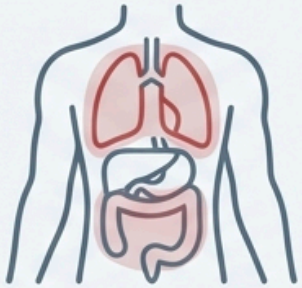
The Damage Control Paradigm: Integrating Resuscitation and Surgery for the Critically Injured Patient

A review of the principles, evolution, and application of a life-saving strategy.

The Modern Trauma Challenge: Patients Arriving on the Brink

"Over the last two decades, public health measures and better pre-hospital care have led to an increasing number of seriously injured patients surviving their initial accident and arriving in hospital."

These patients present with a unique combination of extreme injuries that traditional, linear approaches cannot manage effectively:

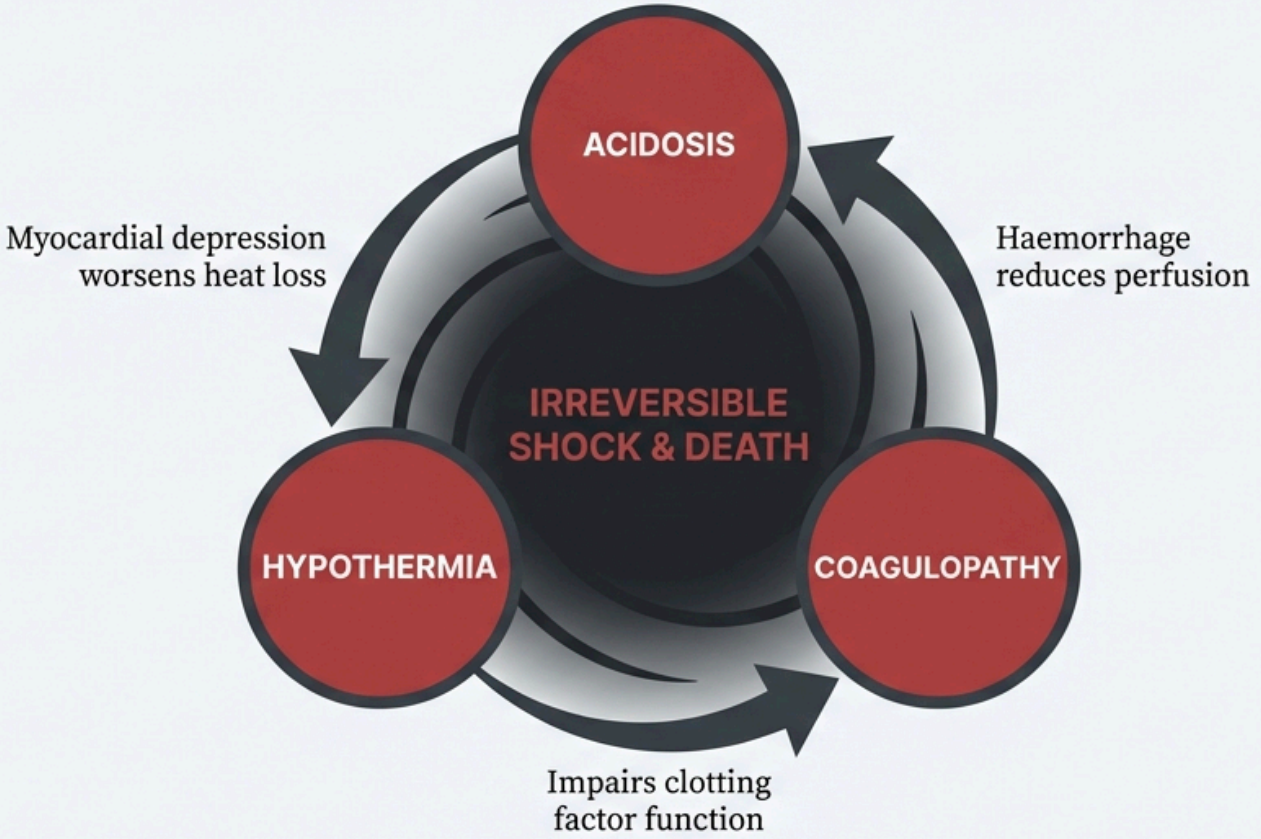


Injuries to multiple body cavities

Massive, uncontrolled haemorrhage

Near-exhausted physiological reserve

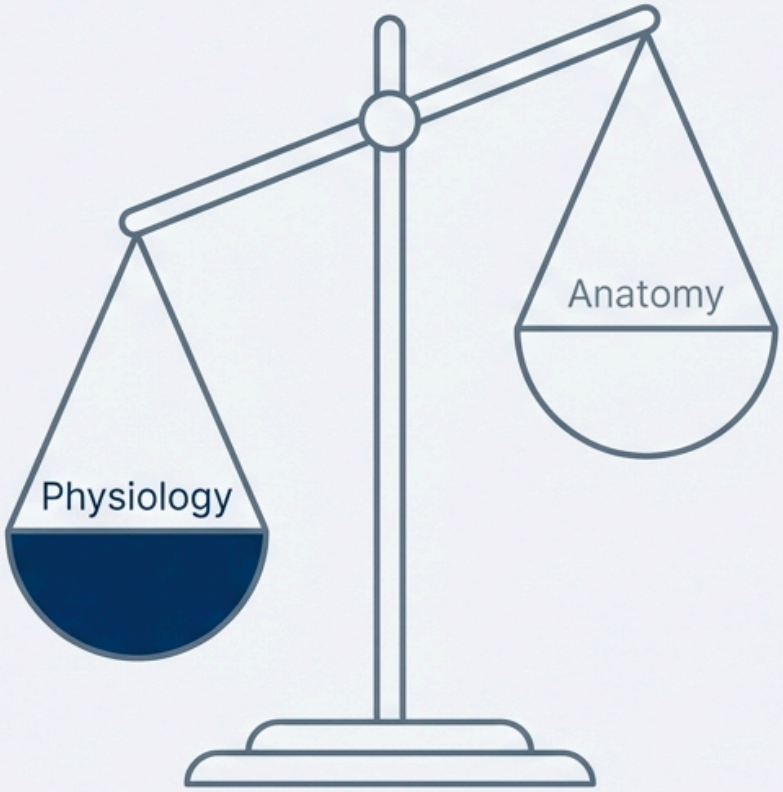
The Vicious Cycle: The Lethal Triad



A combination of acidosis, hypothermia, and coagulopathy precludes definitive surgical repair and, if unchecked, leads to irreversible physiological collapse.

A New Philosophy: Prioritize Physiology Over Anatomy

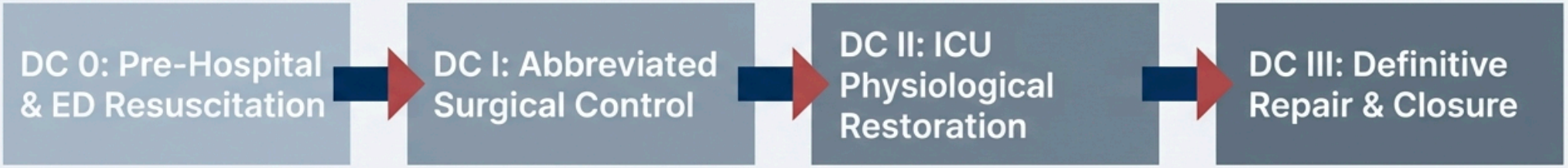
The Damage Control strategy is one of temporization. It intentionally delays
It intentionally delays definitive anatomical reconstruction to first restore the patient's physiological stability and break the lethal triad.



"Damage control strategies prioritize physiological and biochemical stabilization over the full anatomical repair of all injuries."

The Integrated Damage Control Sequence

Modern Damage Control is an inseparable, four-part strategy that begins pre-hospital and continues through definitive care. It is a system, not just a single operation.



DC 0: Pre-Hospital & ED Resuscitation

Immediate hemorrhage control, transfusion, and physiological support begins before arrival and continues in the Emergency Department.

DC I: Abbreviated Surgical Control

Rapid surgical intervention focused solely on controlling bleeding and contamination in the operating room, followed by temporary closure.

DC II: ICU Physiological Restoration

Critical care management in the Intensive Care Unit to correct acidosis, hypothermia, and coagulopathy, and stabilize physiology.

DC III: Definitive Repair & Closure

Return to the operating room for definitive reconstruction of injuries and formal closure once physiological stability is achieved.

> "It is inconceivable that DCS should be practiced separately from DCR; the two strategies are integral to each other."

