Vision inspires action

Enhancing recovery after cardiac surgery

Edwards

Evidence-based discussion

- Challenges in cardiac surgery
- Impact of complications
- Role of hemodynamic management
- Perioperative goal-directed therapy as a proven solution

The heart of the matter: delivering value

Value = Quality / Cost

Value-based healthcare reimbursement models focus on **patient outcomes**, emphasizing **cost**, **quality of care**, and **coordination** of multidisciplinary services.

1. Cohen. Value in Cardiac Surgery: The Price of Saving
2. Kolarczyk, Defining Value-Based Care in Cardiac and Vascular Anesthesiology: The Past, Present, and Future of Perioperative Cardiovascular Care

Many merit-based incentives are aligned with improving outcomes

"It is a time in which all perioperative clinicians must define and demonstrate the value they bring to the patient in order to claim reimbursement for clinical services." Kolarczyk, et al.

Merit-based incentive payment system (MIPS) metrics:

- Prolonged ventilation
- Surgical site infection
- Renal failure
- Extended length of stay

1. STS. https://www.sts.org/registries-research-center/sts-national-database/mips-reporting
2. Kolarczyk, Defining Value-Based Care in Cardiac and Vascular Anesthesiology: The Past, Present, and Future of Perioperative Cardiovascular Care

Opportunity for improving outcomes in cardiac surgery

Fast Track[1,2]

- Opioid sparing anesthesia
- Early extubation
- Early ambulation
- Post-op normothermia
- Post-op pain control

Enhanced Recovery After Surgery (ERAS)[3]

- Nutrition– early feeding
- Opioid sparing anesthesia
- Avoid drains/tubes
- **Precise fluid management**
- Early ambulation

ERAS – Cardiac Surgery[4]

- Blood loss reduction agents
- Glycemic control
- Measures to reduce SSI
- **Goal-directed therapy**
- Multimodal, opioid-sparing pain management
- Avoid hypo- & hyperthermia
- Maintain chest tube patency
- Post-op delirium screening & ICU liberation bundle
- Pre-op alcohol & smoking screen

1. Bainbridge & Cheng. Current evidence on fast track cardiac surgery. Eur Heart Journal 2017
2. Pande RU1, Nader ND, Donias HW, D'Ancona G, Karamanoukian HL. Heart Surg Forum. 2003;6(4):244-8. REVIEW: Fast-Tracking Cardiac Surgery.
3. Grocott, et al. Enhanced Recovery Pathways as a Way to Reduce Surgical Morbidity. Curr Opin Crit Care 2012
4. Engelman, et al. Enhanced Recovery After Surgery (ERAS): An Expert Consensus Statement in Cardiac Surgery. Enhanced Recovery After Surgery – Cardiac Surgery, 2018.

Evidence-based discussion

Challenges in cardiac surgery

Impact of complications

Role of hemodynamic management

Perioperative goal-directed therapy as a proven solution

Complications can be widespread after cardiac surgery[1]

Up to

15% of cardiac surgery patients may have **1+** complications[1]

Acute Kidney Injury can occur in up to **40%** of major cardiac surgery patients[2]

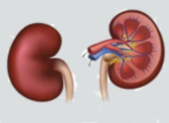
1. Crawford, T., et al. Complications After Cardiac Operations: All Are Not Created Equal. Ann Thorac Surg, 2017.
2. Chew & Hwang. Acute Kidney Injury After Cardiac Surgery: A Narrative Review of the Literature. JCVA 2018.

Complications can increase cost of care[1,3,4]

$18,000 – 20,000

Approximate increase in cost with complication versus without[1,2]

$36,000



Estimated **increase in cost** may be due to AKI after cardiac surgery[3]

1. Boltz, Melissa, et al. Synergistic Implications of Multiple Postoperative Outcomes. *Am J Med Quality*, 2012. (n=2,250, calculated weighted average)
2. Gani, F., et al. Bundled Payments for Surgical Colectomy Among Medicare Enrollees: Potential Savings vs the Need for Further Reform. *JAMA* 2016
3. Alshaikh, H., et al. Financial Impact of Acute Kidney Injury After Cardiac Operations in the United States. Ann Thorac Surg 2018.
4. Eappen, et. Al. Relationship between occurrence of surgical complications and hospital finances. JAMA, 2013

Complications can increase length of stay after cardiac surgery[1]

2/3

Organ dysfunction and **multiple organ failure** are the primary causes of prolonged hospital stay after cardiac surgery[2]

Up to **68%** of cardiac surgery patients *with multiple major postop complications* may have an associated **prolonged hospital LOS**[1]

Up to **62%** may discharge to a location other than home[1]

1. Crawford, T., et al. Complications After Cardiac Operations: All Are Not Created Equal. Ann Thorac Surg, 2017.
2. Polonen, P., et al. A Prospective, Randomized Study of Goal-Oriented Hemodynamic Therapy in Cardiac Surgical Patients. Anesth Analg, 2000.

Complications can increase readmissions after cardiac surgery[1]

1 in 5

Approximately 1 in 5 (18.7%) cardiac surgery patients require readmission, due primarily to[1]

- Infection
- Arrhythmia
- Volume overload

"Efforts to reduce postoperative readmissions should begin by focusing on postoperative complications that can be reliably and validly measured." Lawson, et al. Ann Surg, 2013

1. Iribarne A, Chang H, Alexander J, et al. Readmissions After Cardiac Surgery: Experience of the National Institutes of Health/Canadian Institutes of Health research Cardiothoracic Surgical Trials Network. 2014;98:1274-80. (Study looked at all cause readmissions within 65 days after the operation.)
2. Lawson, et al. Association between occurrence of a Postoperative Complication and Readmission: Implications for Quality Improvement and Cost Savings. *Ann Surg* 2013.

Complications can increase mortality[1,3]

Major infection or AKI
is associated with
10x increase
in mortality[1,2]

1. Alshaikh, H., et al. Financial Impact of Acute Kidney Injury After Cardiac Operations in the United States. Ann Thorac Surg 2018.
2. Gelijns, A., et al. Management Practices and Major Infections After Cardiac Surgery. Journal of the American College of Cardiology, 2014.
3. Crawford, T., et al. Complications After Cardiac Operations.: All Are Not Created Equal. Ann Thorac Surg, 2017.

