

PROTOCOLS

GOAL DIRECTED THERAPY (GDT) – THE OVERVIEW

Vicki Morton, DNP, AGNP, Providence Anesthesiology Associates, Charlotte, NC

Based on historical studies, we know that indiscriminate administration of fluids is associated with poor outcomes in both surgical and non-surgical patients. More recent literature suggests the use of goal

directed fluid protocols utilizing dynamic physiologic parameters to guide fluid resuscitation improves patient outcomes and reduces overall healthcare costs. Gone are the days of relying on inadequate

measures such as CVP, BP, HR, and UOP to determine a patient's volume status. A 2020 analysis done by Johnston et al, demonstrated that a "goal-directed volume resuscitation protocol centered

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PERFUSION

GOAL DIRECTED PERFUSION AND CARDIOPULMONARY BYPASS

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Acute Kidney Injury (AKI) affects 20-40% of cardiopulmonary bypass (CPB) patients. Low oxygen delivery (DO₂) is a predictor of AKI after CPB⁽³⁾. Applying goal-directed perfusion (GDP) during CPB can significantly help improve patient DO₂ and reduce AKI. This can be accomplished in concert with implementing blood conservation techniques and maintaining consistent levels of DO₂ during CPB⁽²⁾. There are several blood conservation techniques that can be utilized for selected patients. One of the most fundamental techniques is the retrograde autologous prime (RAP), which can maximize hematocrit (HCT) by

minimizing dilutional fluid administered to the patient when instituting CPB⁽⁴⁾. In order to successfully maximize crystalloid fluid removal, anesthesia needs to help support the patient's blood pressure, staying within the recommended 10% of baseline mean arterial blood pressure. Perfusion should communicate with anesthesia and slowly implement the RAP process after an adequate activated clotting time has been achieved. Volume displaced will vary but removal of most of the crystalloid in the circuit is usually possible. This is a simple perfusion intervention that maximizes the hematocrit on

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TEE

IS INTRAOPERATIVE TEE THE ULTIMATE GDT MONITOR?

Michael C. Grant, MD, MSE, The Johns Hopkins University School of Medicine, Baltimore, MD

Transesophageal echocardiography (TEE) has a well-established role for the assessment and diagnosis of cardiac structural anomalies including valvular disease, regional wall motion abnormalities and other anatomical variants.¹ Particularly in the setting of valve surgery, TEE remains the gold standard in real-time assessment of heart valve function and pathology. What is less well established is its potential application to the setting of isolated coronary artery bypass grafting (CABG). While prior literature has suggested

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One Program's Experience with Minimally Invasive Hemodynamic Monitoring for GDT
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POST-OP

RECENT META-ANALYSIS SHEDS LIGHT ON EVIDENCE BEHIND GDT IN CARDIAC SURGERY

Subhasis Chatterjee MD, Baylor College of Medicine/Texas Heart Institute, Houston, TX

Many of the studies supporting the use of goal-directed therapy (GDT) come from single center reports. While the evidence-base is still evolving, it is important to accurately understand the current evidence-based real-world outcomes published to

date. Moreover, this also offers opportunities to recognize what additional studies need to be done to improve perioperative outcomes utilizing GDT.

Qu and colleagues have offered a rigorous

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on patient fluid responsiveness is associated with significantly reduced risk for AKI after cardiac surgery.” The authors further recommended “protocol-driven approaches should be employed in intensive care units to improve outcomes”.

Implementing such protocols in a cardiac surgery intensive care unit can prove to be challenging for a multitude of reasons. Outdated practices of evaluating volume status are difficult to evolve.

THE BEST WAY TO CREATE A CULTURE OF CHANGE IS TO UNDERSTAND THE OUTCOME DATA AS IT RELATES TO VARIABILITY IN FLUID ADMINISTRATION.