Phase 0: Pre-Hospital & Emergency Department Control

DC 0: Pre-Hospital & ED Resuscitation → DC I: Abbreviated Surgical Control → DC II: ICU Physiological Restoration → DC III: Definitive Repair & Closure

Core Objective: Injury pattern recognition and abbreviated resuscitation to move the patient to definitive haemorrhage control as quickly as possible.

Key Pre-Hospital Actions

- Truncated scene times ('scoop and run' vs. 'stay and play')

- Early administration of blood products and tranexamic acid (TXA)

- Bypass protocols to Major Trauma Centres

Key Emergency Department Actions

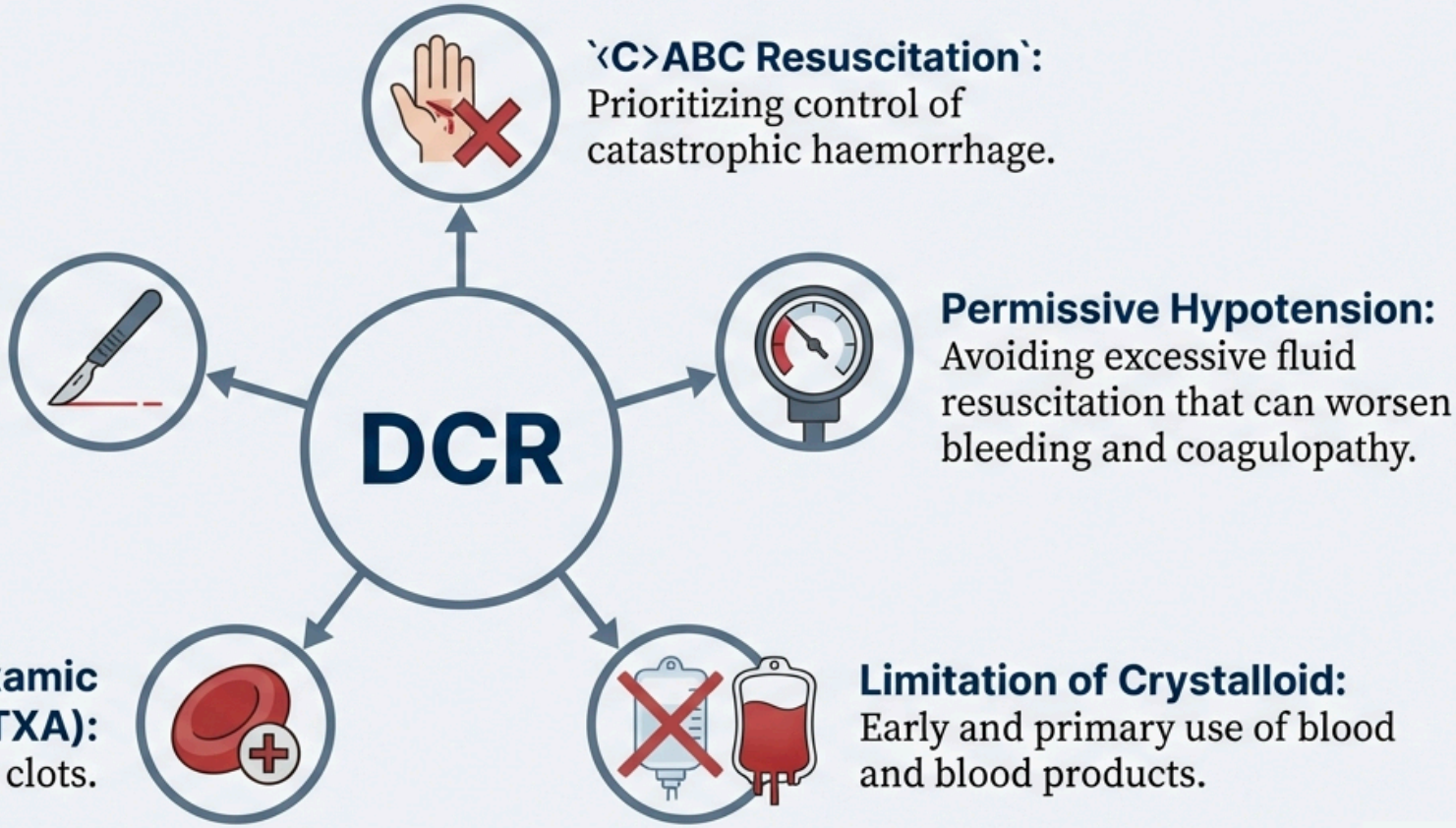
- Rapid Sequence Induction (RSI)
- Aggressive prevention of hypothermia

- Continuation of Damage Control Resuscitation (DCR)

- Expedient transport to the operating theatre

The Modern Engine: Damage Control Resuscitation (DCR)

DCR is a proactive strategy to directly address the Lethal Triad, with origins in recent military conflicts. It focuses on preventing coagulopathy and physiological collapse, rather than simply replacing volume.