Evidence-based discussion

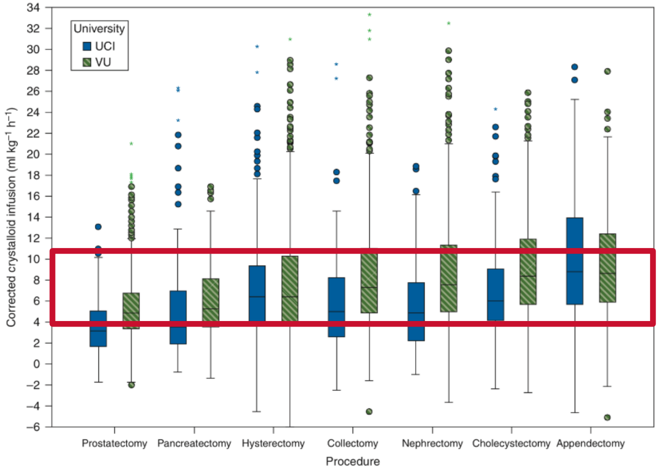
Challenges in cardiac surgery

Impact of complications

Role of hemodynamic management

Perioperative goal-directed therapy as a proven solution

Large variation exists in perioperative fluid administration



The **strongest predictor** of intraop fluid administration was the **provider**.[1]

High variability is shown with only **50%** of cases falling within a **4-10 mL/kg/hr range**[1]

85%

ICU fluid bolus decisions are made by RNs and residents[2]

Intra-op

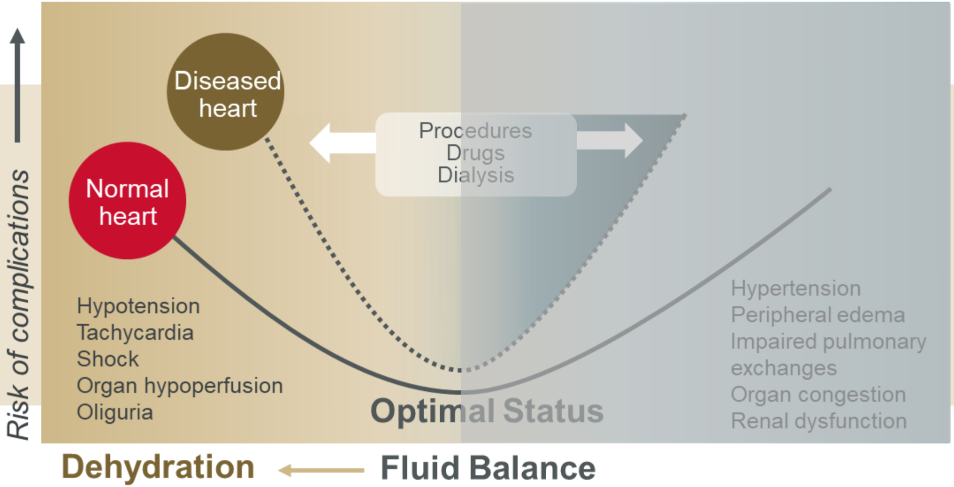
Postop

1. Lilot M, Ehrenfeld JM, Lee C, Harrington B, Cannesson M, Rinehart J. Variabiltiy in practice and factors predictive of total crystalloid administration during abdominal surgery: retrospective two-centre analysis. BJA. 2015;112(6):1392-140.
2. Parke, R.L., et al. Intravenous fluid use after cardiac surgery: a multicentre, prospective, observational study. Crit Care Resusc, 2014.

The problem with fluid restriction

Fluid restriction, coupled with cardiopulmonary bypass and limited cardiovascular reserve, can result in

- **Inadequate post op oxygen delivery**
- **Compromised organ perfusion**

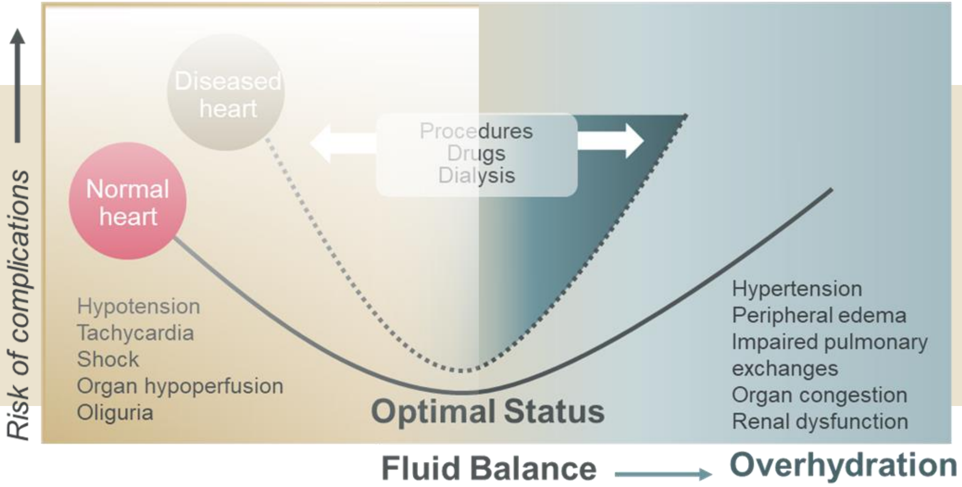


1. Aneman, A., et al. Advances in critical care management of patients undergoing cardiac surgery. Intensive Care Med, 2017.
2. Ronco, C. Diagnosis and management of fluid overload in heart failure and cardio-renal syndrome: The “5B” approach. Seminars in Nephrology 2012;32:129-14

The problem with fluid overload

Fluid overload in cardiac surgery patients has demonstrated significant association with increased

- ❖ **Complications**
- ❖ **Length of stay**
- ❖ **Mortality**



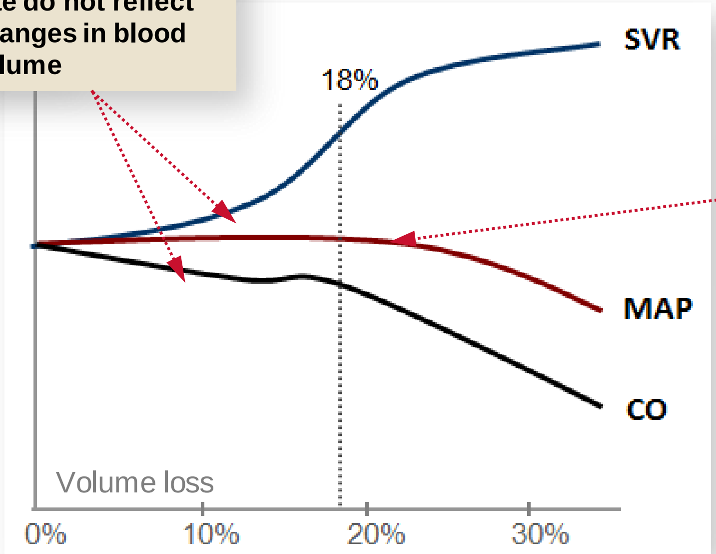
1. Aneman, A., et al. Advances in critical care management of patients undergoing cardiac surgery. Intensive Care Med, 2017.
2. Ronco, C. Diagnosis and management of fluid overload in heart failure and cardio-renal syndrome: The “5B” approach. Seminars in Nephrology 2012;32:129-14

