DAMAGE CONTROL RESUSCITATION (DCR)

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- Early Total Care
- Damage Control

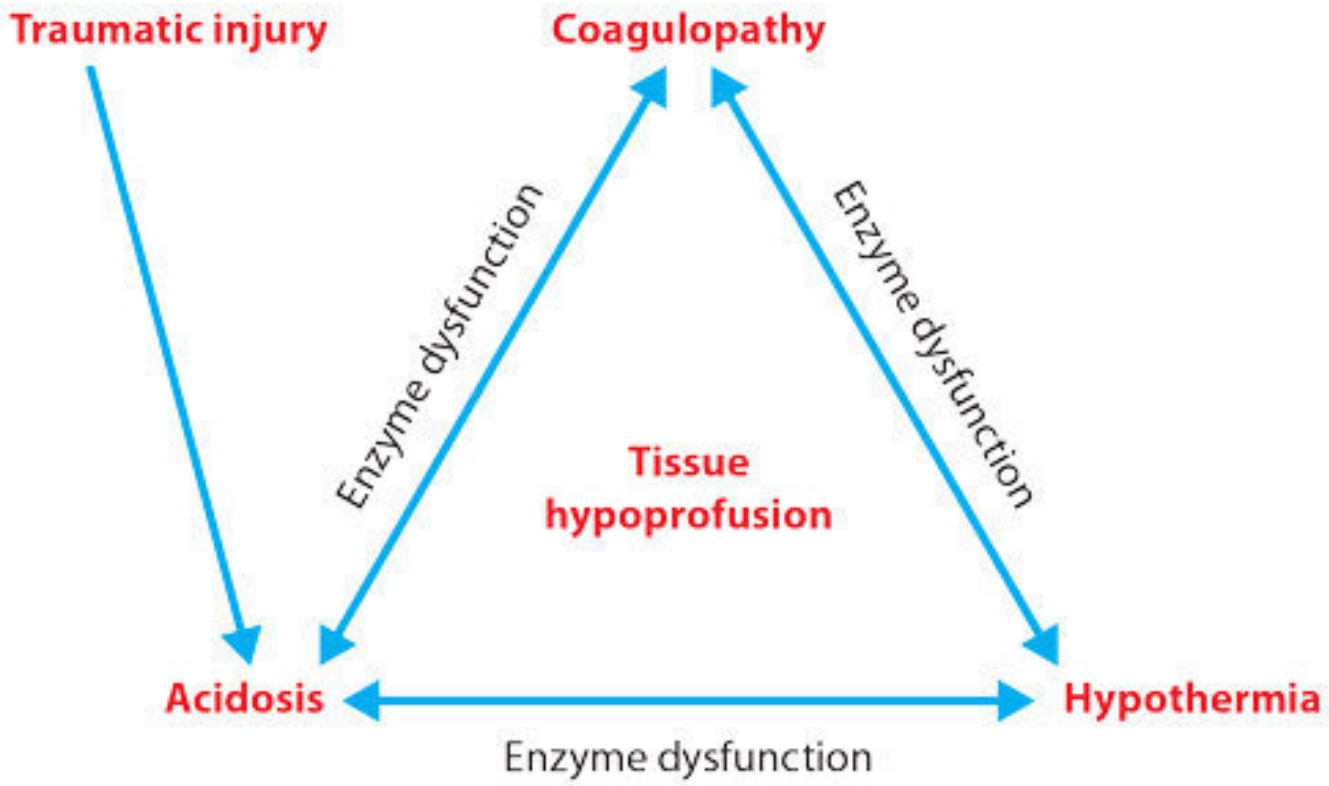
Uncorrected state of shock

- Persistent hypothermia
- Persistent metabolic acidosis
- Nonmechanical bleeding