The best way to create a culture of change is to understand the outcome data as it relates to variability in fluid administration. Utilizing local data to demonstrate the need for improvement can be powerful and provide the “why” behind changing practice. Additionally, this can help illuminate financial implications to the organization. Sharing a portion of the large body of evidence supporting goal directed therapy (GDT) can further support the case for change. Creating multidisciplinary consensus and a standardized approach to postoperative fluid resuscitation has been demonstrated to have a positive impact on outcomes.

There are several minimally invasive and non-invasive products on the market that offer the ability to measure stroke volume, stroke volume variation, cardiac output, and EA Dyne. The goal of GDT is to optimize intravascular volume and oxygen delivery. Figure 1 provides an example of a straightforward GDT algorithm in use at our institutions.

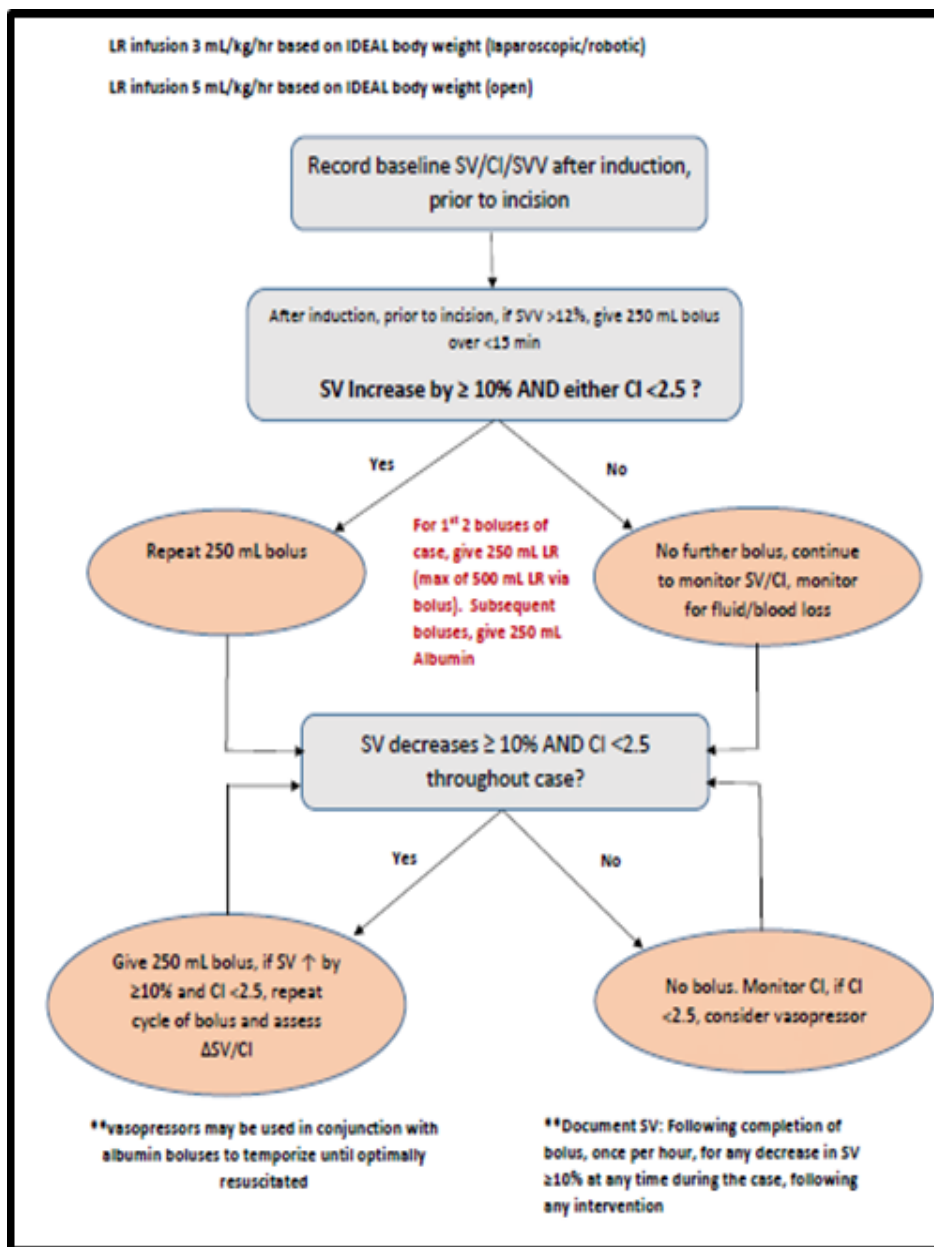


Figure 1: Example of a Goal directed Therapy Algorithm

1. Johnston LE, Thiele RH, Hawkins RB, Downs EA, Jaeger JM, Brooks C, Ghanta RK, Ailawadi G, Kron IL, Isbell JM; Virginia Interdisciplinary Cardiothoracic Outcomes Research Center. Goal-directed resuscitation following cardiac surgery reduces acute kidney injury: A quality initiative pre-post analysis. *J Thorac Cardiovasc Surg*. 2020 May;159(5):1868-1877.e1. doi: 10.1016/j.jtcvs.2019.03.135. Epub 2019 May 17. PMID: 31272751.

2. Martin GS, Kaufman DA, Marik PE, Shapiro NI, Levett DZH, Whittle J, MacLeod DB, Chappell D, Lacey J, Woodcock T, Mitchell K, Malbrain MLNG, Woodcock TM, Martin D, Imray CHE, Manning