Hemodynamic monitoring aids your assessment of the cardiovascular system and tissue oxygenation

Goals of hemodynamic monitoring

- Assure perfusion adequacy
- Promptly detect hemodynamic instability
- Titrate appropriate therapy to specific endpoints
- Differentiate among causes of instability

Changes in arterial pressure and heart rate do not reflect changes in blood volume



MAP can be sustained for 25-30% decrease in circulating volume

1. Kuhn, Christian, and Karl Werdan. "Surgical Treatment Evidence-Based and Problem-Oriented." Ed. René Holzheimer and John Mannick. The American Journal of Surgery183.1 (2002): 101. Web.
2. Giglio, et al. Goal-directed haemodynamic therapy and gastrointestinal complications in major surgery: a meta-analysis of randomized controlled trials. BJA 2009

Evidence-based discussion

- Challenges in cardiac surgery
- Impact of complications
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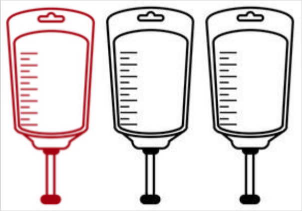
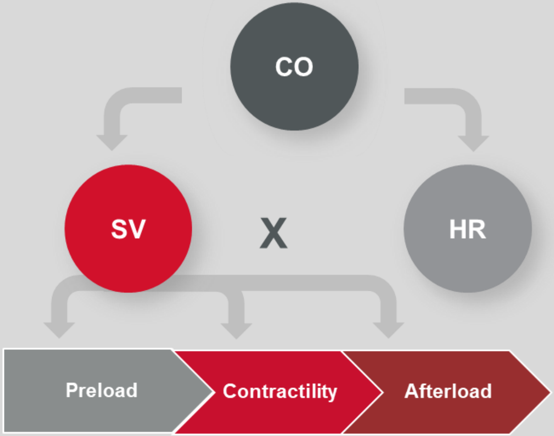
Traditional parameters are not adequate predictors of volume status

- Blood pressure / MAP[1,4]
- Heart rate[1]
- Central venous pressure[2]
- Volume loss estimate[3]



1 in 3

Only 35% of practitioners base fluid management decisions on flow-based parameters[4]



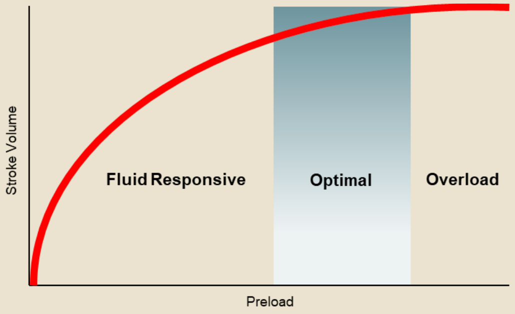
1. Hamilton, et al. Comparison of commonly used clinical indicators of hypovolaemia with gastrointestinal tonometry. *Intensive Care Med* 1997.
2. Marik, et al. Does the Central Venous Pressure Predict Fluid Responsiveness? An Updated Meta-Analysis and a Plea for Some Common Sense. *Crit Care Med* 2013.
3. Stoelting et. al. Basics of Anesthesia, 5th ed. Elsevier - China, p. 349, 2007.
4. Romagnoli, S., et al. Fluid Status Assessment and Management during the Perioperative Phase in Adult Cardiac Surgery Patients. Journal of Cardiothoracic and Vascular Anesthesa, 2016.

Hemodynamic management techniques are evolving to take the guesswork out

The **"Conventional"** approach[1]
predicting the amount of fluid needed based upon the procedure duration and severity

The **"Restrictive"** fluid approach[1]
minimizing fluids to maintain blood pressure

"Perioperative Goal-Directed Therapy"[2]
(PGDT) approach to fluid management considers optimizing volume/fluids via the Frank-Starling Curve



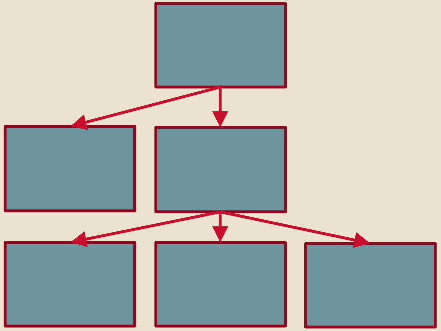
Choice, timing, and ***amount*** of fluid therapy can affect outcome[3]

1. Stolting et al. Basics of Anesthesia, 5th ed. Elsevier - China, p. 349, 2007
2. Michard F. Changes in arterial pressure during mechanical ventilation. *Anesth* 2005
3. Stein, A., et al. Fluid overload and changes in serum creatinine after cardiac surgery: predictors of mortality and longer intensive care stay. A prospective cohort study. Critical Care, 2012.

What is perioperative goal-directed therapy (PGDT)?

PGDT aims to maintain adequate oxygen delivery (DO2) to the end-organs by optimizing hemodynamic variables

Protocol-based	Hemodynamic management protocols help titrate fluids, vasopressors, or inotropes to target values
Individualized	PGDT allows individualized hemodynamic optimization
Perioperative	PGDT optimizes fluid therapy across a continuum of care that may begin during the intraoperative period and proceed postoperatively



- Note: Fluid restriction is <u>not</u> at odds with PGDT. Clinicians can restrict fluids by limiting the background fluid administration and using flow- and/or oxygen delivery-based data to determine the safe limits of fluid restriction.[1]

1. Fergerson, B., et al. Goal-Directed Therapy in Cardiac Surgery: Are We There Yet? Journal of Cardiothoracic and Vascular Anesthesia, 2013.

