Journal of Clinical and Nursing Research, 2026, Volume 10, Issue 1
http://ojs.bbwpublisher.com/index.php/JCNR
Online ISSN: 2208-3693
Print ISSN: 2208-3685

Proposal, Promotion, and Practice and Application of Damage Control Surgery Concept in Trauma Treatment at Grassroots Hospitals

Jingcheng Chen, Yongzhan Chen, Jing Xu

Dongguan Sanju Hospital, Dongguan 523000, Guangdong, China

Abstract: The concept of Damage Control Surgery (DCS) emphasizes prioritizing hemorrhage control, preventing hypothermia, correcting coagulopathy, and acidosis in trauma treatment. The application of the DCS concept in trauma treatment at grassroots hospitals faces numerous challenges such as limited resources, high technical difficulty, and insufficient multidisciplinary collaboration. Therefore, DCS strategies need to be adapted to simplified processes to create conditions for subsequent treatment. This paper retrieves relevant literature to discuss the proposal, promotion, and application of the DCS concept, aiming to provide evidence-based basis for optimizing trauma treatment outcomes at grassroots hospitals.

Keywords: Damage control surgery; Concept promotion; Grassroots hospitals; Trauma treatment

Online publication: Feb 12, 2026

1. Introduction

Trauma is the leading cause of death among young and middle-aged people worldwide, and timely and effective treatment is crucial for reducing mortality [1]. Traditional surgical operations pursue thorough repair of injuries, but for patients with severe trauma who are already in pathological states such as shock, hypotension, coagulopathy, and acidosis, their physiological functions are at the limit of life. However, traditional operations require prolonged procedures, massive blood loss, and stress responses, which will further consume the patient's limited physiological reserves, leading to an increased risk of multiple organ failure [2,3]. Against this background, the concept of Damage Control Surgery emerged. Its core lies in adopting a phased treatment strategy to prioritize stabilizing the patient's vital signs and creating conditions for subsequent definitive surgery [4]. Since its proposal in the 1990s, the DCS concept has been rapidly promoted in the field of trauma medicine, becoming an important paradigm for treating patients with severe multiple injuries [5]. However, the application of the DCS concept at grassroots hospitals faces many challenges. For example, grassroots hospitals lack a sound trauma treatment system, advanced equipment, and technical personnel, making it difficult to fully implement the standardized

processes of the DCS concept. In recent years, with the advancement of the hierarchical diagnosis and treatment system and the strengthening of trauma center construction, grassroots hospitals have begun to actively explore the application model of the DCS concept. This study aims to sort out the development of the DCS concept, analyze its application status and problems in trauma treatment at grassroots hospitals, and provide reference for grassroots hospitals to improve their trauma treatment level. The specific report is as follows.

2. Literature search strategy

Domestic and foreign databases were searched, including CNKI, Wanfang Data, VIP Chinese Science and Technology Journal Database, PubMed, Embase, Web of Science, etc. Core keywords: Damage Control Surgery, Damage Control Concept, Trauma Management, Primary Hospital/Grassroots Hospital. Search time limit: from the establishment of the database to October 2025. Clinical studies (such as randomized controlled trials, cohort studies, case-control studies), systematic reviews, Meta-analyses, expert consensuses, and reviews were included, while non-systematic studies such as conference papers, dissertations, and case reports were excluded. High-quality studies were prioritized, such as those with clear research design, sufficient sample size, complete data, and reasonable statistical methods.

3. Problems faced by trauma treatment at grassroots hospitals

3.1. Shortage of talents and insufficient professional capabilities

(1) Grassroots hospitals refer to primary medical and health institutions that directly provide basic medical and public health services to residents in streets, towns, communities, or rural areas, including township hospitals at or below level 2, community health service centers, township health centers, village clinics, etc. Due to the general shortage of senior surgical talents in emergency medicine, orthopedics, neurosurgery, general surgery, etc., in grassroots hospitals, especially the insufficient number of professional physicians who have received systematic trauma treatment training [6].

