation

report will include the project description, interventions, statement of purpose, methods and tools used for data collection and analysis, historical context of the targeted clinical issue, significant result findings, outcomes, and conclusions, project limitations, and suggestions for project enhancement. Once accessible, the study's findings will be examined to draw conclusions about the intervention's efficacy. It is possible to monitor and evaluate the efficacy of the project's outputs in order to create evidence-based recommendations for their therapeutic application. The conclusions generated from this project's findings can contribute information to the existing study literature regarding alternative therapeutic approaches that would optimize the anesthetic management of trauma surgical patients and improve postoperative outcomes for this patient population.

## **VI. Results**

### **Demographics**

Anesthesia providers received a total of 40 invitations through email to engage in the pre- and post-test educational intervention. Ten people successfully completed the entire trial. Ten individuals filled out the demographic survey section. The participants' average age was 38 years old. The majority of participants (n=6, 60%) were female, as opposed to men (n=4, 40%). A variety of ethnicities were also represented, including Hispanic (n=3, 30%), Caucasian (n=3, 30%), African American (n=2, 20%), and Other (n=2, 20%), although there were no individuals

of Asian heritage. The majority of participants (n = 9, 90%) were certified registered nurse anesthetists (CRNAs), in contrast to anesthesiologists (n = 1, 10%). All participants held a graduate degree, with the majority (n=8, 89%) holding a Doctorate/Ph.D. In addition, participants were asked about their years of experience in the anesthesia field, and the range of practice periods was as follows: 0 to 1 year (n=10, 40%), 2 to 5 years (n=3, 30%), 6 to 10 years (n=0, 0%), and more than 10 years (n=3, 30%). Table 1 provides a summary of the participant's demographic information.

**Table 2.** Participant Demographics

<b>Participants (n = 10)</b>	<b>Number</b>	<b>%</b>
<b><u>Gender</u></b>		
Male	4	40
Female	6	60
Non-binary/third gender	0	0
Other	0	0
<b><u>Ethnicity</u></b>		
Hispanic	3	30
Caucasian	3	30
African American	2	20
Asian	0	0
Other	2	20
<b><u>Position</u></b>		
Certified Registered Nurse Anesthetist	9	90
Anesthesiologist	1	10

Anesthesiologist Assistant	0	0
<b><u>Level of Education</u></b>		
Bachelors	0	0
Masters	1	11
Doctorate/PhD	8	89
<b><u>Years of Experience</u></b>		
0 – 1	4	44
2– 5	3	22
6 – 10	0	0
More than 10	3	33

### **Pre-Test Knowledge of Dynamic Indices**

Using survey questions, a baseline level of participant understanding of dynamic indices was created. The results of the pre-test survey, reported in Table 2, reveal knowledge gaps prior to intervention. In the first question, participants were requested to assign a proportion of variability to fluid responsiveness. One participant (10%) correctly answered "12%" Three participants (30%) selected "10%," two (20%) selected "12%," and one (10%) selected ">12%"; all three choices were incorrect. The next question inquired if more variability in stroke volume indicated fluid responsiveness. Four participants (40%) selected "true" as the correct response. Six (60%) selected "False," the erroneous response. Next, participants were asked what three requirements must be met for pulse pressure variation interpretation. One participant correctly selected "sinus rhythm," "mechanically ventilated with no spontaneous respirations," and "must not have an open chest."

**Table 3. Change in Pre-and Post-Test Knowledge of Dynamic Indices**

Question	Pre-Test	Post-Test	% Change
<b>7. What percentage variability is associated with fluid responsiveness?</b>			
<12%	2 (20%)	1 (10%)	↓10%
>12% *	1 (10%)	7(70%)	↑60%
<10%	3 (30%)	1 (10%)	↓20%
>10%	4(40 %)	1 (10%)	↓30%
<b>Greater variability in stroke volume suggests fluid responsiveness</b>			
True *	4 (40%)	9 (90%)	↑ 50%
False	6(60%)	1 (10%)	↓ 50
<b>To interpret PPV what 3 conditions must be met</b>			
Sinus rhythm *	1(10%)	2 (20%)	↑20%
Mechanically ventilated with no spontaneous respirations*	5(50%)	7(70%)	↑20%
Must not have an open chest *	3 (30%)	9(90%)	↑60%
MAP >65mmhg	1 (0%)	1 (14%)	↑14%
HR <70BPM	0 (0%)	0 (0%)	-
Increased abdominal pressure	2(20%)	0(0%)	↓20%

### Pre-Test Knowledge of adverse effects of fluid overload

When asked about the negative effects of fluid overload in surgical patients, 60% (n=6) answered "all of the above" as the right response (which included: endothelial injury, cell edema, acute lung injury, compartment syndromes). 20% of respondents (n=2) selected "cell edema," while 10% (n=1) selected "acute lung injury."