- Counteracting the lethal triad

Lethal triad

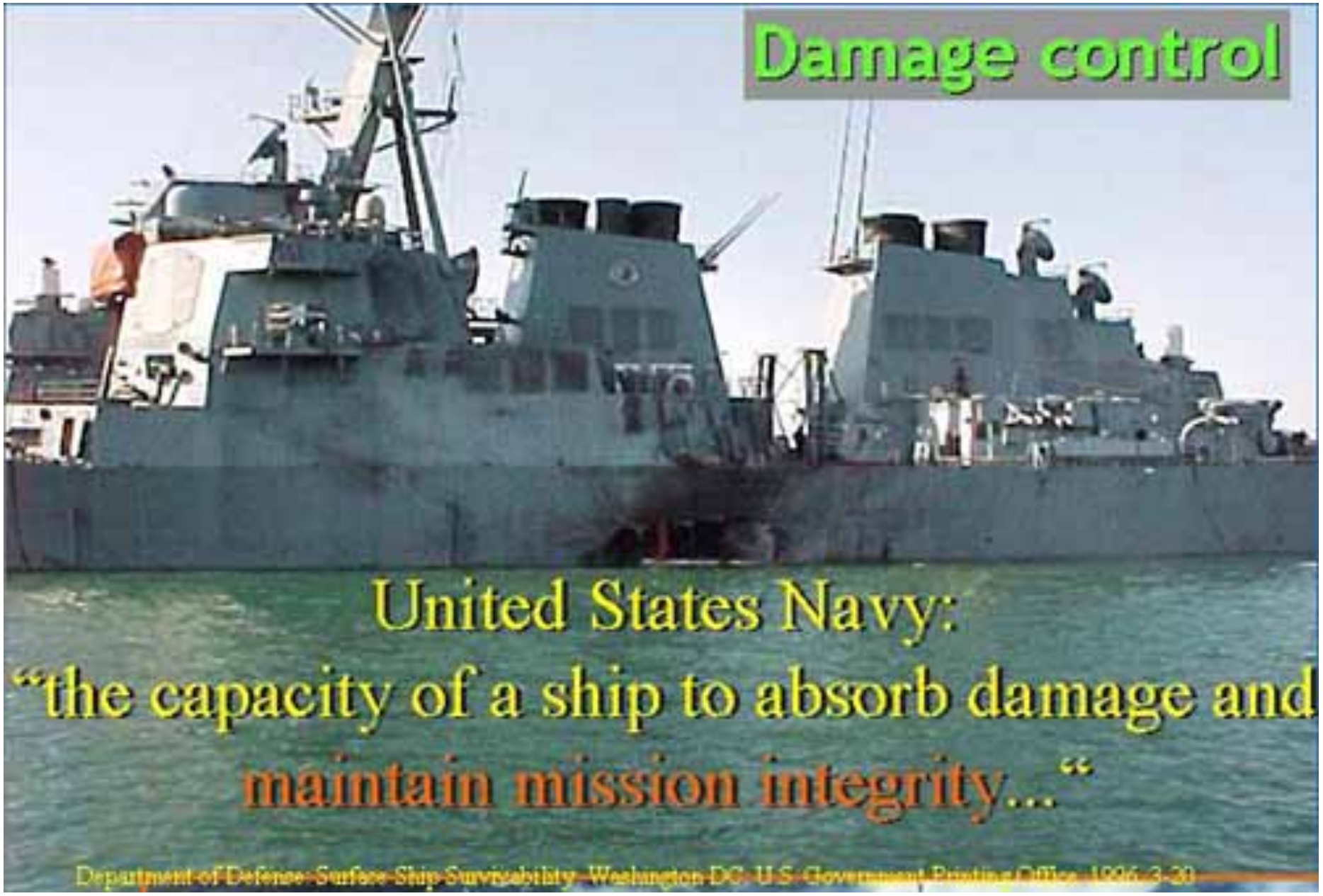
- Coagulopathy
- Hypothermia
- Acidosis