Clinical evidence supports PGDT

Applying PGDT protocols to **optimize flow** *and* **oxygen delivery**

can **improve outcomes**

in critically ill patients and patients undergoing major surgery.[10]

May reduce morbidity

23–56%[1-7]

May reduce hospital LOS

1–2 days[5,6]

May reduce cost per patient

$569-3,315[8,9]

1. Hamilton, et al. A systematic review and meta-analysis on the use of preemptive hemodynamic intervention to improve postoperative outcomes in moderate and high-risk surgical patients. Anesth Analg 2011
2. Brienza, et al. Does perioperative hemodynamic optimization protect renal function in surgical patients? A meta-analytic study. Crit Care 2009
3. Dalfino, et al. Haemodynamic goal-directed therapy and postoperative infections: earlier is better a systematic review and meta-analysis. Crit Care 2011
4. Giglio, et al. Goal-directed haemodynamic therapy and gastrointestinal complications in major surgery: a meta-analysis of randomized controlled trials. BJA 2009
5. Grocott, et al. Perioperative increase in global blood flow to explicit defined goals and outcomes after surgery: a Cochrane Systematic Review. BJA 2013
6. Corcoran et al. Perioperative Fluid Management Strategies in Major Surgery: A Stratified Meta-Analysis. Anesth Analg 2012
7. Pearse et al. Effect of a Perioperative, Cardiac Output-Guided Hemodynamic Therapy Algorithm on Outcomes Following Major Gastrointestinal Surgery: A Randomized Clinical Trial and Systemic Review. JAMA, 2014
8. Manecke, et al. Tackling the economic burden of postsurgical complications: would perioperative goal-directed fluid therapy help? Crit Care 2014
9. Biais, et al. Real-life Implementation of Perioperative Hemodynamic Optimization. Annual Update Intensive Care Emerg Med 2014
10. Fergerson, B., et al. Goal-Directed Therapy in Cardiac Surgery: Are We There Yet? Journal of Cardiothoracic and Vascular Anesthesia, 2013.

Clinical evidence supports PGDT

Implementation of **PGDT** *may improve patient outcomes*

Outcome	OR (95% CI)	NNT
Arrhythmia	0.70 (0.55 to 0.91)	34
Pneumonia	0.69 (0.51 to 0.92)	38
Respiratory failure or prolonged need for mechanical ventilation	0.54 (0.35 to 0.84)	26
Wound infection	0.48 (0.37 to 0.63)	19
Intra-abdominal infection	0.65 (0.45 to 0.93)	35
Sepsis	0.55 (0.33 to 0.91)	43
Nausea/vomiting	0.36 (0.24 to 0.52)	7
AKI	0.73 (0.58 to 0.92)	29
Mortality	0.66 (0.50 to 0.87)	59

1. Chong, M., et al. Does goal-directed haemodynamic and fluid therapy improve peri-operative outcomes? A systematic review and meta-analysis. Eur J Anaesthesiol, 2018. (Analysis includes 95 randomized trials (11,659 adult surgery patients). Data are from "modern" PGDT analysis.)

Clinical evidence supports PGDT

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AKI		
Mortality		

1 in 5

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- Arrhythmia
- Volume overload

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2. Iribarne A, Chang H, Alexander J, et al. Readmissions After Cardiac Surgery: Experience of the National Institutes of Health/Canadian Institutes of Health research Cardiothoracic Surgical Trials Network. 2014;98:1274-80. (Study looked at all cause readmissions within 65 days after the operation.)

The evidence for PGDT in cardiac surgery is growing

Results of 12 studies and 3 meta-analyses in ***cardiac surgery***

are consistent with the larger body of evidence supporting PGDT in other surgical procedures

Can reduce morbidity

60%-70%[1,3]

Can reduce hospital LOS

1-5 days[1,2,3]

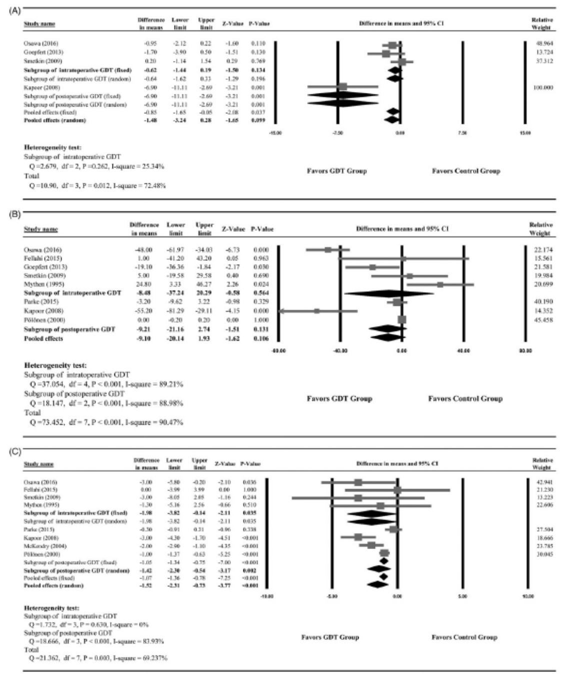
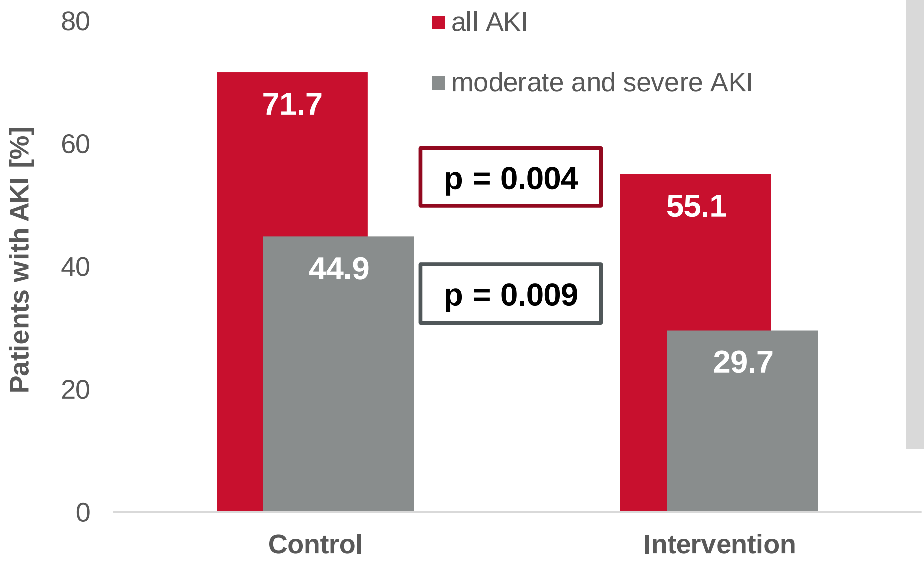


Figure 4. Meta-analysis for secondary outcomes: (A) duration of mechanical ventilation, (B) length of ICU stay, and (C) length of hospital stay.