**Table 4. Change in Pre-and Post-Test Knowledge Related to effects of fluid overload**

Question	Pre-Test	Post-Test	% Change
<b>Excess fluid administration is associated with:</b>			
Endothelial injury	0 (0%)	0(0%)	0%
Cell edema	2 (20%)	0 (0%)	↓20%
Acute lung injury	1 (1%)	0 (0%)	↓10%
Compartment syndromes	0 (0%)	1 (10%)	↑10%
All of the above *	6 (60%)	9(90%)	↑30%

### Pre-Test Knowledge Related to Management of PPV/SVV Guided Fluid Resuscitation

When asked "If respiratory variations in the arterial pressure waveform (PPV or SVV) are >12 to 15 percent, then the patient is assumed to be fluid responsive, and we administer fluid boluses of a balanced electrolyte crystalloid solution in increments of", 80% (n=8) participants answered



“200ml”, while only 10% (n=1) identified the correct answer “250ml”. 20% (n=2) of participants answered the following question about decreased fluid responsiveness correctly. The following question asked which patient would not benefit from PPV/SVV, in which only 10% (n=1) answered correctly.

**Table 5. Change in Pre-and Post-Test Knowledge Related to management of PPV/SVV guided fluid resuscitation**

Question	Pre-Test	Post-Test	% Change
<b>If respiratory variations in the arterial pressure waveform (PPV or SVV) are &gt;10 to 15 percent, then the patient is assumed to be fluid responsive, and we administer fluid boluses of a balanced electrolyte crystalloid solution in increments of:</b>			
100ml	0 (0%)	0 (0%)	-
200ml	8(80%)	3(30%)	↓50%
250ml*	1 (10%)	7(70%)	↑60%
500ml	0 (0%)	0 (0%)	-
<b>Once change in the monitored dynamic parameter is &lt;10 %:</b>			
Fluid administration is stopped to avoid hypervolemia*	2(20%)	5(50%)	↑ 30%
Fluid administration is started to avoid hypovolemia	4(40%)	2(20%)	↓20%
Administer a pressor to avoid hypotension *	2 (20%)	5(50%)	↑30%
Administer a diuretic for fluid overload	4 (40%)	1 (10%)	↓30%

<b>Which patient would not benefit from PPV/SVV guided fluid resuscitation?</b>				
Expected blood loss <500mL*		1 (10%)	5(50%)	↑40%
Case duration <2 hours*		1 (10%)	5 (50%)	↑40%
Case duration >3 hours		1 (10%)	60 (60%)	↑ 50%
Expected blood loss >1500ml		4 (40%)	5(50%)	↑50%
	(*Correct answer			

### Pre-Test Beliefs Related to Use of Dynamic Indices Guided Fluid Resuscitation

Participants were also surveyed about the likelihood of using dynamic markers to direct fluid resuscitation in surgical trauma patients. Three (30%) anesthesia providers selected "most likely," two (20%) anesthesia providers selected "somewhat likely," three (30%) anesthesia providers selected "somewhat unlikely," and two (20%) anesthesia providers selected "most unlikely."

### Post-Test Knowledge of Dynamic Indices

Participants were asked to assign a proportion of variability to fluid response in the first question. 70% (n=7) answered "12%" correctly. All three options were incorrect: one participant (10%) selected "10%," one participant (10%) selected "12%," and one participant (10%) selected ">12%." The next question asked if more stroke volume variability suggested fluid responsiveness. The correct response was chosen by nine participants (90%). One individual (10%) selected "False," the incorrect response. Next, participants were asked what three conditions must be met for interpretation of pulse pressure change. 70% (n=7) chose "sinus rhythm," "mechanically ventilated with no spontaneous respirations," and "must not have an open chest" accurately.