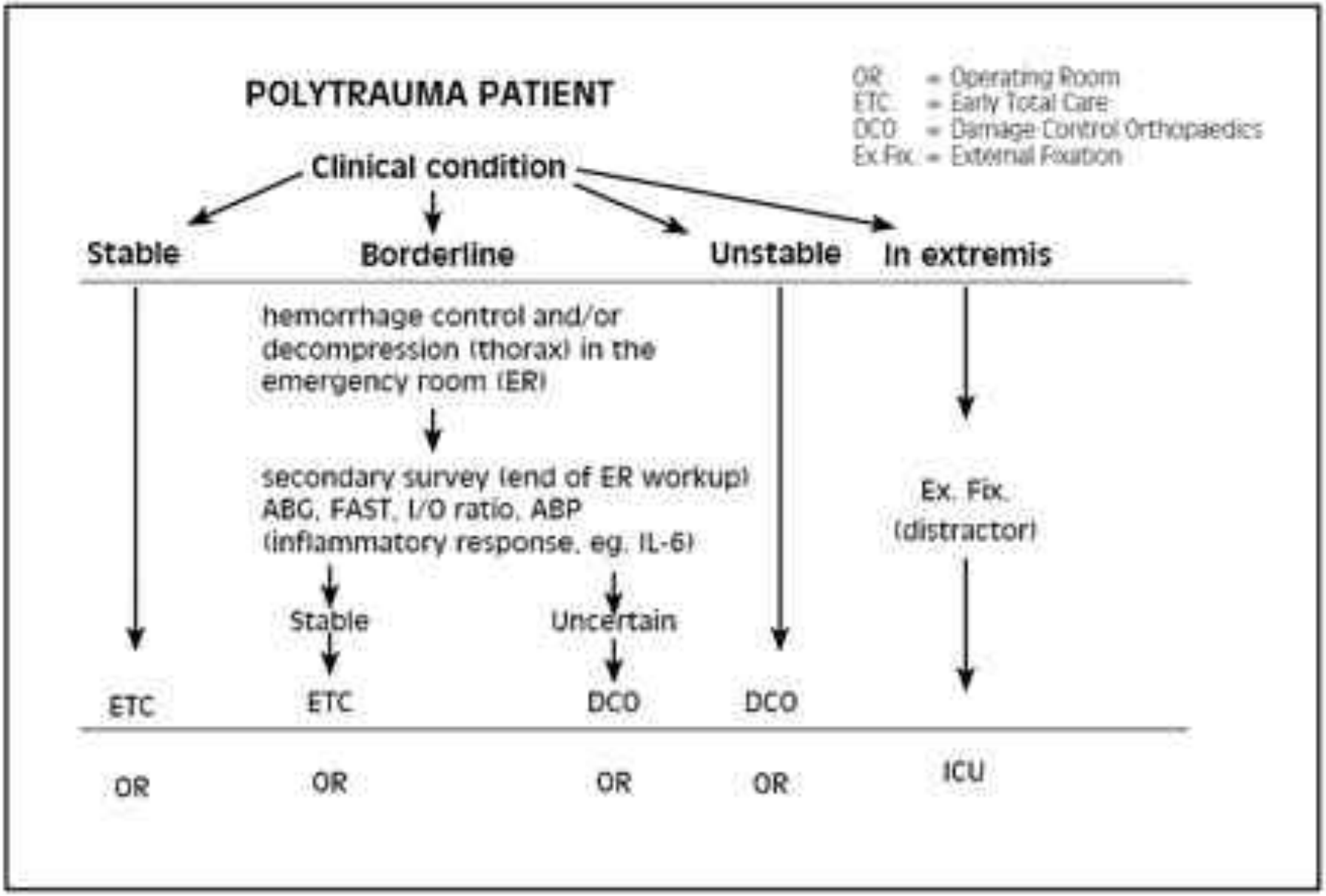


- The enzymes that dictate cellular metabolism function best at a pH of 7.4 and temperature of 37 degrees C.