MW, Howe H, Grocott MPW, Mythen MG, Gan TJ, Miller TE. Perioperative Quality Initiative (POQI) consensus statement on fundamental concepts in perioperative fluid management: fluid responsiveness and venous capacitance. *Perioper Med (Lond)*. 2020 Apr 21;9:12. doi: 10.1186/s13741-020-00142-8. PMID: 32337020; PMCID: PMC7171743.

3. Waldron NH, Miller TE, Thacker JK, et al. A prospective comparison of a noninvasive cardiac output monitor versus esophageal Doppler monitor for goal-directed fluid therapy in colorectal surgery patients. *Anesthesia & Analgesia*. 2014;118:966-75.

PERFUSION:

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CPB, thereby lowering the risk of allogenic transfusion⁽⁴⁾.

Maintaining DO₂ at a level ≥ 280 mL O₂/mm² during moderate hypothermia (>32° C) is critical for optimal perfusion during CPB. Studies suggest avoiding a persistently low DO₂ during CPB can help reduce the risk of AKI^(2,3). The three variables of the DO₂ formula are flow, hematocrit and O₂ Hgb saturation. Focusing on flow and minimizing hemodilution is vital to the GDP strategy. Using electronic perfusion recording (EPR), capturing real-time information during CPB including DO₂ and pump flows, can optimize patient perfusion⁽¹⁾. Perfusionists without EPR can input the flow, hematocrit, and arterial O₂ saturation to calculate DO₂ on a free downloadable online application (Figure 1). The perfusionist should monitor DO₂ at

10–20 minute intervals⁽³⁾. Utilizing GDP and specifically focusing on minimizing hemodilution, increasing pump flow, and monitoring DO₂ during CPB may help improve patient outcomes⁽¹⁾. The GDP strategy has been shown to be effective in reducing AKI and can be integrated into local perfusion protocols as part of a multi-disciplinary team approach to optimize patient recovery^(1,2).

