Implementation of damage control for severe traumas in perilous conditions with limited medical resources

Mise en œuvre du contrôle des dommages pour les traumatismes graves dans des conditions périlleuses avec des ressources médicales limitées

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Abstract

Background: damage control in trauma describes a strategy for the management of haemorrhagic shock centered on limited rescue surgery when required together with resuscitation. The aim is to present the results of a DC protocol for a low resource setting in a conflict environment.
Methods: this is a descriptive study of damage control in severe trauma patients conducted between January 2014 and December 2018 in a peacekeeping hospital deployed in Kidal region, Mali.
Results: during the study period and per year, 9786 consultations were carried out, of which 1468 were surgical consultations. Of the 752 surgeries performed, there were 498 traumas. There was an average of 150 (30,1%) serious trauma per year who underwent DC. They were predominantly male (136 / 90.7%) and soldiers (112 / 74.4%) with a mean age of 26.6 years. 85% were rated absolute emergence (128 / 85%). Traumas of limbs predominated due to weapons (143 / 95,6%). All patients presented haemorrhagic shock received rescue care and DCR with RBC transfusion. For GA + fast sequence induction, we used preferentially propofol (78 / 52%). DCS was indicated mostly for orthopedic stabilization (113 / 75%). Following admission, 136 (90.7%) patients were stabilized. Nine (6.3%) patients had worsened. A total of 100 patients (67%) benefited of Medevac after stabilization. Four deaths occurred after admission to the hospital (5 / 3%).
Conclusion: this study showed that, it is possible to implement effectiveness DC in severe traumas in limited resources environments, by vulgarizing these therapeutics when indicated even in rural and teaching hospitals, develop medical life support plans and medical simulation training.

Keywords: Damage control, traumas resuscitation and surgery, critical and rescue care, haemorrhagic shock, perilous environment.

Résumé

Contexte : En traumatologie, le damage control décrit une stratégie de gestion du choc hémorragique par l'articulation d'une chirurgie de sauvetage limitée associée à des mesures de réanimation.
Objectif de l'article : L'objectif est de présenter les résultats d'une étude concernant les blessés qui ont bénéficié d'un protocole de damage control mis en œuvre dans un environnement de conflit avec des moyens limités.
Méthode : Il s'agit d'une étude descriptive concernant la mise en œuvre de mesures de damage control chez des patients traumatisés graves.
Cette étude a été menée entre janvier 2014 et décembre 2018 dans un hôpital de maintien de la paix déployé dans la région de Kidal au Mali
Résultats : Durant la période concernée, 9786 consultations ont été réalisées dans l'hôpital concerné dont 1468 consultations chirurgicales. Sur les 752 chirurgies réalisées, 498 l'ont été pour des atteintes traumatiques.
En moyenne, 30,1% des traumatismes graves ont bénéficié d'une mesure de damage contrôle. Il s'agissait principalement d'hommes (136 / 90,7%) et de soldats (112 / 74,4%) avec un âge moyen de 26,6 ans. 128 soit 85% se sont trouvés catégorisés comme urgence absolue. Les traumatismes des membres étaient majoritairement des blessures par armes (143 / 95,6%).
Tous les patients présentant un choc hémorragique ont reçu des soins de secours et une DCR avec transfusion de globules rouges. Pour l'induction de l'AG + séquence rapide, c'est le Propofol qui a été utilisé préférentiellement (78 / 52%). La DCS a été indiquée principalement pour la stabilisation orthopédique (113 / 75%). Après l'admission, 136 (90,7%) patients ont été stabilisés. Neuf (6,3 %) patients ont vu leur état s'aggraver.
Au total, 100 patients (67%) ont bénéficié d'une évacuation médicale après stabilisation. Seuls quatre décès sont survenus après l'admission à l'hôpital (3%).
Conclusion : Cette étude a montré qu'il est possible de mettre en œuvre un damage control efficace pour des traumatismes graves même en environnement difficile et lorsque l'on dispose de ressources limitées. Il importe donc d'enseigner largement ce type de technique dans les hôpitaux universitaires mais également dans les établissements ruraux en diffusant des protocoles de prise en charge et en développant des formations par simulation.