**Post-Test Knowledge of adverse effects of fluid overload**

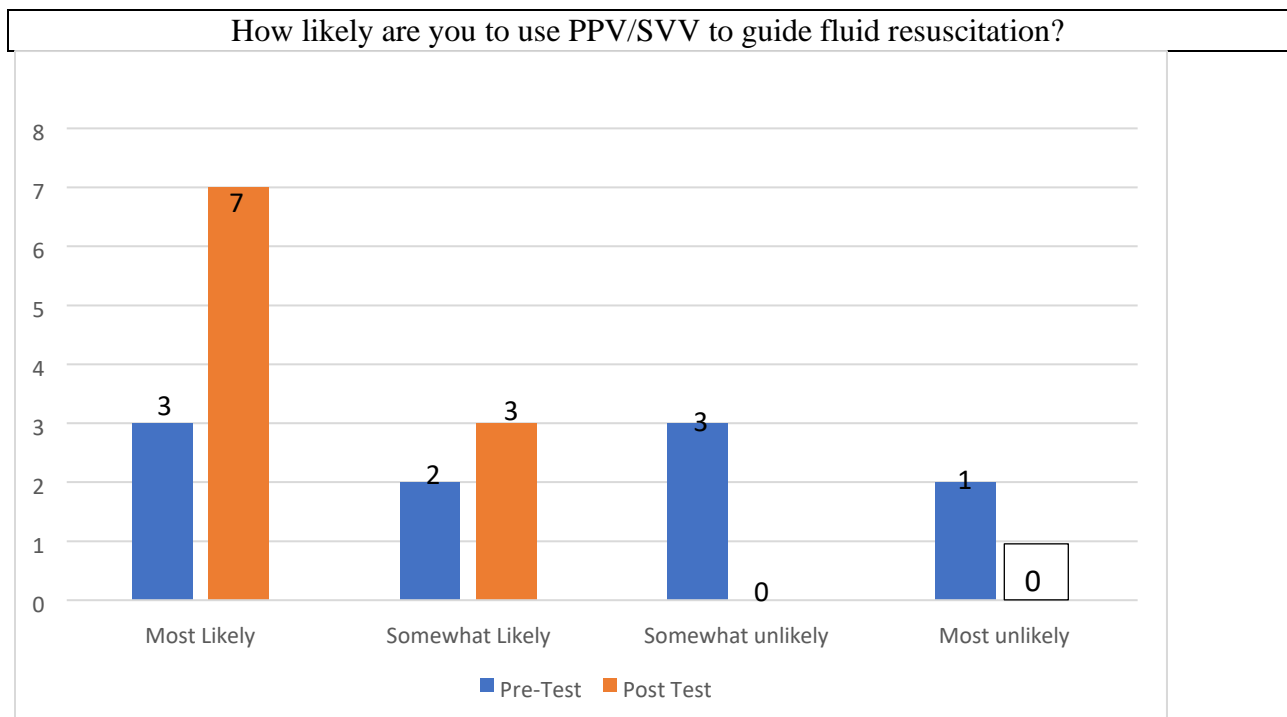
90% (n=9) of the correct responses about the detrimental effects of fluid excess in surgical patients were "all of the above" (which included: endothelial injury, cell edema, acute lung injury, compartment syndromes). 10% (n=1) of respondents chose "compartment syndromes."

**Post-Test Knowledge Related to Management of PPV/SVV Guided Fluid Resuscitation**

When asked, "If respiratory variations in the arterial pressure waveform (PPV or SVV) are greater than 12 to 15 percent, the patient is assumed to be fluid responsive, and we administer fluid boluses of a balanced electrolyte crystalloid solution in increments of," 70% (n=7) of the participants correctly identified the correct answer as "250 mL." While 30% (n=3) selected "200ml" erroneously. 50% (n=5) of subjects responded correctly to the following question regarding decreased fluid responsiveness. 50% (n=5) correctly identified the patient who would not benefit from PPV/SVV in response to the following question.

**Post-Test Beliefs Related to Use of Dynamic Indices Guided Fluid Resuscitation**

The likelihood of employing dynamic indicators to direct fluid resuscitation in surgical trauma patients was also questioned. This survey question was designed to evaluate and compare participants' knowledge and views regarding the use of dynamic indices-guided fluid resuscitation prior to and during the educational module. 100% (n=10) of respondents selected "most likely," representing a 70% increase from the pre-test survey. This increase may suggest that anesthesia provider opinions regarding fluid resuscitation optimization using dynamic indices have improved.



### Limitations

One of the study's limitations is the small sample size. It would have been desirable if the project had been strengthened with greater resources. A notable limitation of the study was that participants were required to complete the post-test survey immediately after viewing the educational module presentation. A longer post-intervention time period may have enhanced posttest scores and project outcomes. The virtual delivery technique may have imposed extra limits on the study because the entire project was conducted asynchronously via an online platform.

### **Future Implications for Advanced Nursing Practice**

Overt fluid resuscitation is still a concern that surgical trauma patients face. This issue has been linked to higher morbidity and mortality. By monitoring fluid responsiveness, PPV and SVV guidance can reduce the incidence of overt fluid administration. Although fluid responsiveness monitors have been found to be useful in critically sick mechanically ventilated patients, no protocols or teaching opportunities for their usage at the intervention site are in place. Although 70% of participants reported they had never received PPV/SVV training, after the educational module, 90% said they would be "very likely" to employ this technique if their facility offered it. This small sample size implies that, while not extensively used, PPV and SVV guided fluid resuscitation can become broadly accepted once widely spread. Because of these encouraging outcomes, larger-scale quality improvement projects with a broader range of participants should be implemented. More study will boost its acceptance and application in improving patient outcomes following anesthesia.

### **Conclusion**

Improving the results and experiences of patient care for unique surgical populations, notably trauma patients, requires the use of evidence-based practice. The outcomes of this study highlight the importance of continuing education in anesthesia practice and education designed to improve anesthetic care for vulnerable populations. The prevention of excess fluid volume is an essential component of fluid therapy for trauma patients.<sup>14</sup> Inadequate microcirculation altered endothelial function, and increased capillary leakage all contribute to multiple organ failure and increased mortality due to volume overload.<sup>14</sup> Intraoperative volume resuscitation or goal-directed

therapy guided by fluid responsiveness is associated with decreased mortality, hospital length of stay, and duration of mechanical ventilation in surgical trauma patients, according to a review of the scientific literature.<sup>12,13,14</sup>

The findings provide support for a new standard of perioperative care for surgical trauma patients based on fluid responsiveness assessments.<sup>17,18</sup> By increasing anesthesia providers' knowledge of dynamic indices and fluid resuscitation, this virtual educational module was intended to improve the anesthetic care of surgical trauma patients. Analyzing the pre- and postsurvey results indicates that this quality improvement project met its objective of enhancing anesthesia providers' understanding of the use of pulse pressure variation and stroke volume variation to optimize fluid resuscitation and care outcomes in surgical trauma patients.