1. Kramer, Robert, MD and Kelting, Tyler, CCP, Commentary: Goal-directed or flow-directed perfusion? *J Thorac Cardiovasc Surg* 2021;:-1-2 <https://doi.org/10.1016/j.jtcvs.2020.12.075>

2. Ranucci Marco, et al., (2018) Goal-directed perfusion to reduce acute kidney injury: A randomized trial. *The Journal of Thoracic and Cardiovascular Surgery*, November 2018 p. 1918-1927 <https://www.sciencedirect.com/science/article/pii/S0022522318310298>

3. Tomoya Oshita, et al., (2020) A Better Predictor of Acute Kidney Injury After Cardiac Surgery: The Largest Area Under the Curve Below the Oxygen Delivery Threshold During Cardiopulmonary Bypass

The image shows a web-based application for calculating DO₂. It has a blue header with a menu icon and the title 'DO₂ Calculator'. Below the header, there are four input sections: 'BSA (m²)' with a sub-label 'Patient BSA', 'CPB Flow (L/min)' with a sub-label 'Enter CPB Flow', 'HCT (%)' with a sub-label 'Enter HCT', and 'PO₂' with a sub-label 'Enter PO₂'. At the bottom, there is a grey button labeled 'Clear'.

Figure 1: Free online DO₂ calculator application (reproduced with permission, for details email christakampert@umm.edu)

Journal of the American Heart Association. 28 Jul 2020;9:e015566 <https://doi.org/10.1161/JAHA.119.015566>

4. Pierre Tibi, M., & al., e. (2021). STS/SCA/AmSECT/ SABM Update to the Clinical Practice Guidelines on Patient Blood Management. *Journal of Extracorporeal Technology*, 97-124. *JECT*2100053 97..124 (smithbucklin.com).

TRANSESOPHAGEAL ECHOCARDIOGRAPHY (TEE):

IS INTRAOPERATIVE TEE THE ULTIMATE GOAL DIRECTED THERAPY MONITOR?

Michael C. Grant, MD, MSE, The Johns Hopkins University School of Medicine, Baltimore, MD

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that TEE may influence surgical and anesthetic decision-making or augment the interpretation of hemodynamic perturbation in the operating room, most non-academic centers have been slow to adopt the widespread use of TEE for CABG procedures.

Recently, a team of investigators from Johns Hopkins University School of Medicine published a study designed to evaluate the association between intraoperative TEE and outcomes following isolated CABG.² The study, which utilized the Society of Thoracic Surgeons (STS) Adult Cardiac Surgery Database, examined 1.2 million patients undergoing CABG from 2011-2019, of which 680,000 (54%) were performed with intraoperative TEE. Interestingly, the use of TEE in CABG has increased on an annual basis in a linear fashion, from 40% in 2011 to >60% in 2019, and patients who received TEE had higher risk profiles, including greater

incidence of major comorbidity, urgent/emergent procedures and mechanical circulatory support. Despite this, after adjusting for patient-level demographic and clinical variables as well as major institutional confounders, including region, academic standing and volume, propensity-matching analysis revealed that intraoperative TEE was associated with a reduction in operative mortality (death from any cause within 30 days of surgery). This finding was driven by significant reductions in mortality among moderate (STS risk 4-8%) and high (STS risk > 8%) risk patients.

There are several mechanisms by which TEE may confer improved outcomes, including: assistance with de-airing, early identification of pericardial effusion or aortic dissection and recognition of acute regional wall motion/valvular abnormalities.³ In illustration of this point, patients who received TEE were nearly 5-fold more likely to have an unplanned

valvular procedure. In addition, TEE provides vital information regarding resuscitation, allowing for the targeted administration of fluids and vasoactives based upon real time assessment of fluid status and global cardiac function. As a result, intraoperative TEE may well represent the true gold standard in goal-directed therapy, regardless of the cardiac surgical procedure.

1. Lawton JS, Tamis-Holland JE, Bangalore S, et al. 2021 ACC/AHA/SCAI Guideline for Coronary Artery Revascularization: A Report of the American College of Cardiology/American Heart Association Joint Committee on Clinical Practice Guidelines. *Circulation*. 2021 Dec 9;CIR0000000000001038.

2. Metkus TS, Thibault D, Grant MC, et al. Transesophageal Echocardiography in Patients Undergoing Coronary Artery Bypass Graft Surgery. *J Am Coll Cardiol*. 2021 Jul 13;78(2):112-122.

