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# The concept of damage control: Extending the paradigm in the prehospital setting☆,☆☆

## *Le concept de* damage control *: extension préhospitalière du paradigme*

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ABSTRACT

*Objective.* – The purpose of this review is to present the progressive extension of the concept of damage control resuscitation, focusing on the prehospital phase.
*Article type.* – Review of the literature in Medline database over the past 10 years.
*Data source.* – Medline database looking for articles published in English or in French between April 2002 and March 2013. Keywords used were: damage control resuscitation, trauma damage control, prehospital trauma, damage control surgery. Original articles were firstly selected. Editorials and reviews were secondly studied.
*Data synthesis.* – The importance of early management of life-threatening injuries and rapid transport to trauma centers has been widely promulgated. Technical progress appears for external methods of hemostasis, with the development of handy tourniquets and hemostatic dressings, making the crucial control of external bleeding more simple, rapid and effective. Hypothermia is independently associated with increased risk of mortality, and appeared accessible to improvement of prehospital care. The impact of excessive fluid resuscitation appears negative. The interest of hypertonic saline is denied. The place of vasopressor such as norepinephrine in the early resuscitation is still under debate. The early use of tranexamic acid is promoted. Specific transfusion strategies are developed in the prehospital setting.
*Conclusion.* – It is critical that both civilian and military practitioners involved in trauma continue to share experiences and constructive feedback. And it is mandatory now to perform well-designed prospective clinical trials in order to advance the topic.


*Mots clés :*
*Damage control*
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RÉSUMÉ

*Objectif.* – L'objectif de cette mise au point était de présenter l'extension progressive du concept de *damage control* (DC), en s'intéressant plus spécifiquement à sa phase préhospitalière.
*Type d'article.* – Revue de la littérature dans Medline au cours des dix dernières années.
*Source des données.* – Base de données Medline à la recherche d'articles publiés en anglais ou en français, entre avril 2002 et mars 2013. Les mots-clés utilisés étaient : *damage control resuscitation*, *trauma damage control*, *prehospital trauma*, *damage control surgery*. Les articles originaux ont d'abord été sélectionnés. Les éditoriaux et les commentaires ont été par ailleurs étudiés.
*Synthèse des données.* – L'importance de la prise en charge immédiate sur le terrain des traumatismes graves avec hémorragie et du transport rapide vers un centre de traumatologie est largement

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promulguée. Les méthodes d'hémostase externe connaissent des progrès techniques, avec le développement de garrots et de pansements hémostatiques opérationnels, pouvant autoriser un contrôle plus simple, rapide et efficace des saignements extériorisés. L'hypothermie est indépendamment associée à un risque accru de mortalité, mais est accessible à une prévention initiée dès la prise en charge sur le terrain. L'impact d'une réanimation liquidienne excessive semble négatif. L'intérêt de la solution saline hypertonique est dénié. La place de vasopresseur comme la noradrénaline au début de la réanimation est encore en débat. L'utilisation précoce d'acide tranexamique est promue. Des stratégies de transfusion spécifiques sont développées en milieu préhospitalier.

*Conclusion.* – Il est essentiel que les praticiens civils et militaires impliqués dans les traumatismes continuent à partager les expériences et les commentaires constructifs. Et il nous faut maintenant réaliser des études cliniques prospectives bien conçues afin de faire avancer le sujet.



## 1. Introduction

Damage control was initially a naval tactic. It described actions like extinguishing local fires, stuffing mattresses into gaping holes, dogging down watertight doors to limit flooding and damage extension. These principles kept the ship afloat and allowed the ship to continue to fight, until a feasible plan for a definitive repair could be formulated.