## Appendix

### Appendix A. Letter of Support



February 1, 2022

Vicente Gonzalez, DNP, CRNA, APRN  
 Clinical Assistant Professor  
 Department of Nurse Anesthesiology  
 Florida International University

Dr. Gonzalez,

Thank you for inviting Memorial Regional to participate in Doctor of Nursing Practice (DNP) project conducted by Maritza Beza entitled "Fluid resuscitation optimization in surgical trauma patients using PPV/SVV: An Educational Module." in the Nicole Wertheim College of Nursing and Health Sciences, Department of Nurse Anesthetist Practice at Florida International University. I have warranted her permission to conduct the project using our providers.

Evidence-based practice's primary aim is to yield the best outcomes for patients by selecting interventions supported by the evidence. This project intends to evaluate if a structured education targeting providers will increase knowledge on the benefits of using a PPV/SVV to fluid resuscitate surgical trauma patients.

We understand that participation in the study is voluntary and carries no overt risk. All Anesthesiology providers are free to participate or withdraw from the study at any time. The educational intervention will be conveyed by a 15-minute virtual PowerPoint presentation, with a pretest and posttest questionnaire delivered by a URL link electronically via Qualtrics, an online survey product. Responses to pretest and posttest surveys are not linked to any participant. The collected information is reported as an aggregate, and there is no monetary compensation for participation. All collected material will be kept confidential, stored in a password-encrypted digital cloud, and only be accessible to the investigators of this study: Maritza Beza and Dr. Gonzalez. We expect that Maritza Beza will not interfere with normal hospital performance, behave in a professional manner and follow standards of care.

Prior to the implementation of this educational project, the Florida International University Institutional Review Board will evaluate and approve the procedures to conduct this project. Once the Institutional Review Board's approval is achieved, this scholarly project's execution will occur over two weeks. We support the participation of our Anesthesiology providers in this project and look forward to working with you.

A handwritten signature in blue ink that reads 'Suzanne Hale'.

---

Suzanne Hale, MSN, CRNA, ARNP  
 Advanced Practice Provider Director, Broward and Dade  
 Chief, Memorial Regional Hospital  
 Envision Physician Services  
 954-265-2044

## Appendix B. IRB Approval



FLORIDA  
INTERNATIONAL  
UNIVERSITY

Office of Research Integrity Research Compliance,  
MARC 414

### MEMORANDUM

**To:** Dr. Vicente Gonzalez **CC:**  
Maritza Beza

**From:** Elizabeth Juhasz, Ph.D., IRB Coordinator

**Date:** May 12, 2022

**Protocol Title:** "Fluid Resuscitation Optimization in Surgical Trauma Patients Using PPV/SVV: An Educational Module"

A handwritten signature in black ink, appearing to be 'EJ'.

---

The Florida International University Office of Research Integrity has reviewed your research study for the use of human subjects and deemed it Exempt via the **Exempt Review** process.

**IRB Protocol Exemption #:** IRB-22-0197      **IRB Exemption Date:** 05/12/22  
**TOPAZ Reference #:** 111382

As a requirement of IRB Exemption you are required to:

- 1) Submit an IRB Exempt Amendment Form for all proposed additions or changes in the procedures involving human subjects. All additions and changes must be reviewed and approved prior to implementation.
- 2) Promptly submit an IRB Exempt Event Report Form for every serious or unusual or unanticipated adverse event, problems with the rights or welfare of the human subjects, and/or deviations from the approved protocol.
- 3) Submit an IRB Exempt Project Completion Report Form when the study is finished or discontinued.

**Special Conditions:** N/A

For further information, you may visit the IRB website at <http://research.fiu.edu/irb>.



## Appendix C. Invitation to Participants



### Nicole Wertheim College of Nursing & Health Sciences

#### **Fluid Resuscitation Optimization in Surgical Trauma Patients Utilizing Pulse Pressure Variation and Stroke Volume Variation: An Educational Module**

Dear Memorial Health Anesthesia Provider:

My name is Maritza Beza, and I am a student in the Anesthesiology Nursing Program Department of Nurse Anesthetist Practice at Florida International University. I am writing to invite you to participate in my quality improvement project. This project aims to improve health care provider knowledge on the uses of pulse pressure variation and stroke volume variation to optimize fluid resuscitation in surgical trauma patients. You are eligible to participate in this project because you are a member of the Anesthesia Department for Envision at Memorial Health.