3. Metkus TS, Grant MC, Zwischenberger B, et al. Reply: When Will We Stop Debating on the Value of TEE in CABG? *J Am Coll Cardiol*. 2021 Oct 26;78(17):e139-e140.

POST-OP:

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systematic review and meta-analysis entitled the "Significance of perioperative goal-directed hemodynamic approach in preventing postoperative complications in patients after cardiac surgery: a meta-analysis and systematic review." They reviewed 9 randomized controlled trials which included 1148 patients after cardiac surgery comparing pre-emptive hemodynamic interpretation (GDT) versus standard hemodynamic therapy (control). The top line conclusions were that GDT was not associated with a difference in mortality, time of mechanical ventilation, and ICU length of stay (LOS) but was associated with an overall hospital LOS reduction. So, while

there are not a lot of sophisticated economic analyses, it is reasonable to interpret those data as suggesting a cost savings with GDT. Interestingly, all of the studies in this meta-analysis were performed outside of North America.

Looking more closely at the study details, four of the studies focused on intraoperative GDT and five focused on postoperative GDT. For the most part results were similar when looking at the studies combined or separated as intraoperative or postoperative. Notably however, while the use of intraoperative GDT did not appear to reduce the time of mechanical ventilation, the use of postoperative GDT did have a

favorable reduction in mechanical ventilation time. Thus, there is a growing evidence base supporting the use of GDT in enhanced recovery programs, particularly in the postoperative setting. Continued refinement and advanced algorithms to evaluate the efficacy of GDT with respect to prevention of acute kidney injury, reduced postoperative atrial fibrillation, and mitigation of other postoperative complications is necessary.

1. Li P, Qu LP, Qi D, Shen B, Wang YM, Xu JR, Jiang WH, Zhang H, Ding XQ, Teng J. Significance of perioperative goal-directed hemodynamic approach in preventing postoperative complications in patients after cardiac surgery: a meta-analysis and systematic review. *Ann Med*. 2017 Jun;49(4):343-351. doi: 10.1080/07853890.2016.1271956. Epub 2017 Feb 2. PMID: 27936959.

COACHES CORNER

ERAS Program in the Spotlight

INTRAOPERATIVE GDT AT VIRTUA OUR LADY OF LOURDES

One Program's Experience with Minimally Invasive Hemodynamic Monitoring for GDT

Arthur T. Martella, MD, Richard H. Bengel, PA
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The use of minimally invasive hemodynamic monitoring (MIHM) in the cardiac surgery intensive care setting is gaining popularity for many reasons including improved ambulation and continuous advanced monitoring that has not been previously afforded by invasive devices. The usage of MIHM at our institution is a mainstay for lower risk cardiac surgical patients as well as postoperative patients who appear to be deteriorating. As our experience with MIHM has grown, we hypothesized that hemodynamic optimization prior to surgery may impact outcomes. Suboptimal preoperative oral intake compounded by diuretics has led to many of our patients presenting to the operating room in a hypovolemic state.

These discussions led our team to consider a trial at our institution of 20 patients undergoing on-pump CABG and 20 patients undergoing RCABG. We plan to compare them to historical controls. Our hypothesis is that by utilizing our MIHM algorithm to hemodynamically optimize patients prior to CPB or chest insufflation, we will improve outcomes. We plan to compare vasopressor usage on admission to the Cardiac Surgery ICU, postoperative AKI, time to initiation of beta blocker, ICU length of stay and Hospital length of stay. For the CPB group we will also look at DO₂ and indices while on cardiopulmonary bypass, and in the RCABG group time at target cardiac



Core ERAS Team at Virtua Our Lady of Lourdes Hospital, Camden, NJ: From left to right: Abigail Stroud, CCP, Brian Schwartz, CCP, Qiong Yang, MD, Richard Bengel, PA, Josh Park, PA, Melissa Frucci, CCRN. Team members not pictured: Arthur Martella, MD, Charles Stivala, MD, Saad Rasheed, MD, and : Hitoshi Hirose, MD.

index and MAP. We look to have our small data sample completed within Q1 of 2022. We believe that by using a protocolized approach and MIHM with our confidence in MIHM, we could improve outcomes.