1. Aya HD, Cecconi M, Rhodes A. Goal-directed therapy in cardiac surgery: a systematic review and meta-analysis BJA. 2013.
2. Li, Peng, et al. Significance of perioperative goal-directed hemodynamic approach in preventing postoperative complications in patients after cardiac surgery: a meta-analysis and systematic review. Annals of Medicine, 2017.
3. Osawa, E., et al. Effect of Perioperative Goal-Directed Hemodynamic Resuscitation Therapy on Outcomes Following Cardiac Surgery: A Randomized Clinical Trial and Systematic Review. Critical Care Medicine, 2016.

PGDT can reduce AKI in cardiac surgery

- Postoperative acute kidney injury in high risk cardiac surgery patients was significantly reduced by perioperative hemodynamic optimization[1]



*An implementation of the KDIGO guidelines compared with standard care **reduced** the frequency and severity of **AKI** after cardiac surgery in high risk patients*

[55.1% vs. 71.7%; ARR 16.6%]

Reduce AKI
approximately
23%

1. Meersch, M., et al. Prevention of cardiac surgery-associated AKI by implementing the KDIGO guidelines in high risk patients identified by biomarkers: the PrevAKI randomized controlled trial. Intensive Care Med, 2017.

The economic benefits of PGDT can outweigh the cost

AKI can occur in up to

40% of major cardiac surgery patients[1]

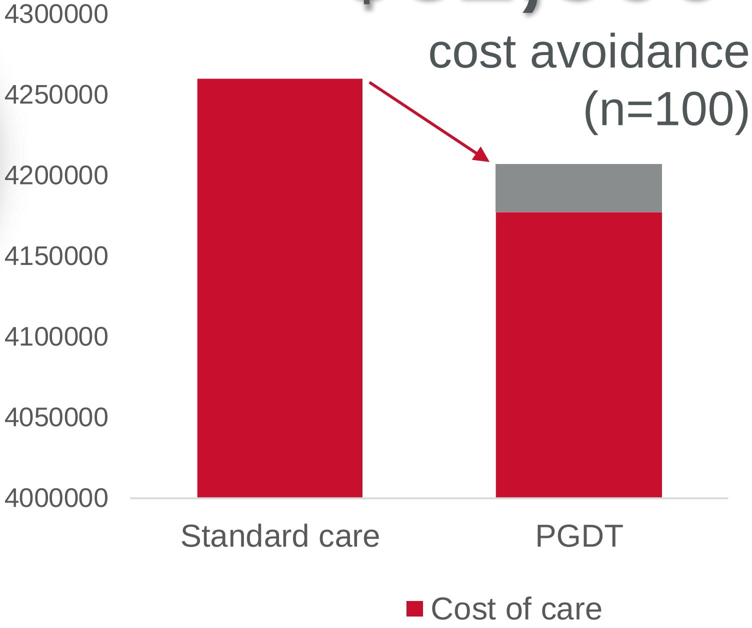
Reduce AKI approximately **23%**

$36,000

estimated **increase in cost** due to AKI after cardiac surgery[2]

$52,800[1,2]

cost avoidance (n=100)



1. Alshaikh, H., et al. Financial Impact of Acute Kidney Injury After Cardiac Operations in the United States. Ann Thorac Surg 2018.
2. Meersch, M., et al. Prevention of cardiac surgery-associated AKI by implementing the KDIGO guidelines in high risk patients identified by biomarkers: the PrevAKI randomized controlled trial. Intensive Care Med, 2017.

PGDT is recommended for cardiac surgery

Enhanced Recovery After Surgery (ERAS): An Expert Consensus Statement in Cardiac Surgery

ERAS® Cardiac Surgery

Enhanced Recovery After Cardiac Surgery Society

*Class I recommendation for Cardiac Surgery: "***Goal-directed therapy should be performed to reduce postoperative complications***."*
ERAS – Cardiac Surgery

SPECIAL REPORT

American Heart Association | American Stroke Association

Cardiac and Vascular Surgery–Associated Acute Kidney Injury: The 20th International Consensus Conference of the ADQI (Acute Disease Quality Initiative) Group

Mitra K. Nadim, MD; Lui G. Forni, BSc, PhD, MBBS, MRCPI, AFICM; Azra Bihorac, MD, MS; Charles Hobson, MD, MHA; Jay L. Koyner, MD; Andrew Shaw, MB; George J. Arnaoutakis, MD; Xiaoqiang Ding, MD; Daniel T. Engelman, MD; Hrvoje Gasparovic, MD, PhD, FETCS; Vladimir Gasparovic, MD; Charles A. Herzog, MD, FAHA; Kianoush Kashani, MD, MSc; Nevin Katz, MD; Kathleen D. Liu, MD, PhD, MAS; Ravindra L. Mehta, MD; Marlies Ostermann, MD; Neesh Pannu, MD; Peter Pickkers, MD, PhD; Susanna Price, MB, PhD, FFICM; Zaccaria Ricci, MD; Jeffrey B. Rich, MD; Lokeswara R. Sajja, MD, MS, MCh; Fred A. Weaver, MD, MMM; Alexander Zarbock, MD; Claudio Ronco, MD; John A. Kellum, MD, MCCM

"**Advanced hemodynamic monitoring of cardiovascular function is recommended** *for progressive or severe AKI or hemodynamically unstable patients*"
Acute Disease Quality Initiative Group

http://www.kidney-international.org

contents

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VOL 2 | SUPPLEMENT 1 | MARCH 2012

kidney INTERNATIONAL

KDIGO — KIDNEY DISEASE IMPROVING GLOBAL OUTCOMES

KDIGO Clinical Practice Guideline for Acute Kidney Injury

"We suggest using **protocol-based management of hemodynamic and oxygenation parameters to prevent development or worsening of AKI** *in high-risk patients in the perioperative setting or in patients with septic shock."*
KDIGO Clinical Practice Guidelines

1. Engelman, et al. Enhanced Recovery After Surgery (ERAS): An Expert Consensus Statement in Cardiac Surgery. Enhanced Recovery After Surgery – Cardiac Surgery, 2018.
2. Nadim, M., et al. Cardiac and Vascular Surgery–Associated Acute Kidney Injury: The 20th International Consensus Conference of the ADQI (Acute Disease Quality Initiative) Group. JAHA, 2018.
3. Kidney International. KDIGO Clinical Practice Guideline for Acute Kidney Injury. Vol 2, Supplement 1, March 2012.