(2) Most grassroots doctors lack an in-depth understanding of the DCS concept and are not proficient in key technologies such as trauma assessment, fixation, hemostasis, and transportation, making it difficult to accurately grasp the timing and extent of damage control in actual treatment, resulting in some patients failing to receive standardized treatment in a timely manner.

(3) Grassroots hospitals have relatively poor working conditions, insufficient software and hardware equipment, low salaries, and limited career development. Young and experienced medical staff tend to flow to large hospitals, leading to a talent shortage.

3.2. Lack of equipment and materials

(1) Emergency equipment such as ventilators, defibrillators, and monitors in grassroots hospitals are insufficient in quantity and aging, which cannot meet the treatment needs of trauma patients [7]. In addition, the reserves of blood products and emergency drugs are insufficient, especially in remote areas, which cannot meet the emergency blood transfusion needs of patients with traumatic massive hemorrhage.

(2) Most grassroots hospitals are equipped with imaging equipment such as CT and MRI, but often lack key equipment such as bedside portable ultrasound machines, bedside X-ray machines, thromboelastography machines, interventional surgery-related equipment (such as DSA, REBOA), and hybrid operating rooms, resulting in the inability to timely complete Focused Assessment with Sonography for Trauma (FAST) or

hemostatic resuscitation.

3.3. Non-standardized treatment processes

The trauma treatment process lacks standardization, early warning for severe trauma before admission is not timely, the connection between pre-hospital emergency care and in-hospital treatment is disconnected, the response efficiency of the green channel is low, and even some grassroots hospitals have not established a clear damage control resuscitation strategy. The choice of fluid resuscitation and surgical timing is arbitrary, which can exacerbate coagulation disorders. The postoperative monitoring and complication management processes are incomplete, affecting the patient's rehabilitation effect [8].

3.4. Lagging informatization construction

(1) The medical information systems between grassroots hospitals and superior hospitals have not achieved interconnection and interoperability, and the data formats of medical records, inspection reports, etc., are not unified and cannot be directly shared, affecting treatment decisions [9].

(2) Grassroots hospitals lack professional information technology personnel, and the support for telemedicine equipment and technology is insufficient, making it impossible to conduct timely remote consultations with superior experts to obtain professional guidance.

(3) Grassroots hospitals lack professional information management personnel, and their ability to train and apply new equipment and technologies is insufficient, affecting medical quality and safety.

4. Connotation and proposal background of the damage control surgery concept

Damage Control Surgery is a treatment concept for severe trauma or complex surgical diseases, whose core is to prioritize ensuring the patient's life safety through a phased treatment strategy [10]. At the beginning of the 20th century, surgical technology gradually advanced, but the mortality rate of patients with severe trauma remained high. In 1983, scholars such as Stone first proposed the concept of "damage control", emphasizing that when severe trauma leads to physiological disorders of the body, priority should be given to controlling fatal factors such as hemorrhage and contamination rather than pursuing a one-time perfect operation [11]. In 1993, Rotondo et al. formally defined it as "Damage Control Surgery" and clarified the process of phased treatment.

5. Promotion of the damage control surgery concept

5.1. International promotion

The DCS concept was first introduced in the treatment of abdominal trauma, and trauma centers in Europe and the United States took the lead in incorporating it into standard treatment processes. By shortening surgical time, controlling hemorrhage and contamination, the mortality rate of patients with severe trauma has been significantly reduced [12]. In recent years, the application scope of the DCS concept has expanded to fields such as orthopedics, vascular surgery, and cardiothoracic surgery, becoming an important strategy for the treatment of complex trauma and critical illnesses [13]. Academic organizations such as the American Association for the Surgery of Trauma (AAST) and the American College of Surgeons (ACS) have promoted the global dissemination of the DCS concept through seminars, training courses, and the publication of guidelines.