`<C>ABC Resuscitation`:
Prioritizing control of catastrophic haemorrhage.

Damage Control Surgery (DC I):
The surgical component to achieve definitive haemorrhage control.

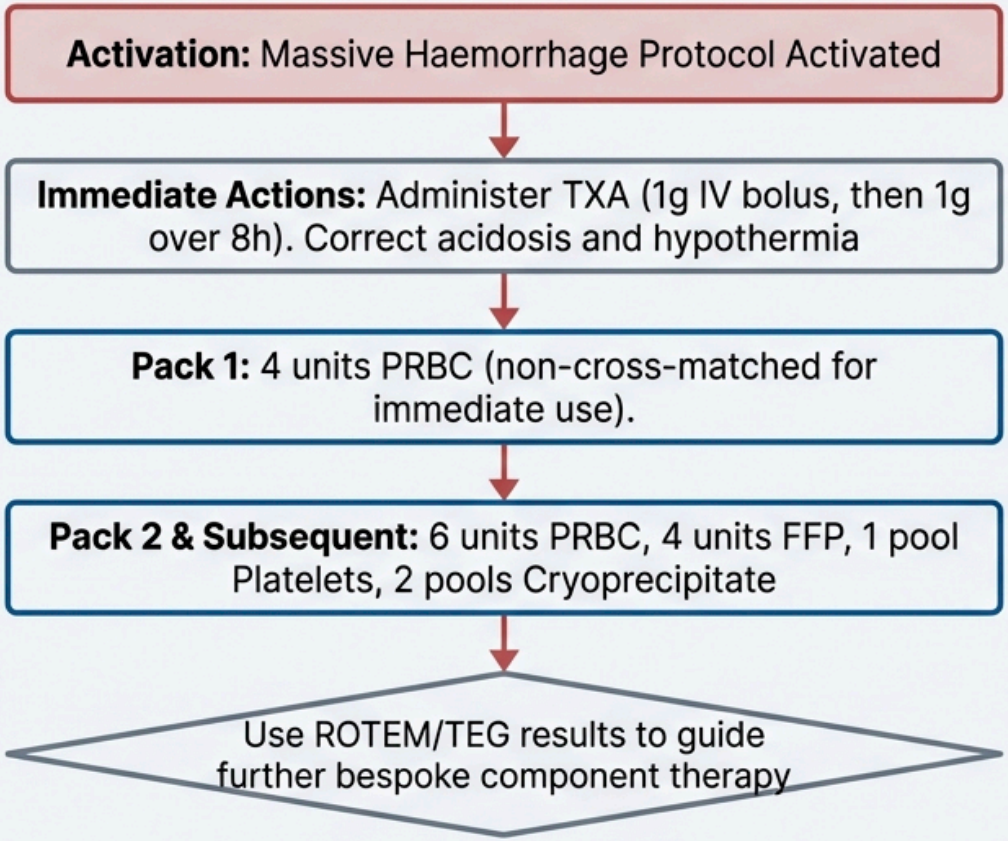
Permissive Hypotension:
Avoiding excessive fluid resuscitation that can worsen bleeding and coagulopathy.

Early Use of Tranexamic Acid (TXA):
To stabilize clots.

Limitation of Crystalloid:
Early and primary use of blood and blood products.

Executing DCR: The Massive Transfusion Protocol

Protocolized administration of blood products reduces mortality and morbidity. Major trauma centres use these protocols to prevent delays and ensure balanced resuscitation.



Key Transfusion Targets
Hb: 70–90 g/L
Platelets: >75 × 10^9/L
PT/PTT: <1.5 × normal
Fibrinogen: >1.5–2.0 g/L

Phase I: The Abbreviated Laparotomy

DC I: Abbreviated Surgical Control → DC II: ICU Resuscitation → DC III: Planned Re-operation

Core Objectives

- ✓ **Control Haemorrhage:** Using the most expedient means possible (packing, aortic occlusion, shunts, ligation).
- ✓ **Limit Contamination:** Simple suture or stapled resection of bowel injuries; drainage of pancreatic/biliary injuries. No complex reconstructions.
- ✓ **Temporary Abdominal Closure:** Using devices like a Bogota bag or negative pressure therapy to prevent abdominal compartment syndrome.