PGDT may add value in cardiac surgery

You can
reduce complications
and **enhance recovery**
with process improvement

Evidence-based

Standardizes care

Improves outcomes

1. Aya HD, Cecconi M, Rhodes A. Goal-directed therapy in cardiac surgery: a systematic review and meta-analysis BJA. 2013.
2. Li, Peng, et al. Significance of perioperative goal-directed hemodynamic approach in preventing postoperative complications in patients after cardiac surgery: a meta-analysis and systematic review. Annals of Medicine, 2017.
3. Osawa, E., et al. Effect of Perioperative Goal-Directed Hemodynamic Resuscitation Therapy on Outcomes Following Cardiac Surgery: A Randomized Clinical Trial and Systematic Review. Critical Care Medicine, 2016.
4. Hamilton, et al. A systematic review and meta-analysis on the use of preemptive hemodynamic intervention to improve postoperative outcomes in moderate and high-risk surgical patients. *Anesth Analg* 2011
5. Grocott, et al. Perioperative increase in global blood flow to explicit defined goals and outcomes after surgery: a Cochrane Systematic Review. *BJA* 2013
6. Lilot, et al. Variability in practice and factors predictive of total crystalloid administration during abdominal surgery: retrospective two-center analysis. *BJA* 2015

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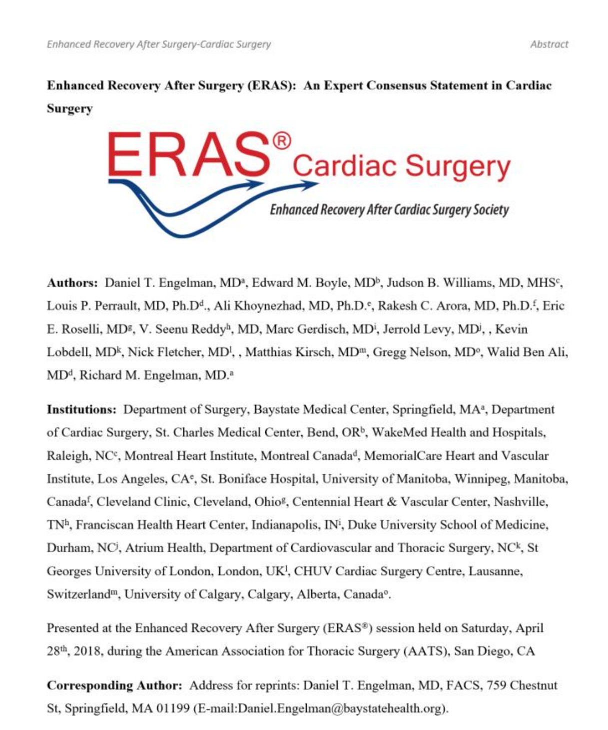
Appendix

ERAS Cardiac Surgery guidelines

Sample PGDT protocols

ERAS in Cardiac Surgery: 2018 formal recommendations



Enhanced Recovery After Surgery-Cardiac Surgery Abstract

Enhanced Recovery After Surgery (ERAS): An Expert Consensus Statement in Cardiac Surgery

Authors: Daniel T. Engelman, MD[a], Edward M. Boyle, MD[b], Judson B. Williams, MD, MHS[c], Louis P. Perrault, MD, Ph.D[d]., Ali Khoynezhad, MD, Ph.D.[e], Rakesh C. Arora, MD, Ph.D.[f], Eric E. Roselli, MD[g], V. Seenu Reddy[h], MD, Marc Gerdisch, MD[i], Jerrold Levy, MD[j], , Kevin Lobdell, MD[k], Nick Fletcher, MD[l], , Matthias Kirsch, MD[m], Gregg Nelson, MD[o], Walid Ben Ali, MD[d], Richard M. Engelman, MD.[a]

Institutions: Department of Surgery, Baystate Medical Center, Springfield, MA[a], Department of Cardiac Surgery, St. Charles Medical Center, Bend, OR[b], WakeMed Health and Hospitals, Raleigh, NC[c], Montreal Heart Institute, Montreal Canada[d], MemorialCare Heart and Vascular Institute, Los Angeles, CA[e], St. Boniface Hospital, University of Manitoba, Winnipeg, Manitoba, Canada[f], Cleveland Clinic, Cleveland, Ohio[g], Centennial Heart & Vascular Center, Nashville, TN[h], Franciscan Health Heart Center, Indianapolis, IN[i], Duke University School of Medicine, Durham, NC[j], Atrium Health, Department of Cardiovascular and Thoracic Surgery, NC[k], St Georges University of London, London, UK[l], CHUV Cardiac Surgery Centre, Lausanne, Switzerland[m], University of Calgary, Calgary, Alberta, Canada[o].

Presented at the Enhanced Recovery After Surgery (ERAS®) session held on Saturday, April 28th, 2018, during the American Association for Thoracic Surgery (AATS), San Diego, CA

Corresponding Author: Address for reprints: Daniel T. Engelman, MD, FACS, 759 Chestnut St, Springfield, MA 01199 (E-mail:Daniel.Engelman@baystatehealth.org).