5.2. Domestic promotion

In 1997, Academician Li Jieshou first proposed the DCS concept in China and carried out theoretical demonstrations, animal experiments, and clinical studies, laying the foundation for the development of the DCS concept in China. From 2006 to 2015, the DCS concept gradually gained attention in China, and more and more hospitals began to try its application, such as in the treatment of abdominal trauma, severe burns, and multiple injuries [14]. Since 2016, the DCS concept has become an important treatment concept in fields such as trauma surgery and emergency medicine in China, widely used in hospitals at all levels. Many hospitals have incorporated the DCS concept into the trauma treatment process and established multidisciplinary collaborative teams to improve the success rate of treating patients with severe trauma. At the same time, a large number of academic conferences and training courses have been held in China to promote the popularization and standardized application of the DCS concept.

In recent years, through academic exchanges, training programs, and case sharing, the awareness of the DCS concept among doctors at grassroots hospitals has been significantly improved. Many grassroots hospitals have realized the importance of this concept in the treatment of severe trauma and multiple injuries and have begun to try its application in the treatment of abdominal trauma, pelvic fractures, etc., especially in controlling hemorrhage, reducing surgical time, and lowering complications [15].

6. Practice and application of the damage control surgery concept in trauma treatment at grassroots hospitals

6.1. Phase 1: Rapid damage control

Due to limited medical resources (equipment, blood sources, specialist strength) and technical level, the first phase of the practice of the DCS concept in trauma treatment at grassroots hospitals is “rapid damage control”, which is a key initial step. For patients with severe trauma whose physiological functions are on the verge of collapse, the attending emergency physician should abandon initial complex assessments and quickly complete a “rapid fatal risk screening” within 5 seconds to determine whether there is “life-threatening massive hemorrhage” (the core), whether they are in a dangerous environment, and whether emergency exposure/separation is required. Avoid delaying the handling of “fatal risks” due to step-by-step assessments.

For example, for visible massive hemorrhage on the body surface, such as limb artery rupture and large blood vessel injury in the neck/axilla/groin area, there is no need to wait for subsequent assessments, and the hemostasis procedure should be initiated immediately. A strong tourniquet (commercial CAT or SOF-T type) can be used to bandage the proximal end of the bleeding limb or compress and bandage the bleeding wound; for patients with occult massive hemorrhage and unstable hemodynamics, such as massive intrathoracic hemorrhage, cardiac tamponade, and rupture of intra-abdominal parenchymal organs, “assessment while treatment” is required, and “thoracotomy or laparotomy” should be performed as early as possible to avoid delaying the treatment timing due to waiting for sufficient blood sources, stable vital signs, or CT and other imaging results. In addition, it should be emphasized that at the pre-hospital treatment scene, the attending physician needs to quickly assess whether the environment where the patient is located poses an immediate danger to the patient or rescuers. The core is to “first escape danger, then implement treatment” to avoid secondary injuries caused by environmental risks. For example, at traffic accident scenes (unextinguished vehicles, risk of secondary collision), fire/explosion scenes, high-altitude fall scenes (fall of remaining objects), electric shock environments, etc., the patient needs to be quickly transferred

to a safe area. If the patient is suspected of spinal fracture, transfer should be performed while maintaining a neutral spinal position to avoid aggravating spinal cord injury. Faced with a complex treatment environment, only by simplifying operational strategies can time and conditions be gained for subsequent rescue and treatment.

6.2. Phase 2: Fluid resuscitation in trauma units

The resuscitation phase in trauma units of grassroots hospitals faces dual challenges of resources and technology, but it is still a key link determining patient prognosis. Feasible measures include:

(1) Prioritize equipping with portable ultrasound, simple hemostatic instruments, and rapid detection equipment to ensure timely Focused Assessment with Sonography for Trauma (FAST) and coagulation function monitoring. Use dynamic monitoring technology to real-time assess hemodynamic status and adjust fluid infusion speed according to indicators such as pulse pressure variation and cardiac output.