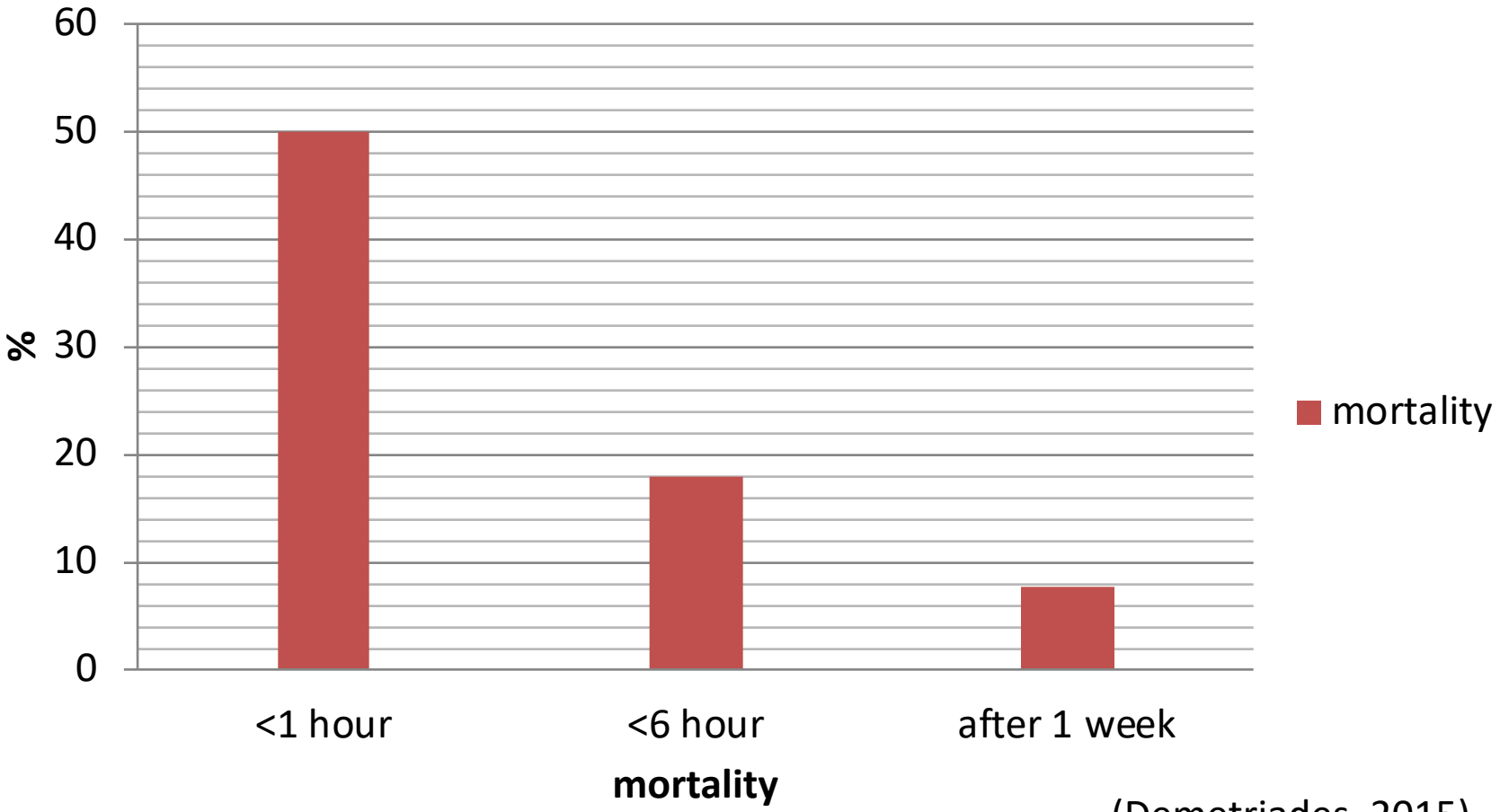
- Phosphorylation to anaerobic metabolism, lactic acid lowers the pH of the body when it exceeds the body's physiologic buffering capacity.
- Lactic acid formation is a result of tissue hypoxia