Class I Recommendations:*

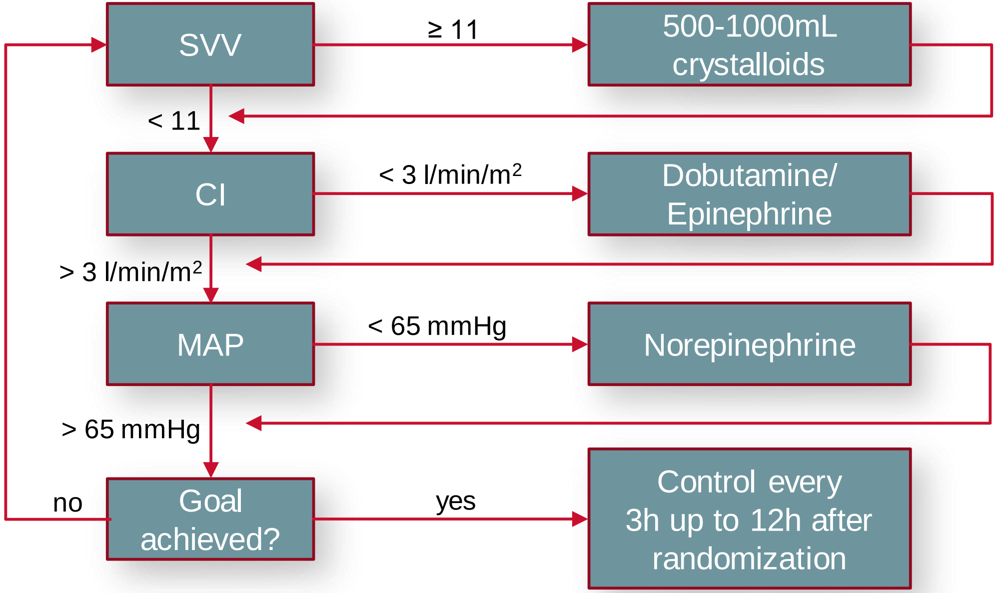
- Blood loss reduction agents
- Glycemic control
- Measures to reduce SSI
- **Goal-directed fluid therapy**
- Multimodal, opioid-sparing pain management
- Avoid hypo- & hyperthermia
- Maintain chest tube patency
- Post-op delirium screening & ICU liberation bundle
- Pre-op alcohol & smoking screen

*Class I = "Strong" recommendation

1. Engelman, et al. Enhanced Recovery After Surgery (ERAS): An Expert Consensus Statement in Cardiac Surgery. Enhanced Recovery After Surgery – Cardiac Surgery, 2018.

Example PGDT protocol

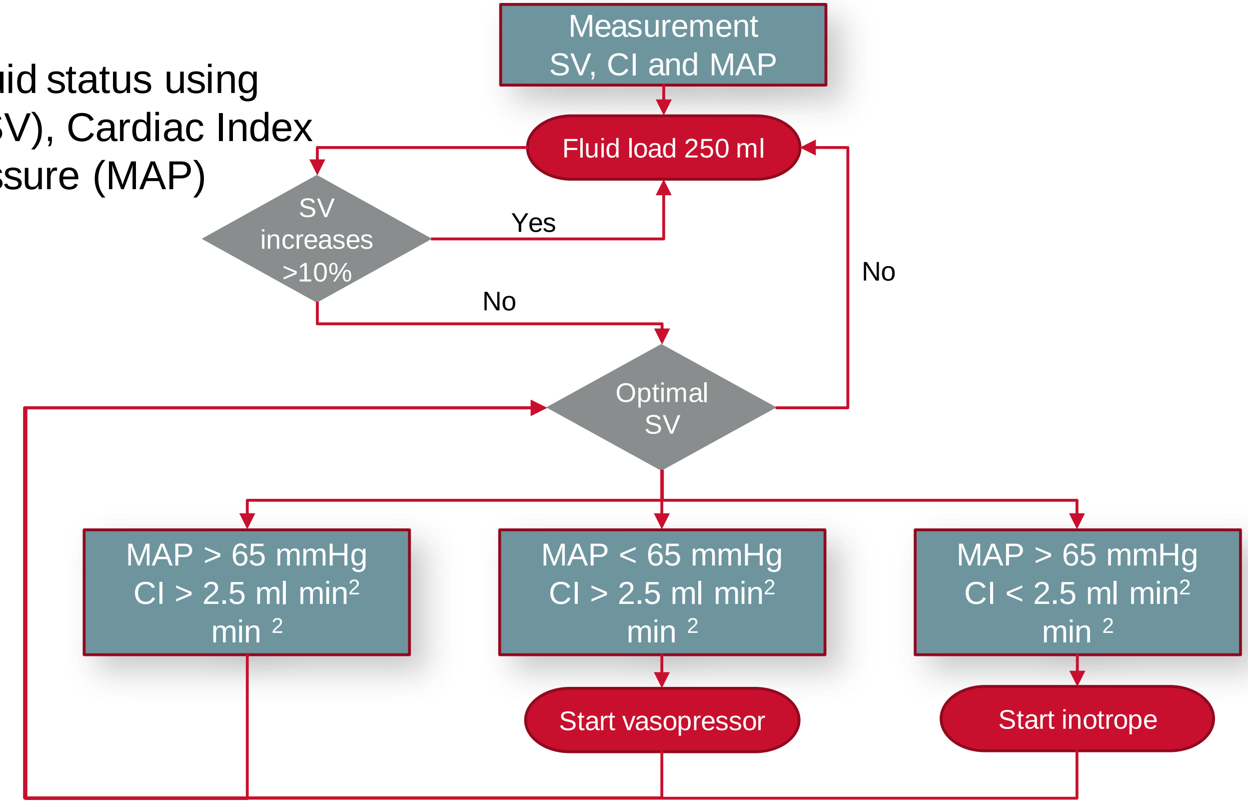
Goal: Maintain adequate fluid status using Strove Volume Variation (SVV), Cardiac Index (CI), and Mean Arterial Pressure (MAP)



1. Meersch, M., et al. Prevention of cardiac surgery-associated AKI by implementing the KDIGO guidelines in high risk patients identified by biomarkers: the PrevAKI randomized controlled trial. Intensive Care Med, 2017. Single-center trial at Department of Anesthesiology, Intensive Care and Pain Medicine University, Hospital Münster, Münster, Germany.

