NO-FEAR

Network Of practitioners For Emergency medicAl systems and cRitical care

WP3 Summary on Damage Control Strategies

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Table of Content

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1. Status of the document

This section contains the status of this document version 1.1 (8th June, 2022). Other versions of the document may supersede this document. Version 1.1 included reformatting and editorial changes.

2. Background

Haemorrhage is the leading cause of preventable death in trauma patient in the first 24 hours. The lethal Triade (Figure 1) is present in the most severely injured patients and is associated with poor outcomes. Its discovery promoted interest in resuscitation strategies that directly target acidosis, hypothermia and coagulopathy. Modern resuscitation after major haemorrhage, therefore, incorporates early haemorrhages control, permissive hypotension and early treatment of anticipated coagulopathy with blood products. In the light of this Damage Control Strategies, this Better Practice Guide document is aimed at limiting the physiological derangement of trauma patients.

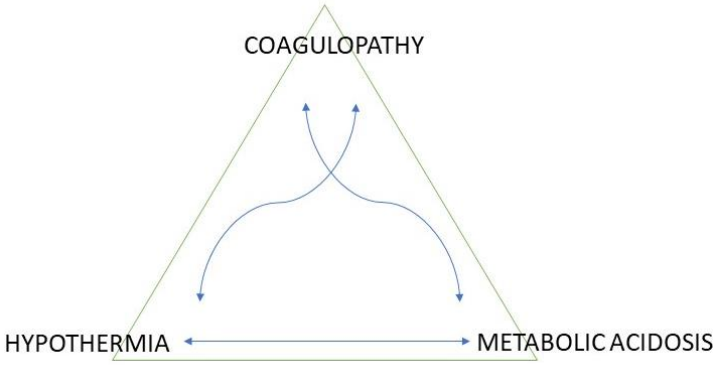

Figure 1: Lethal Triade

Damage control strategies includes:

- Damage Control Resuscitation (DCR): is a systematic approach to the management of the trauma patient with severe injuries, that starts in the emergency room, including early blood product transfusion, reduced crystalloid fluid administration and permissive hypotension in order to prevent the lethal Triade.
- Damage Control Surgery (DCS): all available techniques to obtain a rapid control of haemorrhage and contamination and temporary closure, followed by resuscitation in ICU and subsequent re-look and definitive repair once normal physiology has been restored.

Both works in synergy and in parallel. The goal is to restore normal physiology rather than normal anatomy.

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3. When DCS should be started

Damage control should be initiated in severely injured patients with multisystem trauma, but there is no absolute, evidence-based prediction models for who would benefit.

Parameters as a guideline for instituting damage control, are as follows:

- Haemodynamically Unstable Patients non-Responsive to the initial Resuscitation Procedure
- ph ≥ 7.2
- Serum Bicarbonate Level ≥ 15meq/L
- Core Temperature ≥ 34°C
- Transfusion Volume Of Packed RBCs ≥ To 4000ml
- Total Blood Replacement ≥ 5000ml
- Total Fluid Replacement ≥ 12000ml
- Coagulopathy
- Mass casualty situation.

4. Pre-hospital Damage Control Resuscitation

The Damage Control Resuscitation is based on three key points:

- Scoop and run.
- Control bleeding source: Tourniquet's, compression, Foley's catheters.
- Decrease crystalloid administration.

5. DCR in military setting

In the setting of combat or remote and resource-limited environment, several other concerns influence management decisions as such:

Combat casualty care must take into consideration pre-hospital interventions, location, triage, supply, personnel, transportation, security, and operational conditions specific to theatres of conflict. Of the 4,596 combat deaths reported in COL Brian Eastridge's 2012 review Death on the Battlefield, 976 casualties died with injuries that an expert panel classified as potentially survivable, and the vast majority of these deaths—just over 90%—were secondary to uncontrolled haemorrhage. In the light of this DCR in military setting focuses on improving methods to control severe bleeding and to provide sufficient fluids and blood products to stabilize the injured casualty in the pre-hospital setting.

6. Stages of DCS

STAGE 1: **Patient selection**:

- Hemodynamical instability and hypothermia
- Metabolic instability
- Coagulopathy
- Massive blood transfusion

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- Operating time in unstable patient aim < 60 min
- Multiple and complex injuries
- Mass casualties/multiple P1 patients
- Minimal resources.

STAGE 2: Operative haemorrhage and contamination control:

Pre-operative:

- Adequate communication with anesthesia
- Adequate communication with nursing team
- Prepare special instruments: sternotomy, thoracotomy, vascular instrument, vascular trolley, GIA or TIA staples, Harmonic or Ligasure devices
- Order blood and blood products.

Prepare theatre:

- Warm theatre
- Cell-saving devices
- Prepare hybrid theatre, if available.