- Coagulopathy occurs when the enzymes that cause blood to clot are unable to function, or the body is out of clotting factors
- Hypothermia results when the body loses more heat to the environment


Damage control
United States Navy:
"the capacity of a ship to absorb damage and maintain mission integrity..."
Department of Defense: Surface Ship Survivability. Washington DC: U.S. Government Printing Office, 1996: 3-30


POLYTRAUMA PATIENT
OR = Operating Room
ETC = Early Total Care
DCO = Damage Control Orthopaedics
Ex.Fix. = External Fixation
Clinical condition
Stable
Borderline
Unstable
In extremis
hemorrhage control and/or
decompression (thorax) in the
emergency room (ER)
secondary survey (end of ER workup)
ABG, FAST, I/O ratio, ABP
(inflammatory response, eg. IL-6)
Stable
Uncertain
Ex. Fix.
(distractor)
ETC
ETC
DCO
DCO
OR
OR
OR
OR
ICU

Trimodal distribution of death



(Demetriades, 2015)

DCR

- systematic approach to the management of the trauma patient with severe injuries that starts in the emergency room and continues through the operating room and the intensive care unit

- to improved survival in patients with either blunt or penetrating injures who are approaching physiologic exhaustion

- Damage control resuscitation is a strategy that focuses on attempting to maintain or restore homeostasis in trauma patients.

- rapid arrest of hemorrhage, as well as ongoing resuscitation, some patients will show dramatic improvement

Basic principles DCR

- Arresting hemorrhage
- Restoring blood volume
- Correcting coagulopathy, acidosis and hypothermia.

- Transfusion of blood after primary hemorrhage is a life- saving intervention of the greatest value and enables urgent operations to be successfully performed.

Resuscitation with blood product

- Plasma was used when fresh whole blood was not available
- Plasma gives more time to get fresh whole blood into the patient
- The goal in transfusion of the patient with need for massive transfusion is to deliver a ratio of PRBCs to plasma to platelets of 1:1:1

- The goal of 1:1:1 resuscitation should be 6 units PRBCs: 6 units FFP: 1 unit apheresis platelets.

Use of Tranexamic acid (TXA)

- Antifibrinolitic, inhibiting the activation plasminogen to plasmin
- Reduced the need for transfusion
- Early treatment demonstrated lower risk of death due to bleeding

Crystalloid use in DCR

- low volume resuscitation was associated with lower RBC use, higher ICU-free days, and lower rates of sepsis than high volume resuscitation

Damage Control Resuscitation

- Most preventable trauma deaths are due to uncontrolled hemorrhage
- Strategies to prevent and/or mitigate the effects of each in the bleeding patient

DCR

- intervention that can be delivered to a critically ill patient in any location (emergency department, interventional radiology suite, operating theatre and/or ICU)

Damage control resuscitation strategies

- include body rewarming,
- restrictive fluid administration,
- permissive hypotension,
- balanced blood product administration,
- the implementation of massive transfusion protocols.

DCR

1. Rapid recognation of trauma-injuced coagulopathy and shock
2. Permisive hypotension
3. Rapid surgical control of bleeding
4. Prevention / treatment of hypothermia
5. Avoidance of hemodilution (minimizing use of crystalloid i.v fluid)

6. Transfusion of PRBCs to plasma to platelet in a 1:1:1 unit ratio

7. Early and appropriate coagulation factor concentrate

8. Fresh RBC and whole blood when available

- early blood product transfusion
- immediate arrest and/or temporization of ongoing hemorrhage
- restoration of blood volume and physiologic/hematologic stability.