If you decide to participate in this project, you will be asked to complete and sign a consent form. Next, you will complete a pre-test questionnaire, which is expected to take approximately 5 minutes. You will then be asked to view an approximately 15-minute educational presentation online. After watching the video, you will be asked to complete the post-test questionnaire, which is expected to take approximately 5 minutes. *No compensation will be provided.*

Remember, this is entirely voluntary. You can choose to be in the study or not. If you'd like to participate or have any questions about the survey, please email or contact me at [mbeza003@fiu.edu](mailto:mbeza003@fiu.edu) or 786-440-2602

With gratitude,

Maritza J. Beza, SRNA, BSN, CCRN

## APPENDIX D. Informed Consent



### CONSENT TO PARTICIPATE IN A QUALITY IMPROVEMENT PROJECT

An Educational Module for the Utilization of Pulse Pressure Variation and Stroke Volume Variation to Optimize Fluid Resuscitation in Surgical Trauma Patients: A Quality Improvement Project

#### SUMMARY INFORMATION

Things you should know about this study:

- **Purpose:** Educational module concerning use of pulse pressure variation and stroke volume variation to guide fluid resuscitation in surgical trauma patients.
- **Procedures:** If you choose to participate, you will be asked to complete a pre-test, an educational module via voice over Power Point, and then participate in a post-test
- **Duration:** This will take about a total of 20 minutes total.
- **Risks:** The main risk or discomfort from this research is minimal.
- **Benefits:** Improved knowledge in the utilization of pulse pressure variation and stroke volume variation during fluid resuscitation in surgical trauma patients.
- **Alternatives:** There are no known alternatives available to you other than not taking part in this study.
- **Participation:** Taking part in this research project is voluntary.

Please carefully read the entire document before agreeing to participate.

#### PURPOSE OF THE PROJECT

You are being asked to participate in a quality improvement project. This project aims to improve provider knowledge on the clinical use of pulse pressure variation and stroke volume variation during fluid resuscitation in surgical trauma patients.

#### DURATION OF THE PROJECT

Your participation will require about 20 minutes of your time. If you decide to participate, you will be 1 of 10 participants.

#### PROCEDURES

If you agree to be in the project, we will ask you to do the following things:

Complete an online 10 question pre-test survey, view an educational module via voice over PowerPoint, and then participate in a [post-test survey](#).

#### RISKS AND DISCOMFORTS

The main risk or discomfort from this research is minimal. There will be minimal risks involved with this project, as expected in any type of educational intervention, which may have included mild emotional stress or mild physical discomfort from sitting on a chair for an extended period of time.

#### BENEFITS

The following benefits may be associated with your participation in this project: An improved knowledge in the principles underlying pulse pressure variation and stroke volume variation, current modalities to guide fluid resuscitation and their pitfalls as well as the clinical utility of pulse pressure variation and stroke volume variation.

#### ALTERNATIVES

There are no known alternatives available to you other than not participating in this project. However, if you would like to receive the educational material given to the participants in this project, it will be provided to you at no cost.

#### CONFIDENTIALITY

The records of this project will be kept private and will be protected to the fullest extent provided by law. If in any sort of [paper](#) we might publish, we will not include any information that will make it possible to identify you as a participant. Records will be stored securely, and only the project team will have access to the records.

**PARTICIPATION:** Taking part in this research project is voluntary.

#### COMPENSATION & COSTS

There is no cost or payment to you for receiving the health education and/or for participating in this project.

#### RIGHT TO DECLINE OR WITHDRAW

Your participation in this project is voluntary. You are free to participate in the project or withdraw your consent at any time during the project. Your withdrawal or lack of participation will not affect any benefits to which you are otherwise entitled. The investigator reserves the right to remove you without your consent at such time that they feel it is in the best interest.

#### RESEARCHER CONTACT INFORMATION

If you have any questions about the purpose, procedures, or any other issues relating to this research project, you may contact Maritza Beza at 786-440-2602 / [mbeza003@fiu.edu](mailto:mbeza003@fiu.edu) and Vincent Gonzalez at 305-348-4877 / [gonzalv@fiu.edu](mailto:gonzalv@fiu.edu)

#### IRB CONTACT INFORMATION

If you would like to talk with someone about your rights to be a subject in this project or ethical issues with this project, you may contact the FIU Office of Research Integrity by phone at 305-348-2494 or by email at [ori@fiu.edu](mailto:ori@fiu.edu).

#### PARTICIPANT AGREEMENT

I have read the information in this consent form and agree to participate in this study. In addition, I have had a chance to ask any questions I have about this study, and they have been answered for me. Therefore, I am providing my informed consent by clicking on the "consent to participate" button below.

## Appendix E. Data Collection Instrument (Pre & Post Test Survey)

**FIU** FLORIDA INTERNATIONAL UNIVERSITY

Pretest and Posttest Questionnaire:

**Fluid Optimization Using Pulse Pressure Variation and Stroke Volume Variation in Surgical Trauma Patients**

**INTRODUCTION**

The primary aim of this QI project is to improve the knowledge of CRNAs pertaining to fluid resuscitation optimization using pulse pressures variation and stroke volume variation in surgical trauma patients. Please answer the question below to the best of your ability. The questions are either in multiple choice or true/false format and are meant to measure knowledge and perceptions on PPV/SVV to guide fluid resuscitation in surgical trauma patients.