Damage control surgery (DCS) was first used for patients with abdominal exsanguinating trauma in order to avoid prolonged operative times and prevent the onset of the lethal triad of coagulopathy, acidosis and hypothermia [1]. The concept of delay in definitive therapy while systems support is maintained is in fact the core principle of damage control strategy applied in hemorrhagic trauma. The quotation from Voltaire, "The art of medicine consists of amusing the patient while nature cures the disease", sounds as an inspiration. In essence, damage control equates with abbreviated surgery and restoration of near normal physiology, in a staged approach to a life-threatening injury. DCS appeared to be a strong concept for the surgical teams, as far as it seemed efficient, and it spread firstly to intensive care units, secondly to the prehospital milieu. Hence, DCS was associated with a specific resuscitation strategy, transfusion tactic being the corner stone [2]. And the damage control resuscitation (DCR) concept, initially strictly limited to the hospital, was then prolonged in prehospital setting.

The purpose of this review is to present this progressive extension of the concept of DC in adult trauma patients, from surgery to intensive care and prehospital setting, so creating a continuum of care.

## 2. Birth of the concept of damage control surgery

### 2.1. Definition

In 1983, Stone et al. published the first observation of intentional abbreviated laparotomy [3]. Coagulopathy was not as known as it is today but its severity was well received and the speed of hemostasis was only intended to allow survival. In 1993, Rotondo et al. formalized the principle of abbreviated laparotomy and proposed the term "Damage Control Laparotomy" in a retrospective study of 46 patients, with 22 survivors amongst the most seriously injured (vascular and more than two visceral injuries) [1].

The original description of the "Damage Control Laparotomy" consists of three phases that occur in hospital:

- in the operating room, brief surgical measures in a bleeding patient with unstable hemodynamics: obvious hemostasis, packs, suture of gastrointestinal leaks. Coagulopathy is underway, intervention must be rapid, focused on hemostasis, without trying to ensure one-step final repair;
- in the intensive care unit, avoid lethal triad: warming, correction of acidosis and coagulopathy;
- return to the operating room, after 24 to 72 hours of stabilization, for removal of packs and intestinal anastomoses, final vascular repair, and final closure of the abdomen.

This surgical strategy has been well reported, especially for liver trauma. And DCS has been extrapolated to manage hemorrhage in traumatic thoracic, cardiac, abdominal, urologic, orthopedic, extremity and peripheral vascular injuries. Over the following decade, refinements were made to the basic steps to produce the current model in use today. DCS has been discussed elsewhere in detail, and will not be discussed further here, in order to focus on ownership of the concept by teams in emergency medicine, anesthesia and intensive care.

### 2.2. Indications

The majority of trauma patients treated in both civilian and military settings do not require damage control surgery techniques. Based on the circumstances, and the clinical and biological parameters, predictive criteria of DCS (often confused with coagulopathy or massive transfusion) are proposed in the literature. The usual guidelines for indications of DCS are summarized in Table 1 [4].

Well-designed studies that support the efficacy of DCS are limited. A Cochrane analysis recently assesses the effects of damage control surgery compared to traditional immediate definitive surgical treatment for patients with major abdominal trauma [5]. A total of 2551 studies were identified and soon excluded. No randomized controlled trials were found, and controversies persist [6]. Whatever, the DCS has switched in two decades from a concept to a shared surgical practice, as far as it has convinced the trauma center surgical teams to include it in their daily practice. Undoubtedly developments made are largely a consequence of analysis of data held in the US and UK Joint Theater Trauma Registry, demonstrating audit at its best, with results quickly converted into practice (Iraq and Afghanistan have unfortunately permitted important cohort studies) [7]. On one hand, it could appear naive to anticipate prospective controlled trials of DCS techniques in military setting. On the other hand, ethical considerations might seriously limit the ability to conduct prospective controlled trials in civilian population. And now we will see how the concept of DC has triumphed in intensive care: the main application of the procedure is traumatic hemorrhagic shock.

## 3. Setup of the associated critical care: damage control resuscitation

The term DCR refers to both the surgical techniques and the specific medical strategies. The underlying principle is to provide physiological optimization that will allow the best chance for