Mots-clés : Soins de sauvetage, réanimation et chirurgie des traumatismes, choc hémorragique, damage control, environnement périlleux .

Background

The concept of damage control (DC) for trauma encompasses a strategy for the management of haemorrhagic shock centered on limited rescue surgery, associated with perioperative resuscitation, for critically ill patients.[1,2] This concept was first described as DC surgery (DCS) for military patients with penetrating abdominal trauma complicated of serious haemorrhage.[3] DC resuscitation (DCR) refers to the modalities of pre and intra-hospital resuscitation performed in patients with traumatic haemorrhagic shock under.[4] Considerations are given nowadays to the lethal diamond : coagulopathy, hypothermia, acidosis and hypocalcemia.[5] The concept of DCR combines early transfusion of red blood cell concentrates (RBC) and coagulation factors.[3,6,7] Early aggressive transfusion strategy of plasma / platelet / RBC at a 1/1/1 ratio, has been associated with a reduction in haemorrhagic shock related mortality in the severely traumatized patients in 35%.[7] Despite therapeutic progress,[8,9] haemorrhagic shock remains a major cause of preventable death.[10]

The concept of DCR is the standard of care in war medicine.[5] However, the use of weapons, and traumas caused are no longer confined to armed conflict, but civilians are also frequently victims. The implementation of DCS and DCR is not directly applicable in Kidal, and more generally in sub-Saharan Africa, due to the weakness of medical structures and the location of peacekeeping installations in an insecure zone. The remote DCR[11] requires human and material resources often inaccessible in our precarious conditions. This seems to be confirmed by the fact that there is not enough publications on the treatment of war-wounded in low income countries[12] despite recurring armed conflicts in these areas. This protocol is in line with the international guidelines.[13-15] These recommendations required adaptation because of the environment of the hospital area, particularly the long evacuation times needed. Medical regulations within, and feedback from, the theatre in the war situation also effected changes in the protocol to optimize logistical and organizational aspects of trauma management. In addition, high frequency of terrorist attacks are occurring in Sahelian strip and extending to Guinea gulf countries realizing public health concern, displacement of populations with many socio-economic consequences.

The main objective of this work is to present the results of the implementation of a resource limited DC protocol for the benefit of the seriously wounded who presented haemorrhagic shock for 5 year, between January 1, 2014 and December 31, 2018.

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Methods

Study Framework: description of Togo Level II Hospital (HN2)

The bad security context in Kidal region, where the cities of Kidal, Aguelhok, and Tessalit are located, has led UN to deploy civilian and peacekeeping personnel to stabilize this region. Medical support for forces is provided by a Level II hospital staffed by a Togolese team. This hospital was initially deployed in Sevare since january 2013 before being moved to Kidal in January 2015. In addition to more than 4000 officials, this hospital also provided care to allied forces and local civilian population. The missions of the HN2 involve management of medical-surgical emergencies, stabilization of the wounded, external consultations, hospitalizations, dental care, paraclinical examinations (laboratory and medical imaging), and medical evacuations (Medevac). The HN2-Togo is staffed by 15 doctors (1 chief medical officer, 1 generalist, 5 emergency physicians, 2 surgeons: trauma and generalist, 1 resuscitation anesthesiologist, 1 internist, 1 public health, 1 dental surgeon, 1 pharmacist, 25 nurses). Including technical staff, there were 70 people at the hospital. The HN2 has 1 triage room, 2 consultations, 4 resuscitation beds, 4 intensive care beds, 1 operating room, 1 dental office, 1 laboratory, 1 medical Imaging unit with 2 ultrasounds machins and 1 fixed Rx, 1 pharmacy and 1 aero medical evacuation team (Amet). There were an armored ambulance and a light ambulance. All these human and material resources give the HN2 a daily capacity of 5 surgical procedures, 40 medical consultations and 10 dental consultations. The hospitalization capacity of HN2 is 20 hospitalizations with an average duration of seven days. The hospital is self-sufficient in medications and consumables for 60 days minimum. The level of prioritization for wounded evacuation is as defined: "Alpha" (A) patients are those who must be evacuated within 90 minutes, four hours for "Bravo" (B), and 24 hours for "Charlie" (C).[16] Patients categorized as "Echo" (E) are those who died before they arrived at the hospital.