Example PGDT protocol

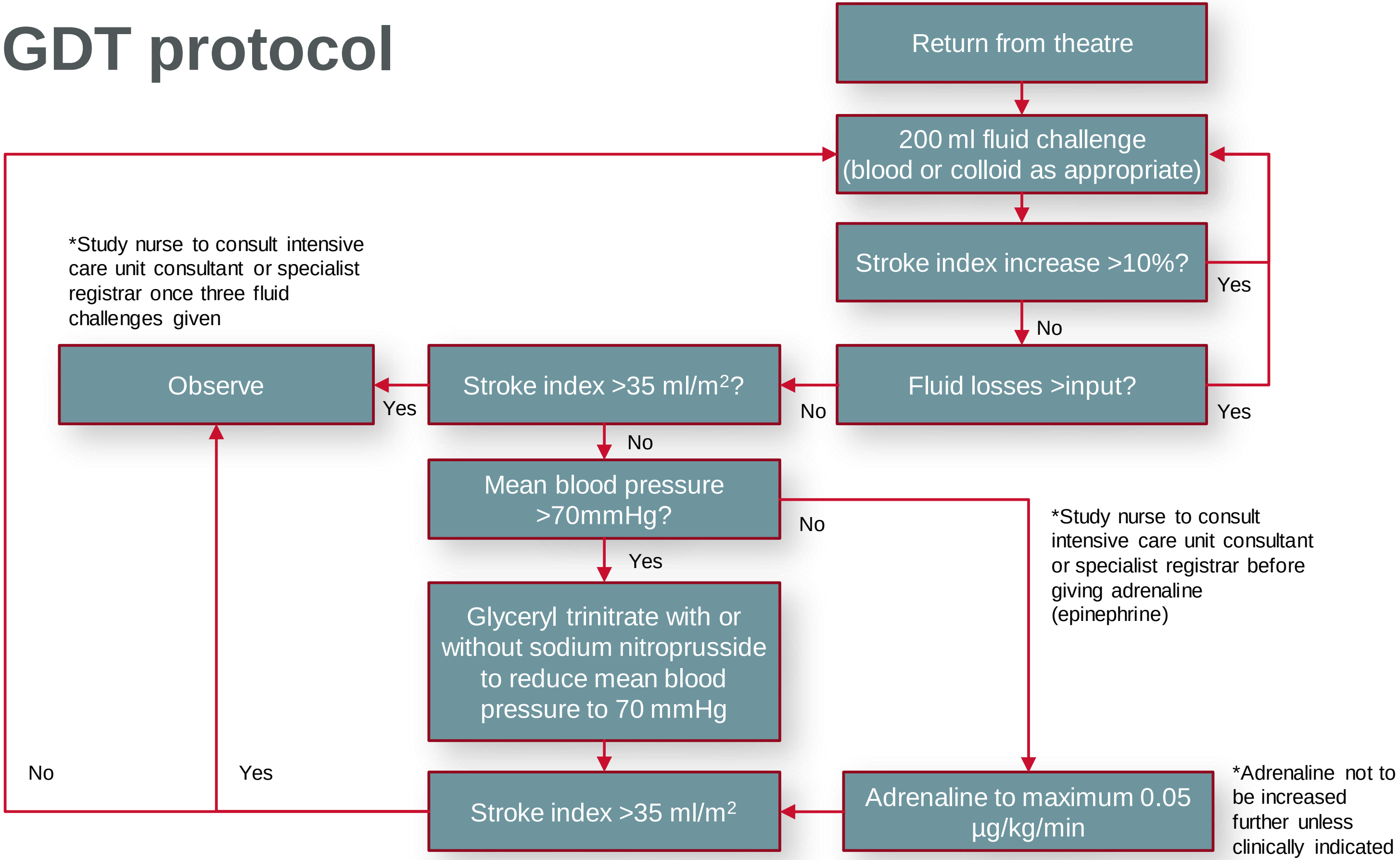
Goal: Maintain adequate fluid status using change in Stroke Volume (SV), Cardiac Index (CI), and Mean Arterial Pressure (MAP)



1. Calvo-Vecino, J. M., et al. Effect of goal-directed haemodynamic therapy on postoperative complications in low-moderate risk surgical patients: a multicentre randomized controlled trial (FEDORA trial). BJA, 2018. Multi-center randomized controlled trial at Hospital Universitario Infanta Leonor, Madrid; Hospital Universitario Ramon y Cajal, Madrid; Hospital Clı´nico Universitario Lozano Blesa, Zaragoza; Hospital de Vinalopo, Alicante; and Hospital de Torrevieja, Alicante.

Example PGDT protocol

Goal: Maintain adequate fluid status using Stroke Volume Index (SVI) and Mean Arterial Pressure (MAP)



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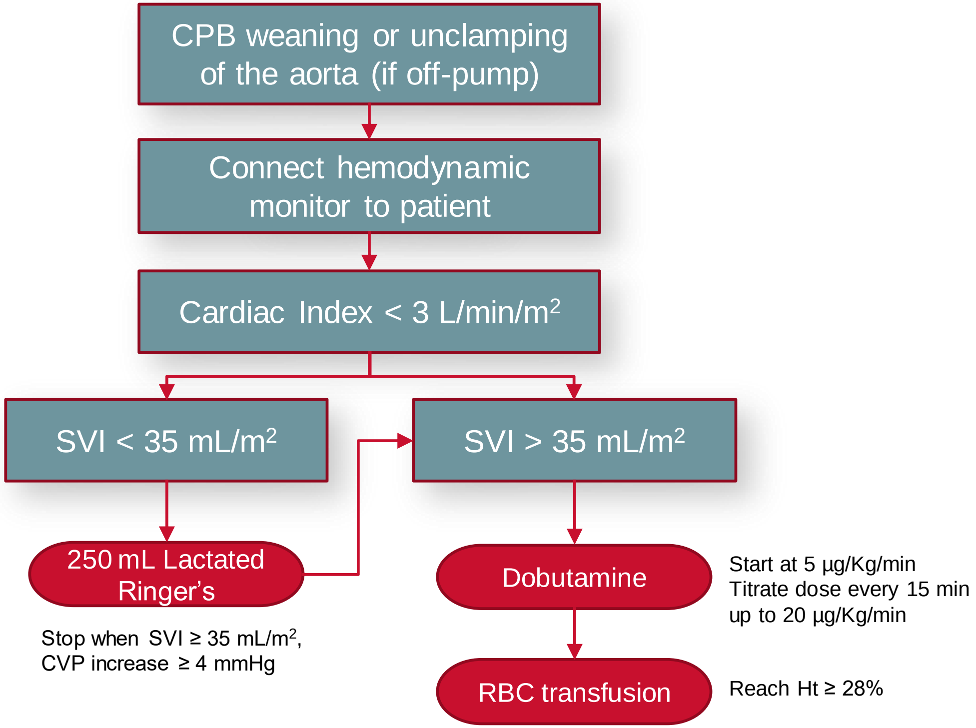
Example PGDT protocol

Goal: Maintain adequate fluid status using Cardiac Index (CI) and Stroke Volume Index (SVI)



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