6.0 DAMAGE CONTROL RESUSCITATION

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The damage control resuscitation (DCR) section will address the following recommendation statement: The Protocol shall incorporate the principles of damage control resuscitation, specifically giving highest priority to treating the source of hemorrhage (Statement number 3).

6.1 DCR Definition

DCR principles in traumatic injury include abbreviated surgical and/or endovascular interventions for hemorrhage control and management of intra-abdominal contamination, with definitive surgical repair delayed until stabilization and hemostatic control have been achieved.

- In addition, DCR includes critical care support to correct deranged physiologic measures (hypothermia, acidosis, and coagulopathy).
- Furthermore**,** DCR is generally accepted as a complementary strategy usually accompanying Damage Control Surgery (DCS). DCS focuses on surgical interventions to address life-threatening hemorrhage and delays all other surgical care until metabolic and physiologic derangements have been treated.[1]

6.2 DCR Goals

The principal goal of DCR is to restore hemostasis, prevent or mitigate the development of tissue hypoxia, oxygen debt and burden of shock, as well as coagulopathy. More specifically, DCR prevents 'blood failure', with a goal of restoring blood functionality (improving oxygen delivery and tissue perfusion, reducing acidosis, preventing fibrinolysis, reducing coagulopathy, protecting the endothelium, and reducing platelet dysfunction).[2]

6.3 DCR Components

DCR consists of the following elements:

1. Compressible hemorrhage control (tourniquets, dressings, and closure of scalp wounds);
2. Early administration of anti-fibrinolytic therapy (TXA);
3. Rapid surgical or angiographic control of non-compressible (torso) or junctional (neck, axilla, or groin) hemorrhage;
4. Avoidance of the overuse of crystalloid and colloids;
5. Prevention or correction of acidosis, hypothermia, and hypocalcemia; and
6. Hemostatic resuscitation (early blood and blood products) with minimum ratio of 2:1 of RBC:plasma.

6.4 Patient Selection

The two most commonly used scores validated in the trauma setting, used to predict massive transfusion, and help the clinician decision on activation of the MHP are the Shock Index (SI) (blood pressure divided by heart rate) and the ABC (Assessment of Blood Consumption) score (one point each for penetrating injury, blood pressure <90 mmHg, heart rate >120 and a positive FAST [Focused Assessment with Sonography for Trauma]), with the shock index performing slightly better in trauma. New data suggest that resuscitation intensity of >4 units of fluid within the first 30 minutes may represent an important alternative metric to identify patients who require MHP activation (1 unit of fluid is defined as any of 1 U RBC, 1 U FP, 500 mL colloid, or 1L crystalloid). In addition, retrospective studies suggest that delays in initial blood component administration is associated with worse outcomes (each 1 minute delay to the arrival of the first pack of blood components is associated with a 5% increase in the risk of death). In contrast, over-activation (i.e., MHP activation that is ultimately not required) may lead to unnecessary transfusion, wastage of blood components, and

diversion of human resources away from competing needs. Despite concern that appropriate and timely activation are critical, there are no criteria with both high sensitivity and specificity for predicting the need for massive transfusion.

6.5 Ratio-Driven Component Resuscitation

The initial management of the rapidly bleeding patient that precludes the use of laboratory-guided transfusion should begin with immediate RBC transfusion and then transfusions at a RBC:plasma ratio of 2:1.

- Two prospective randomized trials have failed to confirm a survival benefit of a higher ratio of 1:1 (compared to 2:1).[3, 4]
- A large retrospective review of experience before and after implementation of 1:1 resuscitation failed to find a mortality benefit.[5]
- The Canadian consensus conference on massive transfusion recommended a ratio of 2:1 followed by transition to laboratory-guided blood component administration as soon as possible.[6]
- No blood components should be transfused without a clear order and specified infusion rate from the team leader or delegate.

6.6 Importance of Early Hemorrhage Control

The highest priority should be given to controlling the source of hemorrhage. Ongoing hemorrhage leads to worsening coagulopathy and other physiologic derangements. Although the role of DCR outside of traumatic injury is unknown, prompt hemorrhage control is likely to be an important component of care.

6.7 Importance of Preventing and Correcting Hypothermia

All massively bleeding patients should have a temperature measured within 15 minutes of arrival or protocol activation and then at a minimum of every 30 minutes (or continuously where available) until the protocol is terminated.

- All patients should receive interventions to prevent hypothermia and achieve normothermia.
- All patients should receive warmed intravenous fluids and blood to avoid hypothermia. In both traumatic injury and postpartum hemorrhage, temperature monitoring is infrequently performed and when measured, hypothermia is common.

Hypothermia in traumatic injury is associated with worse outcomes, although prospective trials have not confirmed whether aggressive warming protocols would alter outcomes. Mild hypothermia (1°C drop in temperature) is associated with a 22% increase in the risk of transfusion. Warming of patients improves their comfort and therefore even in the absence of a confirmed survival benefit it should be a core part of every MHP.

6.8 Adjuncts to Damage Control Resuscitation

Prevent further hemorrhage with direct pressure, topical hemostatic dressings, and/or tourniquets, if possible, to minimize the risk of shock. Resuscitative Endovascular Balloon Occlusion of the Aorta (REBOA) can be highly effective if rapidly implemented by skilled and designated teams. Another important adjunct to treat hyperfibrinolysis in severely bleeding patients is TXA, which should be administered as soon as intravenous or intraosseous access is achieved but always within 3 hours from the time of injury or within 3 hours from MHP activation in all other patients.

TXA improves mortality in the setting of trauma and postpartum hemorrhage. It is most effective when given immediately, with the survival benefit decreasing by 10% for every 15 minute delay in administration and with no benefit after 3 hours from injury onset of bleeding. There is no increased risk of venous or arterial thromboembolic complications. Dosages and infusion rates vary depending on the study protocol (1 gram bolus plus 1 gram infusion over

8 hours,1 gram bolus and 1 gram bolus repeated at 1 hour, 1 gram bolus and repeated if ongoing bleeding at 30 minutes or greater, 2 gram bolus at the scene of the injury).[4] Due to lack of benefit and potential evidence of harm, universal TXA administration to patients with massive gastrointestinal bleeding cannot be recommended[7]. In these cases, decision to give TXA should be made by the clinical team on a case by case basis, after careful consideration of risks and benefits.

6.9 Damage Control Surgery (DCS)

DCS can be defined as abbreviated surgery for hemorrhage and contamination control. DCS, which aims to restore homeostasis by the rapid control of hemorrhage and contamination, should be conducted emergently in patients who are undergoing DCR. Definitive repair is deferred until the patient is euthermic and coagulopathy has been corrected.[2]

References

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