Method

All patients who were received at HN2 from January 2014 to December 2018, and who were treated according to a DCR or DCS protocol, were included. The data collection was based on the hospital's records of consultations, hospitalizations, and operating records, as recommended in the updated contingent own equipment manual of 2017.[17] The collection was carried out by the coordinating physician and the study's investigative doctors trained for this purpose. For each victim supported, the following data was extracted: 1) socio-demographic data; 2) circumstances of the accident or attack; 3) level of evacuation prioritization of the victim; 4) presence or absence of haemorrhagic shock; 5) clinical, standard X-ray, FAST ultrasound and blood test data; 6) emergency and 72-hour post-operative intensive care, 7) type of anaesthesia and analgesia; 8) immediate evolution; 9) information on medical evacuation; and 10) occurrence of death, if appropriate. All the data was initially collected on a standardized and anonymous form and then entered later in an Excel spreadsheet (Microsoft® Redmond, USA) by the coordinating doctor of the study after agreement of committee of ethics and protection of persons from the medical staff.

Operational definitions

Limited medical resources: areas with limited blood, reagents, surgical equipment, insufficient medical transport, absence of CT scanners.

Local conditions: isolated regions, climatic constraints (heat, sandstorm), long distancies from largest cities.

Results

The review of activities of the hospital in this hostile environment (figure 1) during the study period was as follows: 9786 consultations of which 1468 surgical consultations, 8282 biological examinations, 2222

Figure 1 : ambulance fired by terrorist

Figure 2 : triage, categorization during massive casualties

x-rays and ultrasounds, 1306 hospitalizations and 578 Amet per year.

Description of the trauma patients

On average and annually, 752 surgeries were performed, 498 (66%) were traumas. Among these, there were 150 (30,1%) severe traumas requiring care according to the DC protocol. These 150 averaged wounded every year were mostly men (136 / 90.7%) of whom almost 75%military (112 / 74.4%). The mean age of the injured were 26.6 years with ranged from 4 to 52 years. Most of the injuries were related to armed conflicts in the region: complex kamikaze attack with explosions of mines / improvised explosive devices (77 / 51%), heavy weapons (36 / 24%) and gunshot (31 / 20,6%). Injuries related to road accidents were minor (6 / 4.4%). The injuries caused were often treated in mass casualty context, admission of more than 5 serious wounded at the same time, needing special procedures as categorization (figure 2). Among traumatized patients, the majority were classified as absolute (128 / 85%) emergence and (23 / 15%) relative emergence. All patients presented haemorrhagic shock. The anatomical location of trauma was predominantly in limbs (105 / 69.8%). Some patients had multiple fractures (56 / 37.2%) or multiple injuries (17 / 11.6%).

Description of medical care

All patients had benefited from a medical assessment with laboratory analysis and radiological imaging (figure 3). All patients received emergency rescue care and DCR (see Table I). They had been transfused by 1 packed RBC / 1 fresh frozen plasma.; in half of cases received poly transfusion. General anaesthesia with fast sequence induction was required using: Propofol (92 / 61%) and Ketamine (41 / 27%). For the maintenance, Fentanyl was the only morphinic available and Ketamine or Propofol (113 / 75%) were used according to the hemodynamic state of patients. Regional anaesthesia was performed for 13 including three cases of peripheral nerve blocks under ulstrasounds. We use multimodal analgesia for all patient with morphine in 44 cases.

