Damage control resuscitation: evidence-based systematic review for treating traumatized patients

ABSTRACT

The aim of this study is to analyze concepts and updates on Damage Control Resuscitation (DCR), focusing on critical patient approaches, therapeutic failures identification, and the relevance of damage control in trauma.

Method: This article presents a systematic review ofdamage control resuscitation in trauma, encompassing both consolidated and emerging literature, using informative tables in accordance with PRISMA 2020 guidelines. Conducted between March 2023 and March 2024, using the research descriptor "Resuscitation for damage control" in PubMed. Studies published between 2016 and 2023, freely accessible in English and Portuguese, were included, while those not aligning with the objective were excluded. Out of 979 articles found, 10 were selected after applying inclusion and exclusion criteria.

Results: Damage Control Resuscitation (DCR) is based on three pillars: permissive hypotension, minimization of crystalloid use, and balanced resuscitation. This approach aims to maintain adequate blood pressure, limit crystalloid use to avoid complications, and balance blood product transfusion. Hypocalcemia has emerged as a new challenge in the lethal triad of trauma, impacting coagulation and mortality. New techniques, such as REBOA and viscoelastic tests (TEG and ROTEM), are being explored to improve resuscitation in severe trauma cases. Tranexamic acid (TXA) also stands out as an effective treatment for excessive bleeding in trauma situations. The importance of pre-hospital care and early interventions is emphasized to optimize bleeding control and resuscitation in traumatized patients.

Conclusion: Damage Control Resuscitation (DCR) is an evidence-based strategy for treating traumatized patients, focusing on permissive hypotension, reduced crystalloid use, and balanced transfusion. In resource-limited settings, alternatives such as whole blood use can be adopted. Pre-hospital care and early interventions are crucial for better outcomes and survival.

INTRODUCTION:

The Damage Control Resuscitation (DCR) is an eligible protocol in manyscenarios, whether emergency room, intensive care unit, operating room and/or interventional radiology. Patients with severe shock associated with imminent metabolic repercussions and multiple organ injuries, which would require a long time for definitive correction. The literature taughtthat searching for a definitive approach in critically unstable patients often leads to death during initial care or a few hours later. [1–3]

The demand to cover these patients with a severe profile, the need in favor of the rapid control of hemodynamic instability caused by traumaemerged from the DCR protocol, being used around the world.

The aim of the studyis to analyze concepts and updates on DCR, focusing on critical patient approaches, therapeutic failures identification, and the relevance of damage control in trauma.[3,4]

METHODOLOGY:

Searched between March 2023 and April 2024 from the PubMed database, using the descriptor in Health Sciences (Decs): “Resuscitation for damage control” free acess Papers which fullfill the inclusion criteria.

The inclusion criteria were papers published between 2016 and 2023 in English or Portuguese presented a consistent with the objective of the research. After applying the criteria, from 979 papers in primary search, 10 were selected, read and summarized.The selection of articles in this particular period aimed to follow the most recent evidence of scientific production on the topic. As an exclusion criterion, articles that did not respond to the research object or having less based evidence,such as case reports.

RESULTS:

According to the information obtained in the reviewed studies, the management of DCR is based on three important pillars, permissive hypotension, minimization of the use of crystalloids and balanced resuscitation. The first principle brings an approach to blood pressure management aimed at ensuring adequate perfusion of organs, avoiding exacerbation of bleeding. The strategy involves maintaining a “hypotensive” state with a target systolic blood pressure of 80 mmHg (or a mean arterial pressure of 80 mmHg in cases of neurotrauma) to minimize future blood loss and prevent displacement of blood clots [5].

The reduction of using crystalloids, emerged as one of the three principles of RCD. Previously, liberal use of these fluids was associated with serious complications, including coagulopathy, hypothermia, and acidosis[6]

The third pillar of DCR, we can emphasize the use of balanced proportions of transfusion of blood products, particularly plasma, platelets and red blood cells (RBCs), in a ratio of 1:1:1, approaching whole blood[6–8].

The table 1 summarizes the following variables are shown: Title of the article, Authors/year and Proposed treatment.

Table 1-proposal terapeutics

Title	Author, year	Porposal
Resuscitation for Hypovolemic Shock	Kyle J Kalkwarf, 2017.	Limit the use of large crystalloid transfusions. Ratio in resuscitation 1:1:1. Whole blood transfusion as superior method in resuscitation. Avoid hypothermia.
Reboa as a new damage control component in hemodynamically unstable noncompressible torso hemorrhage patients	Ordoñez CA, 2020	Propose two new deployment algorithmsfor hemodynamically unstable noncompressible torso hemorrhage patients: Blunt and REBOA
Ressuscitação para controle de danos	Jason M Samuels, 2017.	Use of pharmacological therapies designed to inhibit clot degradation in seriously injured patients, using tranexamic acid.
Damage control: Concept and implementation	Malgras, 2017	Permissive Hypotension, maintaining a systolic blood pressure around 80 mmHg.
Prehospital Damage Control: The Management of Volume, Temperature… and Bleeding!	Lugo, 2020	Consensus and summarizes the experience of the Trauma and Emergency Surgery Group in managing trauma intensive care over the past 30 years.
The Role of TEG and ROTEM in Damage Control Resuscitation	Jason B. Brill, 2021.	TEG and ROTEM can predict massive transfusion and development of coagulopathy
Whole blood for blood loss: hemostatic resuscitation in damage control	Juan Carlos Salamea-Molina,2020.	Use of whole blood in resuscitation providing a practical alternative in resource-limited settings.
Optimal Fluid Therapy for Traumatic Hemorrhagic Shock	Chang, 2017.	Discusses the paradigm shift in traumatic hemorrhagic shock resuscitation with the advent of DCR
Traumatic hemorrhage and chain of survival	Latif RK, 2023.	The prehospital and hospital chain of survivorship care

DISCUSSION:

The literature shows the three pillars of DCR are a well-established strategy, the first principle brings an approach to blood pressure management aimed at ensuring adequate perfusion of organs, avoiding exacerbation of bleeding. The strategy involves maintaining a “hypotensive” state with a target systolic blood pressure of 80 mmHg (or a mean arterial pressure of 80 mmHg in cases of neurotrauma) to minimize future blood loss and prevent displacement of blood clots[2–6,8,9].Placing in a unanimous position among the reviewed authors and studies.