**PERSONAL INFORMATION**

1. Gender: Male    Female    Other \_\_\_\_\_

2. Age: \_\_\_\_\_

3. Ethnicity:  
Hispanic    Caucasian    African American    Asian    Other \_\_\_\_\_

4. Position/Title: \_\_\_\_\_

5. Level of Education: Associates    Bachelors    Masters    Other \_\_\_\_\_

6. How many years have you been an anesthesia provider?  
Over 10    5-10 years    2-5 years    1-2 years

Page 1 of 4

- c. 250ml  
d. 500ml
9. Once change in the monitored dynamic parameter is <10 %:
- Fluid administration is stopped to avoid hypervolemia
  - Fluid administration is started to avoid hypovolemia
  - Administer a pressor to avoid hypotension
  - Administer a diuretic for fluid overload
10. Which patient would not benefit from PPV/SVV guided fluid resuscitation?
- Expected blood loss >1000 mL
  - Case duration < 2 hours
  - Case duration >3 hours
  - Expected blood loss > 1500ml.
11. How likely are you to use PPV/SVV to guide fluid resuscitation?
- Most likely
  - Somewhat likely
  - Somewhat unlikely
  - Most unlikely
12. How likely are you to recommend using PPV/SVV to guide fluid resuscitation?
- Most likely
  - Somewhat likely
  - Somewhat unlikely
  - Most unlikely

**QUESTIONNAIRE**

1. Goal-directed fluid therapy is best described by which of the following?
- Giving a predetermined volume of fluid based on ideal body weight.
  - Giving a predetermined volume of fluid based on blood pressure and pulse.
  - Optimizing the fluid given to a patient based on mean arterial pressure.
  - Optimizing the fluid given to a patient based on stroke volume and cardiac output.
2. What percent of fluid boluses fail to achieve the intended effect of increasing cardiac output?
- 25%
  - 50%
  - 15%
  - 75%
3. Excess fluid administration is associated with:
- Endothelial injury
  - Cell edema
  - Acute lung injury
  - Compartment syndromes
  - All the above
4. This lethal triad has been described as the cause of morbidity and mortality in trauma patients
- Hypothermia, hypovolemia, coagulopathy

Page 2 of 4

- Hypothermia, acidosis, coagulopathy
  - Hypothermia, alkalosis, coagulopathy
  - Hypothermia, metabolic alkalosis, coagulopathy
5. To interpret PPV what 3 conditions must be met
- Sinus rhythm
  - Mechanically ventilated with no spontaneous respirations
  - Must not have an open chest
  - Mean arterial pressure >65mmHg
  - Heart rate < 70bpm
  - Increased abdominal pressure
6. Greater variability in stroke volume suggests fluid responsiveness
- True
  - False
7. What percentage variability is associated with fluid responsiveness?
- <12%
  - >12%
  - <10%
  - >10%
8. If respiratory variations in the arterial pressure waveform (PPV or SVV) are >10 to 15 percent, then the patient is assumed to be fluid responsive, and we administer fluid boluses of a balanced electrolyte crystalloid solution in increments of:
- 100ml
  - 200ml

Page 3 of 4

## Appendix F. Educational Module PowerPoint Presentation

**FIU**

### Fluid Resuscitation Optimization in Surgical Trauma Patients Utilizing Pulse Pressure Variation and/or Stroke Volume Variation: A(n) Educational Module

Maria J. Beza  
Nicole Werthen College of Nursing & Health Sciences  
Florida International University  
nbeza@fiu.edu

**FIU**

### LEARNING GOALS

- Outline the background of fluid resuscitation for trauma
- Determine current fluid resuscitation methods and their goals
- Understand the physiology of the effect of respiratory variation on hemodynamics
- Recognize clinical applications of PPOCV

**FIU**

### Background

- Trauma
- Release of chemical mediators
- Increase in capillary permeability
- Loss of intravascular fluid into interstitial space
- Hypoperfusion and edema

**FIU**

### Current Methods

**Problem Identification**

**FIU**

### Consequences

- Over resuscitation
- Optimal timing & fluid amount? (fluid resuscitation vs. permissive hypotension)
- Residual volume (AKA)
- Additional hemodynamic response

**FIU**

### CURRENT PRACTICE

#### Static (traditional) measures of fluid status

**FIU**

### Pitfalls of Static Measures

**Inconsistent prediction of fluid responsiveness**

Although static indices, such as central venous pressure and pulmonary capillary wedge pressure, have been traditionally used for assessing patient's volume status, their value has been questioned for predicting fluid responsiveness.

**Complications** CVCs and PACs require central venous access and have been associated with a number of complications, including arrhythmias, risk to vascular or cardiac structures, catheter-associated bloodstream infections, pneumothorax, and venous thromboembolism.

**Data interpretation is difficult** Data from CVCs and PACs may be challenging to interpret both due to the lack of standardization of techniques and the hemodynamic complexity of patients receiving them. Several studies have characterized poor interobserver reliability and challenges interpreting intracardiac pressures from PACs, even among trained clinicians.