The surgical procedures performed for the patients who benefited from DCS is presented in Table II. Laparotomies included repairs such as resection, anastomosis, or

Table I Diagnostic tests, emergency rescue care and damage control resuscitation.

Types of diagnosis and non-surgical therapy		**Number of interventions performed for the 150 patients**	
Diagnostic tests	FAST Ultrasound	1 254	53
	Standard X-ray		364
	Laboratory tests		837
Emergency and critical care	Central venous access	692	52
	Oxygen therapy		75
	Tracheal intubation		40
	Mechanical ventilation		40
	Fluid replacement		79
	Transfusion		150
	Administration of vasopressors		23
	Administration of tranexamic acid		150
	Narcotics		44
	Morphin		44

Table II damage control surgery procedures performed .

Types of surgery	**Number performed**
Orthopaedic stabilization	75
Hemostasis laparotomy	20
Open reduction internal fixation of fractures	17
Rescue amputation	11
Fasciotomy	10
Suturing	9
Thoracic drainage	8
Vascular ligation	7
Hepatic packing	2

Figure 3 : team performing X-rays and FAST ultrasound

excision and suture for perforated small bowel and or small bowel stoma, and stomy for perforated large bowel. Hepatic packing was done for ruptured liver. In addition to the surgical procedures described, numerous extractions of foreign bodies, suturing, local care, and orthopaedic stabilizations were done.

All patients with open or untreated trauma, were systematically treated with antibiotics, analgesia, anti-inflammatory drugs, thromboembolism prophylaxis, tetanus toxoid and gastric protection. The electrolytic balance was assured with an early resumption of feeding in the absence of contraindication. Following their care, 136 (90.7%) patients were stabilized. Nine (6.3%) patients had worsened. A total of 100 patients (67%) received medical evacuation (Medevac) after stabilization in accordance with UN standards. Four deaths occurred after admission to the hospital (5 / 3%) due sometimes to life-threatening early critical lesions (figure 4) associate to hemorrhagic shock, acute post trauma coagulopathy irreversibly leading to multi-organ failure.

Discussion

Implementation of DC protocols within HN2

The management of seriously traumatized patients, including war-wounded in isolated situations is complex. It is based on three pillars: equipment (technical platform, etc.), personnel (staffing, training), and use of standardized protocols. Respect for these principles at HN2 enabled the simultaneous care of 29 victims, including 5 'alpha' and 10 'bravo', after attack of Kidal camp in 2016.[18] Following this attack, three hemostasis laparotomies, two exploration thoracotomy, one rescue amputation, two limb vascular ligations, and numerous debridements with orthopaedic stabilization were performed within a short time. The quality of the triage of the wounded also played a key role in the care of these wounded.[19] The protocols implemented at HN2 throughout the five years covered by the study are DC laparotomy, orthopaedic and DCR. These protocols are an adaptation of internationally recognized protocols to fit with constraints in isolated situations.

Figure 4 : ballistic cranio cerebral wound

Damage control laparotomy

In all cases of laparotomy performed at HN2, the abdominal cavity was not completely closed to prevent abdominal compartment syndrome and allow surgical revision after Medevac. The techniques of damage control laparotomy with incomplete closure of the abdominal cavity have evolved since primary skin closure with suture or installation of clips, followed by improvised vacuum plastic silos such as the pockets of Bogota, up to the modified vacuum packs of Barker.[20] If the onset of abdominal compartment syndrome seems to be under control, the major challenge remains the management of fascial retractions and intra-abdominal overpressure with loss of substance of the abdominal wall and wide abdominal hernia. When