Improved survival in trauma patients was identified with the reduction in crystalloid use, establishing this practice as the second pillar of DCR[6]

Previously, liberal use of these fluids was associated with serious complications, including coagulopathy, hypothermia, and acidosis. Crystalloids dilute clotting factors, cool the patient, cause acidosis, and can lead to edema and organ dysfunction. Furthermore, they are associated with a series of complications, such as heart, respiratory, gastrointestinal and immunological problems, increasing mortality. Limiting the use of crystalloids also reduces the need for transfusions in patients with severe injuries. [1,6,7,10].

Several authors have established as the last pillar the use of balanced proportions of transfusion of blood products, particularly plasma, platelets and red blood cells (RBCs), in the ratio of 1:1:1, since this proportion is close to whole blood.

Plasma transfusions are beneficial in reducing inflammation, edema and vascular permeability, improving platelet function and alleviating blood hypercoagulability[7]. To speed up plasma transfusion, pre-thawed or liquid plasma is increasingly used, facilitating earlier transfusions and better results. Its implementation in the RCD led to a reduction in the use of crystalloids, morbidity from abdominal compartment syndrome, infection, organ failure and mortality from hemorrhage[6,7,11].

In environments with limited resources, where this practice may not be available, the use of whole blood appears as an alternative, having advantages of a physiological proportion of components, including red blood cells, plasma, platelets and clotting factors, which can help to restore the balance of these components in the patient's body. It may also be more convenient, as component therapy eliminates the need for separate storage and administration of different parts of the blood [12].

Ordoñez et al. in 2020, they noticed the presence of hypokalemia in 50% of patients before the start of blood transfusion, and suggested the inclusion of this condition as a new pillar to be corrected in polytraumatized patients. But there is still no consensus in the literature.[13]

This state of pre-existing trauma is potentially worsened by initial treatment via an DCR in which blood and blood products are transfused. Early management of hypocalcemia in trauma patients may be more significant than previously believed because as serum calcium levels fall, a state of coagulopathy occurs, which can lead to continued hemorrhage and possible death. However, there is still no well-established pathophysiology and management, therefore, further studies are still required to establish a better targeted approach[13,14].

Resuscitation efforts in patients requiring massive transfusion in trauma have been discussed, including viscoelastic tests. The importance of recognizing hypocoagulable tracings and promptly addressing modifiable factors that contribute to trauma-induced coagulopathy (TIC). Values obtained from viscoelastic testing help determine appropriate interventions such as plasma transfusion, anticoagulant reversal, and targeted treatments for anticoagulant-associated hemorrhage. Furthermore, the role of assessing fibrinolysis in guiding antifibrinolytic therapy, in parallel to the usually already established methods[10,11].

In therapy guided by viscoelasticity, it is possible to analyze the slow kinetics of the clot, such as its strength, thus identifying the moment or need to perform a fibrinogen or platelet transfusion. Although some studies suggest potential benefits of viscoelastic-guided resuscitation, more research is needed to establish its superiority over conventional approaches[11].

The tranexamic acid (TXA), which is a medicine used to prevent and treat excessive bleeding, acts to delay and decompose blood clots, thus reducing bleeding. TXA is particularly useful in situations where there is uncontrolled bleeding, such as trauma, surgery, heavy menstrual bleeding, or certain medical conditions such as hemophilia. One of the significant advances in the use of TXA came from the CRASH-2 trial, a large-scale study that demonstrated its effectiveness in reducing mortality in trauma patients when administered shortly after injury within 3 hours[15]. Since then, TXA has become a crucial component of trauma care protocols around the world. It is important to note that although TXA can be highly beneficial in certain situations, it is not suitable for everyone, and medical professionals must carefully assess each patient's condition before administering it[2].

Ordoñez and Cols, 2020 began to advocate in favor of Resuscitative Endovascular Balloon Occlusion of the Aorta (REBOA), as a new pillar in the control of hypovolemia.[12,13] In addition to the fact this treatment model needs a complex treatment center, a high qualified staff must be

presente, difficulting the implamentation em many centers. Maybe for those reasons, the REBOA has not yet been established by other authors.

Despite the conduct already established in relation to DCR, the importance of pre-hospital care as the first step to guarantee bleeding control and resuscitation in traumatized patients must be reinforced. Furthermore, early interventions without increasing hospital transfer time are essential to optimize the success rate[16].

CONCLUSION

The Blood Component Resuscitation approach emerges as a multifaceted, evidence-based strategy for the effective management of trauma patients during the DCR . Through its three pillars - permissive hypotension, minimization of crystalloid use and balanced resuscitation.

The context of limited resources in some healthcare settings may require viable alternatives, such as the use of whole blood. Furthermore, the continued evolution of therapy, including use of viscoelastic testing, highlights the importance of adapting to each patient's individual needs. Transexamic acid also stands out as a crucial tool in reducing excessive bleeding and the importance of a pre-hospital care earlye management.

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