What This Operation Is NOT

- ✗ Definitive vascular reconstruction
- ✗ Bowel anastomosis or stoma creation
- ✗ Complex solid organ repair

Patient Selection is Critical: When to Commit to Damage Control

"Excessively liberal use of DCS may condemn patients to unnecessary extra procedures... In contrast, attempts at primary definitive surgical management in patients with **severe physiological compromise** will almost **inevitably lead to poor outcome.**"

Massive Transfusion

>10 units PRBC

Severe Metabolic Acidosis

pH < 7.30

Hypothermia

Core Temp < 35°C

Coagulopathy

Visible "non-surgical" bleeding

Lactate

> 5 mmol/L

Prolonged Operative Time

> 90 minutes

The later that the decision to damage control is made, the less successful the outcome is likely to be.

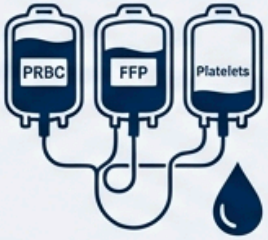
Phase II: Intensive Care Resuscitation & Restoration

DC I: Abbreviated Surgical Control → **DC II: ICU Physiological Restoration** → DC III: Planned Re-operation

Core Objective: Reverse the sequelae of metabolic failure and support physiological recovery.

Aggressive Core Rewarming

The cornerstone of reversing coagulopathy and improving perfusion.



Correction of Coagulopathy

Guided by laboratory or bedside testing (ROTEM), continue balanced component therapy.

Guided Haemodynamic Support

Using invasive monitoring to optimize oxygen delivery. Lactate clearance is a key prognostic marker.

Tertiary Survey

A complete head-to-toe examination and imaging (once stable) to identify all occult injuries.

Phase III: Planned Re-operation and Definitive Repair

DC I: Abbreviated Surgical Control → DC II: ICU Physiological Restoration → **DC III: Definitive Repair & Closure**

Timing

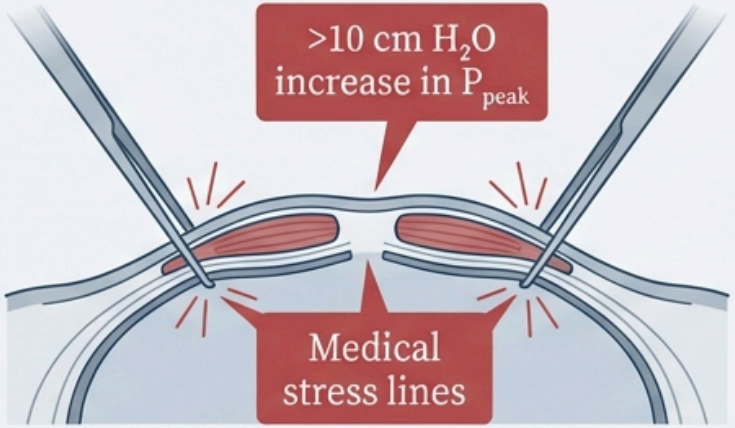
Critical and patient-dependent. Occurs once physiology has normalized (normothermic, normal coagulation, pH, and lactate), typically within 24–36 hours.

Operative Plan

1. Careful removal of abdominal packing.
2. Complete re-examination of all intra-abdominal contents.
3. Definitive vascular and intestinal repairs.
4. Attempt at formal fascial closure.