Haemorrhage control:

→ 4 quadrant packing

In patient with witness arrest or pre arresting

→ Aortic cross clamping: Thoracic or abdominal hiatus

→ REBOA or trans-arterial catheterization

Arrest all venous and arterial bleeding

→ Arterial bleeding: shunted, ligated, repair

→ Venous bleeding: packing or ligation

Occlusion of inflow into bleeding organ

→ Pringle in livers

Intra-operative or post-operative catheter-directed embolization.

Control of contamination:

Multiple visceral and or vascular injuries: "clip and drop"

→ Stapler devices or simple suturing

→ Biliary and genitourinary injuries can be temporized by external drainage: T-tube or ureterostomy

Pancreatic injuries should be widely drained and packed.

Temporary abdominal closure:

→ bogotà bag

→ negative pressure therapy closure.

STAGE 3: Physiological restoration in the ICU:

- Restoration of the body temperature
- Optimization of oxygen delivery
- Correction of coagulation
- Physiologic endpoints improvement
- Early identification of complications

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- Complete secondary and tertiary survey.
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STAGE 4: Definitive surgery:

Timing:

- Injury sustained and pattern of injury
- Early (24-48 hours): vascular shunts, proximal bowel injuries
- Later (48-72 hours): packing for liver injuries once coagulopathy has settled
- Physiological stability
- Adjunctive procedure.

Re-look laparotomy:

- Planned
- On demand.

STAGE 5: Abdominal wall closure:

Delayed primary abdominal closure:

- Intra-operative findings
- High intra-abdominal pressures.

Secondary abdominal closure:

- Vacuum assisted closure: KCI-ABThera
- Skin-closure only
- Grafts using Vicryl mesh
- Biological meshes: Human (AlloDerm) or porcine (Permacol)
- Split-thickness skin grafts
- Wittmann patch: Velcro-like sheets that are pressed together to secure closure and peeled apart for abdominal re-entry
- Mesh mediated traction
- Large Hernias: component separation and flap reconstruction.

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7. Why it is important to proceed to an attempt at standardizing Damage control (damage control resuscitation and damage control surgery) strategies?

Modern damage control combines principles of Damage control surgery (DCS) and Damage control resuscitation (DCR) to achieve a management strategy in surgical patients suffering from life-threatening metabolic derangements as those present in posttraumatic and major emergency and some mass emergency patients. Even though damage control strategies were first described over 80 years ago, the acquisition of these concepts into routine emergency practice has been very slow in adoption and is still not known and practiced in many realities. Damage control approach when used correctly can improve survival in previously unsalvageable patients; when used incorrectly, it can subject patients to imprudent risk and contribute to morbidity. The impact of standardized protocols existing in the experience from the US have shown a definitive benefit for better survival and shorter hospital stay.

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About the Authors:

Doctor Pietro Fransvea, MD

	Pietro Fransvea is a Trauma and Acute Care surgeon at Fondazione Policlinico Universitario A. Gemelli IRCCS, Rome and a PhD candidate at Catholic University of Sacred Heart. Since the first years of medicine, he devoted himself to surgery and especially to acute care and trauma. He improved his knowledge and training attending the Trauma Centre of the University of Maryland and the Trauma Centre of Tygerberg Hospital in Cape Town. Over the years, he has also been interested in the management of surgical patients in the context of the mass casualties and therefore of everything related to the damage control strategy. His main research fields of interest are: trauma pathophysiology and management, acute care surgery, minimally invasive surgical and endovascular approaches, trauma system organizations and infection in surgery.

Professor Daniele Gui, MD.

	Daniele Gui has been Director of the Department of Emergency Surgery and Trauma of the Policlinico Gemelli up to 2019. He is an emergency surgeon from 1973, belongs to the ACS, AAST, and numerous other scientific societies. He is an Associate Professor of the Italian Center for Research (CNR). Independently from his academic career, he has dedicated his interest and time to European funded research in the Security Sector. From 1990, he set up a European Medical Security Group and participated as responsible to FP6/FP7/Horizon 2020 projects in crisis management, trauma and mass casualty incidents, CBRNe response, hospital organization, hospital cybersecurity issues and ethical issues. The group is composed of 10 experts.

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	Daniele Gui	UCSC	
1.1	Pietro Fransvea Rachele Brancaleoni	UCSC	8th June 2022
	Tom Flynn	TFC Research and Innovation Ltd.	

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- https://jts.amedd.army.mil/: The mission of the Joint Trauma System (JTS) is to improve trauma readiness and outcomes through evidence-driven performance improvement.

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- https://www.wses.org.uk/: The World Society of Emergency Surgery.
- https://www.estesonline.org/: European Society for Trauma and Emergency Surgery.