**FIU**

### Methods for assessing fluid responsiveness

- LVOI velocity time integral (VTI) on echo
- Superior vena cava collapsibility index (SV-CVI) on IVC
- PPV/SVV
- Pulse contour analysis

Accurate indicators of fluid responsiveness

**FIU**

### Pulse Pressure Variation & Stroke Volume Variation

- Reduced sensitivity of the heart to changes in stroke volume by mechanical inspiration
- Independently predict placement on P0 curve
- Prove accurate prediction of fluid responsiveness

**FIU**

### Physiology

**FIU**

**FIU**

### Systems in current use

**FIU**

### Summary of the evidence

- Shorter LOS** Goal-directed fluid therapy based on dynamic indices (stroke volume variation, pulse pressure variation) compared to non-goal-directed fluid therapy in major surgery: a randomized controlled trial.
- Reduced mortality** The effects of goal-directed fluid therapy based on dynamic parameters on post-surgical outcomes: a meta-analysis of randomized controlled trials.
- Reduced mortality** Does goal-directed hemodynamic and fluid therapy improve peri-operative outcomes? A systematic review and meta-analysis.

**FIU**

### Summary of the evidence

- Clinical judgement: Most trauma resuscitation- will we get there? probably not.
- Arterial Waveform Analysis- Preload indicator - relies on the expansion from inspiration to expiration of the patient.
- PPV - Pulse Pressure Variation- Greater than 13% = preload responsive
- SVV - Stroke Volume Variation- Greater than 10% = preload responsive

**FIU**

### REFERENCES

- Schwartz K. Update on the assessment of fluid responsiveness. *J Anesth*. 2008;34(2):185-196. doi:10.1007/s00540-008-0272-4
- Marik PE, Baram M, Vohra B. Does central venous pressure predict fluid responsiveness? A systematic review of the literature and the use of central venous catheters. *Chest*. 2008;134(1):172-178. doi:10.1377/chest.07-2331
- Monter K, Marks PE, Nsouli J. Prediction of fluid responsiveness on update. *Ann Intensive Care*. 2016;1(1):11. doi:10.1186/s13054-016-2167-7
- Lopes MR, Oliveira MA, Pereira VO, Lemes AP, Auler JD Jr, Michard F. Goal-directed fluid management based on pulse pressure variation monitoring during high-risk surgery: a pilot randomized controlled trial. *Crit Care*. 2005;11(5):R151. doi:10.1186/cc117
- Beza J, Ogles M, Blawie N, Michard F. The effects of goal-directed fluid therapy based on dynamic parameters on post-surgical outcomes: a meta-analysis of randomized controlled trials. *Crit Care*. 2014;18(5):R68. Published 2014 Oct 28. doi:10.1186/s13054-014-0584-4

**FIU**

- Michael F, Murchford GW, Kibiam MR, Ernst PE, Fogel SL. Potential return on investment for implementation of personalized goal-directed fluid therapy in major surgery: a randomized database study. *Perfusion (Abingdon)*. 2015;31(1). Published 2015 Oct 18. doi:10.1186/s13741-015-0021-0
- Pearce RM, Harrison DA, MacDonald N, et al. Effect of a perioperative, random output-guided hemodynamic therapy algorithm on outcomes following major gastrointestinal surgery: a randomized clinical trial and systematic review of goal-directed resuscitation approaches. *JAMA*. 2014 Oct 8;312(14):1475-1484. doi:10.1001/jama.2014.2305
- Yang X, Du B. Does pulse pressure variation predict fluid responsiveness in critically ill patients? A systematic review and meta-analysis. *Crit Care*. 2014;18(5):R95. Published 2014 Nov 27. doi:10.1186/s13054-014-0882-4
- Mark PE, Cavallazzi R, Vizza T, Hassel A. Dynamic changes in arterial waveform derived variables and fluid responsiveness in mechanically ventilated patients: a systematic review of the literature. *Crit Care Med*. 2008;37(5):2842-2847. doi:10.1097/CCM.0b013e31813a1916

**FIU**

- Dawkins RJ, Probst JJ, Sheehy JF. Outcomes of haemorrhage shock and the epidemiology of preoperative death from injury. *Scandinavian*. 2010;35(2):142-148. doi:10.1111/j.1365-3113.2010.04511.x
- Waisbald G, Gombi A, P. G. De Almeida, D. P. Roche e Silva, M., & Pol-de-Figueredo, L. F. (2007). Pulse pressure respiratory variation as an early marker of cardiac output fall in experimental hemorrhagic shock. *Artif Organs*, 31(3), 286-289.
- Cheng MA, Wang Y, Berberich MM, McConville I. Does goal-directed hemodynamic and fluid therapy improve peri-operative outcomes? A systematic review and meta-analysis. *Eur J Anaesthesiol*. 2018;35(7):465-469. doi:10.1191/eaj.2018.00077r
- Are all trauma centers created equal? Level 1 to level 1 trauma center patient transfers in the setting of rapid trauma center proliferation. *J Trauma Acute Care Surg*. 2005;58(5):820-825. doi:10.1097/TA.0000000000000278
- Stevens K. May 31, 2015 "The Impact of Evidence-Based Practice in Nursing and the Next Big Issue" *Q&A: The Online Journal of Issues in Nursing* Vol. 18, No. 2. Manuscript 4