The Challenge of Closure

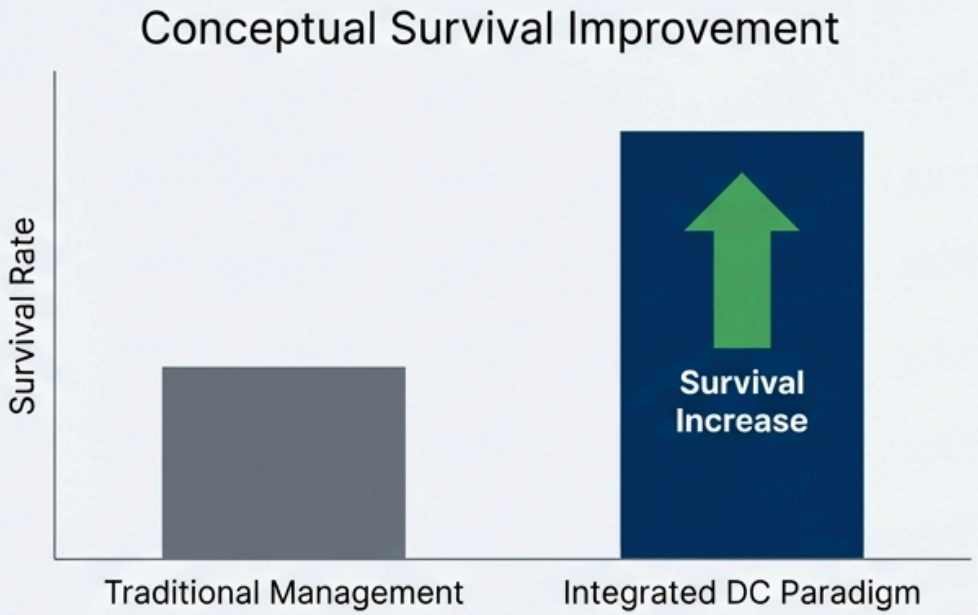
If fascial closure creates tension (e.g., peak airway pressure increases >10 cm H_2O), the fascia is left open. The patient returns to the ICU for diuresis and frequent washouts, with most abdomens closed within one week.



The Outcome: Improved Survival and a New Standard of Care

The use of DCR and DCS have been associated with improved outcomes for the severely injured.

- **The Power of DCR:** Evidence shows DCR is associated with:
  - A reduction in overall resuscitation volumes.
  - Lower incidence of organ failure and post-injury complications.
  - Improved survival in damage control laparotomy patients.



The Ultimate Benefit

DCR may allow borderline patients, who would previously have required DCS, to undergo early definitive surgery as their physiological derangement is corrected earlier.

Core Principles of the Damage Control Paradigm

1 Patient Selection is Critical

- Damage control is a powerful tool for a specific subset of trauma patients, not a universal approach.
- Rely on objective physiological derangement and injury mechanism to guide the decision.

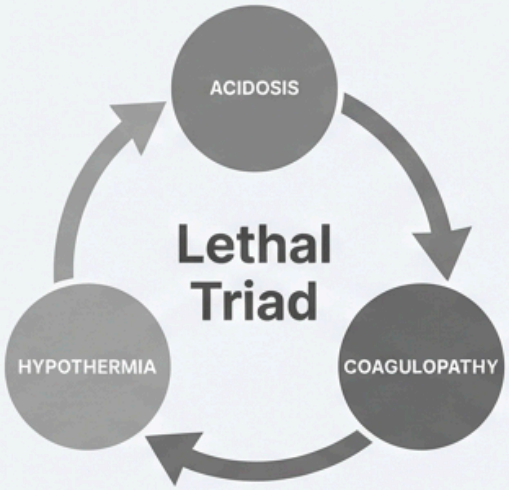
2 It is an Integrated System

- DCS and DCR are not separate concepts; they are two halves of a single, coordinated strategy.
- Success depends on seamless execution from the pre-hospital phase through to the ICU and final surgery.

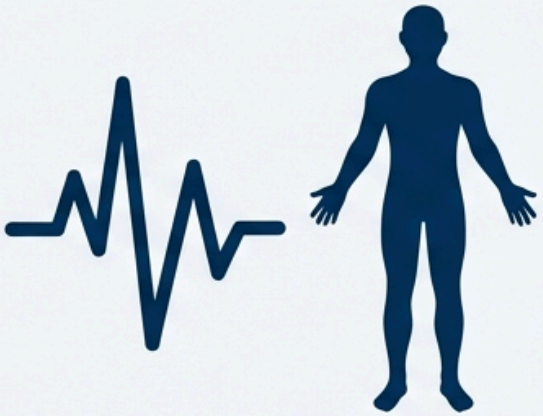
3 Physiology is the Priority

- The guiding mantra is to stabilize the patient's physiology first, even at the expense of short-term anatomical repair.
- This philosophy must inform every decision made by the entire trauma team.

Breaking the Cycle:
The Modern Damage Control Paradigm



Integrated DCS + DCR



SURVIVAL

Physiology Over Anatomy