(2) Use bedside thromboelastography to real-time monitor coagulation function and guide the transfusion of blood products based on the results.

(3) Adopt body cavity lavage rewarming, intravenous infusion of warmed fluids (37–40℃), and combine with warm air blankets, heating mattresses, and other equipment to quickly raise the patient's core temperature above 36 ℃.

(4) Establish a Trauma Team Activation (TTA) group, and work collaboratively with a Multidisciplinary Team (MDT) including surgery, anesthesia, ICU, and laboratory departments to formulate standardized resuscitation processes and clarify the time nodes and division of responsibilities for each link.

6.3. Phase 3: Definitive surgery

After the patient's condition stabilizes, grassroots hospitals select the appropriate timing for definitive surgery according to their own capabilities and the patient's situation.

(1) Use minimally invasive technologies such as laparoscopy and thoracoscopy for definitive surgery to reduce surgical trauma and blood loss, shorten surgical time, and lower the risk of infection.

(2) For vascular injuries, customized vascular grafts or vascular stents are used for reconstruction according to the location and degree of injury.

(3) Introduce tissue-engineered skin, tendons, bones, and other repair materials for covering wounds and repairing defective tissues.

(4) With the help of intraoperative three-dimensional image navigation systems, real-time locate the injury site and surrounding tissue structures, and dynamically adjust the surgical strategy according to the patient's physiological status in combination with real-time monitoring equipment such as hemodynamics and coagulation function.

(5) Establish a green channel for trauma treatment, integrate multidisciplinary teams such as surgery, critical care medicine, anesthesia, and imaging, and realize the whole process from preoperative assessment, surgical implementation to postoperative rehabilitation.

6.4. Application effects

Against the background of limited resources and relatively weak trauma treatment capabilities at grassroots hospitals, the application of the DCS concept has not only optimized the treatment process but also highlighted its unique adaptability and advantages. Scholars such as Yang Mei selected 100 emergency critically ill trauma

patients as research objects, and the results showed that the rescue success rate of the observation group was higher than that of the control group ($p < 0.05$), indicating that the DCS concept helps improve the rescue success rate [16]. By controlling massive hemorrhage, repairing life-threatening organ injuries and other measures, Damage Control Surgery prioritizes handling life-threatening injuries, stabilizes vital signs, gains valuable treatment time for patients, and improves the success rate. Scholars such as Li Xiaodong selected the clinical data of 120 patients with severe abdominal trauma and acute abdomen, and the results showed that the indwelling time of drainage tubes, postoperative exhaust time, eating time, and hospital stay of patients treated with Damage Control Surgery were shorter than those of the control group; the incidence of postoperative complications such as infection and anastomotic leakage was significantly lower than that of the control group ($p < 0.05$), indicating that the DCS concept helps promote patient recovery and reduce the incidence of complications [17]. This concept emphasizes avoiding further damage to the patient's physiological functions caused by excessive surgery. Through phased treatment, sufficient internal environment adjustment and organ function support are obtained during the resuscitation phase, which helps reduce the risk of complications and improve the quality of rehabilitation.

7. Conclusion

Since its proposal in the 1980s, the concept of Damage Control Surgery has continuously developed and become a core strategy in the field of trauma treatment. At grassroots hospitals, although the application of the DCS concept faces challenges such as insufficient equipment and inadequate training, significant progress has been made by simplifying surgical processes, strengthening multidisciplinary collaboration, and optimizing transfer mechanisms; secondly, through the in-depth assistance model of "Grade A tertiary hospitals–grassroots hospitals", carry out trauma treatment simulation drills and damage control resuscitation technology training, focusing on improving the capabilities of emergency assessment, hemostasis, resuscitation, performance of definitive surgery, and postoperative intensive care. In the future, with the deepening of technological innovation and regional collaboration, the DCS concept will be further integrated into the grassroots emergency process, providing more effective evidence for improving the level of grassroots trauma treatment.

Disclosure statement

The authors declare no conflict of interest.

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