- Rewarming
- Correction of coagulopathy
- Hemodynamic stabilization

Prehospital Damage Control Resuscitation

- Information must be gathered quickly and shared with the medical team
- The predominate aims of the team are to limit further blood loss
- To protect the airway and to provide adequate analgesia

- Performing temporizing measures to control bleeding
- Minimizing factors that exacerbate hemorrhage
- Shortening the time to definitive hemostasis

Physiologic parameters

- weak or absent radial pulse, core body temperature < 35 degrees C, systolic blood pressure < 100 mmHg, and heart rate > 100

- Plasma, platelets, and red cells are transfused in nearly equal proportions
- Administration of nonhemostatic crystalloid solution is minimized
- the ratio of plasma to red cells administered close to 1:1

Policy: To provide a mechanism to facilitate replacement of massive blood loss with appropriate blood and blood products within a clinically significant timeframe.

Protocol: Application of the Massive Transfusion Protocol requires a multidiscipline/multiservice practice based on clinical judgment and decision-making, clear communication patterns and strong cooperative efforts.

1. The decision to utilize the Protocol will be determined by one of the following appropriate trauma team members:
   a. Trauma/CC anesthesiologist
   b. Trauma staff attending
   c. EM staff attending
   d. Senior Trauma Resident
   e. EM 4 resident
   f. PGY 3 ED surgical resident

   NOTE: The protocol can be initiated at <u>any time</u> during the trauma patient's hospitalization, including prior to arrival to the MGH ED.

2. Appropriate candidates for this Protocol include:
   a. any patient with an initial blood loss of at least 40% of blood volume (estimated at 30 ml/kg), or in whom it is judged that at least 10 units of blood replacement is immediately required;
   b. any patient with a continuing hemorrhage of at least 250cc/hour (or 20 ml/kg/hr);
   c. any patient, when clinical judgment is made such that blood loss as identified in "A" and "B" is imminent.

3. If the protocol is initiated prior to the patient's arrival at the MGH, an 'Trauma Pack' should be utilized.

4. Once the decision is made to initiate the Massive Transfusion Policy, the appropriate physician needs to:
   a. Call Blood Bank 6-3623 or use red phone in emergency department.
   b. Provide the following information:
      (1) Patient's name
      (2) Patient's MRN
      (3) Location of patient
      (4) Products anticipated
      (5) Status of blood sample for typing
      (6) Plan for blood delivery (runner to pickup, other)
   c. Request on the telephone release of "4 units of Emergency Uncrossmatched RBCs" and send:
      (1) a Request slip with the patient's full name, MRN, location, and products requested;
      (2) a Pickup slip with the patient's full name, MRN, location, and products requested.

5. Blood Type:
   a. If no in-date blood sample exists, send a properly labeled, signed, and dated blood bank sample to Blood Bank for ABO typing.
   b. Release of FFP, Platelets, and ABO matching RBCs require that blood typing sample be received by the Blood Bank.

6. Administer an anti-fibrinolytic
   Based on RCT evidence, trauma patients have improved chance of survival if treated with a bolus and infusion of an antifibrinolytic within the 3 hours of injury.

7. Request set-up of additional Blood Products
   Send a Request Slip with the patient's full name, MRN, location and products requested.

8. Request release of additional Blood Products
   All requests for Release Of Blood require a Pick Up Slip with the patient's full name, MRN, and product requested.

9. The Clinical Team and the Transfusion Medicine service maintain joint responsibility for the success of the Massive Transfusion Protocol. A Transfusion Medicine Physician is available at all times by pager.

10. RBC Selection:
    a. At least 4 units of Emergency –release, uncrossmatched Group O Rh-negative RBC's will be available for immediate release to any patient.
    b. All patients will receive Rh negative cells as long as inventory is adequate. An effort will be made to provide Rh negative cells to females under age 50 as long as inventory is adequate. The laboratory will decide to switch the patient to Rh-positive RBCs based on the available inventory and the anticipated RBC requirement.
    c. Group O RBCs will be used until the patient's blood group is known after which the patient will be switched to group-specific RBCs.