RECENT ERAS® CARDIAC PUBLICATIONS:

>> Click titles for online weblinks

Hensley NB, Grant MC, Cho BC, Suffredini G, Abernathy JA. [How Do We Use Dashboards to Enhance Quality in Cardiac Anesthesia?](#) *J Cardiothorac Vasc Anesth*. 2021 Oct;35(10):2969-2976.

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UPCOMING MEETINGS:

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Society of Thoracic Surgeons 58th Annual Meeting, January 29-31, 2022 - Miami, FL



American Association for Thoracic Surgery 102nd Annual Meeting, May 13-17, 2022 - Boston, MA



ERAS Society 8th World Congress, June 1-3, 2022 - Madrid, Spain



ERAS Cardiac Society Spring Educational Webinar and Sponsor Invitational, April 22-23, 2022 - virtual



Society of Cardiovascular Anesthesiologists, May 14-17, 2022 - Palm Springs, CA



European Association for Cardio-Thoracic Surgery 36th Annual Meeting, October 5-8, Milan, Italy

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ERAS® stands for Enhanced Recovery after Surgery, and we improve surgical care and recovery through research, education, audit, and implementation of evidence-based practices. In early 2017, a group of cardiac surgeons, anesthesiologists, and intensivists first met to establish the Enhanced Recovery After Cardiac Surgery (ERACS®) Society to achieve these goals for patients undergoing heart surgery. This initial organization's work led to the publication of the first-ever expert consensus recommendations for a cardiac surgical enhanced recovery protocol. We have since joined with the ERAS® Society and have established an organization of multinational experts representing all aspects of healthcare delivery. ERAS® Cardiac is a non-profit organization with the mission to develop evidence-based expert consensus statements promoting best practice recovery practices. The goal is to provide hospitals with better guidance for developing local protocols that are part of a continuous quality improvement process for better patient care, and reduce postoperative complications and costs after heart surgery.

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ERAS® Society

The ERAS® Society is an international organization with enhanced recovery guidelines for several surgical sub-specialties. Beginning as the ERAS® Study Group in 2001, team leaders Professor Ken Fearon (University of Edinburgh) and Professor Olle Ljungqvist (Karolinska Institutet) spearheaded the developments made in multimodal surgical care. The ERAS® Study Group soon discovered that there were a variety of local traditions in practice, as well as an inconsistent application of evidence-based best practices. This prompted the group to examine the process of change from tradition to best-practice. Since its inception, the ERAS® Society has expanded to include several subspecialties, emphasized the benefits of standardized best-practices across the continuum of the perioperative period, highlighted the importance of data-driven self-evaluation, and promoted the improvement of patient care.

Our Organizational Structure

Our ERAS® Cardiac Society is made up of experts from around the world, including participation from all members of the healthcare team. Our members strive to implement enhanced recovery principles at their local institutions while advancing improved patient care internationally through collaboration, education, and dissemination of up-to-date knowledge regarding optimal perioperative care. Our organization is divided into an Executive Board, Advisory Board, and a pool of Subject Matter Experts.

Corporate financial support will be used to promote the mission of the ERAS® Cardiac Society. We are committed to standardizing best practice surrounding the preoperative and perioperative care of cardiac surgical patients through expert consensus, review of the literature and open communication. This unrestricted support does not represent the ERAS® Cardiac Society's support or agreement to promote any pharmaceutical, device, or technology related to the sponsors.

For more information and to become a sponsor please contact:
 Bonnie Engelman, MA, Director of Sponsor Relations, ERAS® Cardiac Society by mail at bengelman@erascardiac.org

To learn more about our organization, including our board members and upcoming meetings:

www.erascardiac.org