Figure 5 : Polycriblage in a child

comparing these different techniques, the results are variable and debated.[21] The extension of DC laparotomy to non-traumatic surgical abdominal emergencies should also be beneficial in limited medical resources.[22]

Orthopaedic Damage Control

The achievement of local haemostasis had been achieved through the use of tourniquets and haemostatic dressings. Amputations were decided upon with respect to the indications for amputations in emergency.[23] As part of the activity of HN2, orthopaedic DC relies on the combination of debridement-dressing and temporary bone stabilization to avoid serious infectious complications that could compromise subsequent attempts at reconstruction.[24] The current literature suggests no significant difference in the risk of compartment syndrome between orthopaedic and early reconstructive surgery. However, improved outcomes have been associated with orthopaedic damage control by the implementation of the DCR.[25]

Damage control resuscitation

In terms of diagnosis and treatment, there are current standards of care for damage control for the wounded.[6,26] The treatment includes early introduction of blood products with aggressive transfusion according to protocol plasma / platelet / RBC ratio: 1/1/1;[8] early use of tranexamic acid; use of vasopressors and compliance with contraindications to the use of coagulation factors.[27] Similarly, measurement of lactate, pH and base deficit, and the assay of coagulation factors is needed during patient monitoring. In all cases, management optimization includes 3 components: DC ground zero, DC resuscitation and DC surgery.

Transposition of DC implementation from HN2 to other medical facilities in Sub-Saharan Africa

Sub-Saharan Africa remains an area where medical facilities are limited, often with a lack of equipment and trained personal continuously. The example of HN2 shows, however, quality care for severe wounded is possible.

Necessary requirements:

- The presence of medical equipment: advanced technologies used in developed countries[8] still seem not very accessible in these regions. However, HN2 activity report shows that simple, effective, safe and less expensive solutions can be used in a limited resourced environment.[19,24,28] This equipment should form the basis for staffing of medical facilities in this region.
- Respect standardized care protocols (DCR, DCS, etc.). Quality care of the wounded requires compliance with standardized protocols. However, constraints inherent to the sub-Saharan zone require an adaptation of these protocols to the realities on the ground.
- The presence of trained personnel. The training of medical, nurses and paramedics in damage control strategy is essential to deal with emergencies.[29] This training should include knowledge of protocols and use of equipment.

At a time when this mission is coming to the end[30], it seemed useful to share this feedback to strengthen the hospital organization in collective emergency situations in our regions. Promote more civilian-military health collaboration both in rural and teaching hospitals should help overcoming new and emerging public health challenges in our regions and more generally barriers to the culture of research and innovation in Africa[31]

Conclusion

Providing care when you have bombings in your hospital is a challenge, you need to run to underground or bunker for safety and come-back. That can be more difficult in regions where there is few or no traumas centers. The HN2 hospital and staff, infrastructure, civilian and military population are subject to attacks and different types of threats. The activity report of HN2 shows that it is possible to meet this challenge, but many actions need to be undertaken such as the implementation of protocols of emergency care (damage control, etc.) adapted to the specific constraints of these regions, improvement of medical facilities and regular training of medical and nurses. For these actions to be efficient, they could be part of regional development programs with the support of national and international partners.

List of abbreviations

Amet: aero-medical evacuation team
DC: damage control
DCS: damage control surgery
DCR: damage control resuscitation
FAST: Extended-focused abdominal sonography for trauma
GA: General anesthesia
HN2: Togo level 2 hospital
IED: improvised explosive devices
Medevac: medical evacuation
RBC: red blood cells
UN: United Nation

Declarations

Ethical Approval and Consent to participate: All procedures performed in our study were in accordance with the ethical standards of the institutional and national research committee and with the 1964 Helsinki declaration and its later amendments. For our type of study (retrospective study), formal consent was not required.

Authors' contributions

HDS perform manuscript conception and draft critically revised the manuscript. HDS, EP, SA, DL, YC contribute to important scientific knowledge giving the final approval.

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