11. Blood Component Requests:
    After the initial assessment, the clinical team should request more blood as follows:
    a. If hemorrhage appears controllable and if < 10 TOTAL units (or 40 ml/kg) are anticipated, the clinical team should order RBCs (in addition to the emergency-release 4 units); and send a properly labeled "Pick-up slip" for these units.
    b. If > 10 TOTAL units (or 40 ml/kg) are expected to be needed, the clinical team should request (in addition to the initial 4 emergency RBCs):
       (1) 10 RBCs
       (2) 10 FFP
       (3) 1 dose of platelets
       (4) For children, make size appropriate adjustments to the above request.
    c. Upon receipt of a properly labeled "Pick Up Slip" indicating the location (ED, OR, ICU, etc) the request will be filled and units issued ASAP. The blood bank will fill partial orders so as not to delay the entire order. For example, 6 RBCs and 4 FFP and 1 dose of platelets may be issued immediately and then followed by 4 RBCs and 6 FFP.
    d. It is the responsibility of the clinical team to insure that issued blood components will be promptly delivered to the bedside.

12. Blood component ratio during resuscitation:
    a. Target a ratio of 2 RBCs to 1 FFP (include cell saver in count of RBCs).
    b. Give 1 dose of platelets (eg, 6 units for an adult) for each blood volume resuscitation
    c. Adjust the platelet dose for children based on estimated blood volume.

13. Transport of the patient from the ED to the OR or to Radiology:
    a. It is ESSENTIAL that the clinical team communicate to the blood bank when the patient is being moved from the ED to the OR or to Radiology so that additional blood units, as available, will be directed to the proper location.
    b. Failure to communicate the movement of the patient will lead to delays in administration of blood components.

Note: The blood bank staff is instructed **NOT** to issue blood to two locations for one patient simultaneously.

14. Laboratory monitoring for on-going blood support in cases requiring > 10 units of RBCs (40 ml/kg):
    a. Transfusion support should be individualized for each patient.
    b. The following "general guidelines" apply:
       (1) Check H/H, Platelet count, INR, and Fibrinogen after each blood volume lost/infused.(80 ml/kg)
       (2) Include the number of "cell saver" units in the tally of packed RBCs.
       (3) Target a ratio of 2 RBCs to 1 FFP during the course of acute bleeding.
       (4) Anticipate fibrinolysis and treat with additional boluses of anti-fibrinolytics if there is ongoing diffuse bleeding.
       (5) Verify that the INR is < 2.5 and fibrinogen >100. Values outside these ranges may indicate systemic fibrinogenolysis, DIC, or failure to avoid hemodilution.
       (6) In the absence of platelet infusion, anticipate a halving of the platelet count with each blood volume resuscitation (80 ml/kg). Transfuse platelets to maintain an anticipated platelet count >50,000/uL.
       (7) A stat AST or ALT can be used to document shock liver (values >800) which is a poor prognostic sign and an independent indication for anti-fibrinolytic therapy.
    c. Monitor and treat abnormalities of ionized Ca++, K+, pH and temperature.

15. At the end of surgery, notify the ICU and the Blood Bank when leaving the OR on route to the ICU.
    a. Take a sufficient number of units of blood, not in a cooler, with the patient to cover the next 30 minutes of blood transfusion support.
    b. Return the residual units in the cooler to the Blood Bank.
    b. The blood bank will issue a fresh cooler of blood to the ICU according to an established hospital policy for moving unstable patients from OR to ICU..

16. Not all massive injured patients can be saved. The decision to withdraw support for the massively injured patient should be made by consensus of the treating team and with approval of the trauma attending responsible for the case. Considerations include likelihood of survival, nature of injuries, and impact of blood requirements on other patients in the hospital in need of blood support. Consultation with the senior blood bank physician on duty is welcome.

THANK-YOU