## Reference

- Osman D, Ridel C, Ray P, et al. Cardiac filling pressures are not appropriate to predict hemodynamic response to volume challenge. *Critical Care Medicine*. 2007;35(1):64-68. doi:10.1097/01.ccm.0000249851.94101.4f

2. Marik PE, Cavallazzi R, Vasu T, Hirani A. Dynamic changes in arterial waveform derived variables and fluid responsiveness in mechanically ventilated patients: a systematic review of the literature. *Crit Care Med.* 2009;37(9):2642-2647. doi:10.1097/CCM.0b013e3181a590da
3. Silva JM Jr, de Oliveira AM, Nogueira FA, et al. The effect of excess fluid balance on the mortality rate of surgical patients: a multicenter prospective study. *Crit Care.* 2013;17(6):R288. Published 2013 Dec 10. doi:10.1186/cc13151
4. Nisanevich V, Felsenstein I, Almogy G, Weissman C, Einav S, Matot I. Effect of intraoperative fluid management on outcome after intraabdominal surgery. *Anesthesiology.* 2005;103(1):25-32. doi:10.1097/00000542-200507000-00008
5. Michard F, Teboul JL. Predicting fluid responsiveness in ICU patients: a critical analysis of the evidence. *Chest.* 2002;121(6):2000-2008. doi:10.1378/chest.121.6.2000
6. Dave C, Shen J, Chaudhuri D, et al. Dynamic Assessment of Fluid Responsiveness in Surgical ICU Patients Through Stroke Volume Variation is Associated With Decreased Length of Stay and Costs: A Systematic Review and Meta-Analysis. *J Intensive Care Med.* 2020;35(1):14-23.
7. Mayer J, Boldt J, Mengistu AM, Röhm KD, Suttner S. Goal-directed intraoperative therapy based on autocalibrated arterial pressure waveform analysis reduces hospital stay in high-risk surgical patients: a randomized, controlled trial. *Crit Care.* 2010;14(1):R18. doi:10.1186/cc8875
8. Scheeren TW, Wiesenack C, Gerlach H, Marx G. Goal-directed intraoperative fluid therapy guided by stroke volume and its variation in high-risk surgical patients: a prospective randomized multicentre study. *J Clin Monit Comput.* 2013;27(3):225-233. doi:10.1007/s10877-013-9461-6
9. Lopes MR, Oliveira MA, Pereira VO, Lemos IP, Auler JO Jr, Michard F. Goal-directed fluid management based on pulse pressure variation monitoring during high-risk surgery: a pilot randomized controlled trial. *Crit Care.* 2007;11(5):R100. doi:10.1186/cc6117
10. Avital G, Snider EJ, Berard D, et al. Closed-Loop Controlled Fluid Administration Systems: A Comprehensive Scoping Review. *J Pers Med.* 2022;12(7):1168. Published 2022 Jul 18. doi:10.3390/jpm12071168
11. Kalkwarf KJ, Cotton BA. Resuscitation for Hypovolemic Shock. *Surg Clin North Am.* 2017;97(6):1307-1321. doi:10.1016/j.suc.2017.07.011
12. Cantle PM, Cotton BA. Balanced Resuscitation in Trauma Management. *Surg Clin North Am.* 2017;97(5):999-1014. doi:10.1016/j.suc.2017.06.002

13. Holly C. *Practice-Based Scholarly Inquiry and the DNP Project*. New York, NY: Springer Publishing Company, Llc; 2019.
14. Dang D, Dearholt SL. *Johns Hopkins Nursing Evidence-Based Practice: Model and Guidelines Third Edition*. Indianapolis Sigma Theta Tau International; 2018.
15. Teboul JL, Monnet X, Chemla D, Michard F. Arterial Pulse Pressure Variation with Mechanical Ventilation. *Am J Respir Crit Care Med*. 2019;199(1):22-31. doi:10.1164/rccm.201801-0088CI
16. Yang X, Du B. Does pulse pressure variation predict fluid responsiveness in critically ill patients? A systematic review and meta-analysis. *Crit Care*. 2014;18(6):650. Published 2014 Nov 27. doi:10.1186/s13054-014-0650-6
17. Palmer L. Fluid Management in Patients with Trauma: Restrictive Versus Liberal Approach. *Vet Clin North Am Small Anim Pract*. 2017;47(2):397-410. doi:10.1016/j.cvsm.2016.10.014
18. Cocchi MN, Kimlin E, Walsh M, Donnino MW. Identification and resuscitation of the trauma patient in shock. *Emerg Med Clin North Am*. 2007;25(3):623-vii. doi:10.1016/j.emc.2007.06.001

