Injury, Int. J. Care Injured 45S (2014) S39–S42

Contents lists available at ScienceDirect

Injury

journal homepage: www.elsevier.com/locate/injury

Pre-hospital and early in-hospital management of severe injuries: Changes and trends

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ARTICLE INFO

Keywords:
Trauma
Pre-hospital management
In-hospital management
Trends

ABSTRACT

The pre-hospital and early in-hospital management of most severely injured patients has dramatically changed over the last 20 years. In this context, the factor time has gained more and more attention, particularly in German-speaking countries. While the management in the early 1990s aimed at comprehensive and complete therapy at the accident site, the premise today is to stabilise trauma patients at the accident site and transfer them into the hospital rapidly. In addition, the introduction of training and education programmes such as Pre-hospital Trauma Life Support (PHTLS®), Advanced Trauma Life Support (ATLS®) concept or the TEAM® concept has increased the quality of treatment of most severely injured trauma patients both in the preclinical field and in the emergency trauma room. Today, all emergency surgical procedures in severely injured patients are generally performed in accordance with the Damage Control Orthopaedics (DCO) principle. The advancements described in this article provide examples for the improved quality of the management of severely injured patients in the preclinical field and during the initial in-hospital treatment phase. The implementation of trauma networks, the release of the S3 polytrauma guidelines, and the DGU "Weißbuch" have contributed to a more structured management of most severely injured patients.

Introduction

The pre-hospital and early in-hospital management of most severely injured patients has dramatically changed over the last 20 years. In this context, the factor time has gained more and more attention, particularly in German-speaking countries. While the management in the early 1990s aimed at comprehensive and complete therapy at the accident site, the premise today is to stabilise trauma patients at the accident site and transfer them into the hospital rapidly – not any treatment that is possible should be conducted at the accident site, unless it is vital for life [1,2]. This, for example, applies to preclinical intubation and volume therapy, both of which will be discussed in this article.

Besides these paradigm changes regarding the treatment of most severely injured patients, the introduction of training and education programmes has increased the quality of treatment of most severely injured trauma patients – both in the preclinical field and in the emergency trauma room. Examples are the Pre-hospital Trauma Life Support (PHTLS®) programme for the preclinical field and the Advanced Trauma Life Support (ATLS®) concept or the TEAM® training for the initial in-hospital phase. The latter is a globally established concept for the treatment of most severely injured trauma patients in the emergency trauma room, which was established in Germany in 2003. Nowadays, the ATLS® concept is used extensively on a national level. Furthermore, the strategies of Damage Control Surgery are taught in the Definitive Surgical Trauma Care (DSTC™) programme. Altogether, this has not only led to improvements of the factor time but also of the treatment's quality.

Important advancements regarding the structural prerequisites have been achieved by introducing the "Weißbuch of the German Trauma Society (DGU)" in 2006 and by establishing comprehensive trauma networks. The extent and content regarding the treatment of most severely injured patients have been brought to a maximum level by completing the S3 polytrauma guidelines of the DGU in 2011 [3–6]. A few articles have already shown that the implemented restructuring of the management of most severely injured patients in combination with the latest guidelines can lead to improved patient outcomes [7]. Particularly the implementation of empirical knowledge, experience, and evidence-based contents

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http://dx.doi.org/10.1016/j.injury.2014.08.016
0020–1383/

into clinical processes as well as the meaningful communication of these insights within predefined programmes have created a fairly wide basis for the improvement of the management of severely injured patients. Continuous evaluation and improvement of this content and its rapid communication is a crucial aspect in this context. Identifying adverse events and errors within these processes plays a vital role [8–10], as well as the identification of errors and deaths that could have been prevented. According to Davis et al., [11] up to 6% of trauma-related deaths could have been prevented. Gruen et al. [10] were able to show that the delayed treatment of active torso haemorrhages (pelvis, abdomen, and thorax) was the most common cause for preventable deaths. The delayed diagnosis and treatment of pelvic haemorrhages seems to be the number one "killer". Soreide et al. [12] showed that this type of bleeding – besides traumatic brain injuries – is responsible for most of the deaths, particularly during the early trauma phase, and that it is feasible and mandatory to improve the treatment of such bleeding. This is also true with regard to the paramount importance of a structured and meaningful transfusion and coagulation management for which multiple improvements are expected in the future [13].

Advancements in airway management

Endotracheal intubation still represents the gold standard in terms of maintaining a safe airway and ventilation. However, intubation is an invasive procedure potentially causing considerable risks. Moreover, there are some specific aspects that must be considered in the preclinical field: level of experience (existing education), conditions at the incident scene (jammed patients etc.), type of patient transfer (air transportation vs. ground-based), duration of patient transfer, and comorbidities in the respiratory tract plus (assessable) intubation barriers. Therefore, preclinical intubation should only be performed after the strict consideration of alternative indications. The uncritical use of preclinical intubation – as a so-called "must" of the preclinical management of trauma patients – even appears to be harmful rather than beneficial. The following ATLS® principle should always be considered: Do not cause further harm! [6] Based on TraumaRegister DGU®, it was possible to show in patients with thoracic injuries that preclinical intubation may result in disadvantages even in patients without respiratory insufficiency [14]. A recent study about Anglo-American emergency medical services demonstrated that intubation – for example when conducted due to the aggressiveness of patients rather than based on clear intubation criteria – was associated with significantly increased rates of pneumonia and extended hospitalisation [15].

A 2011 AUC matched-pair analysis based on TraumaRegister DGU® that was conducted in moderately injured patients (mean ISS score of 15.1) showed even clearer that the outcome of preclinically intubated patients was significantly worse (higher rates of multi-organ failure and organ failure, sepsis, etc.) despite similar baseline conditions [16]. This analysis is of particular relevance for emergency medical services in German-speaking countries.

This change over the last 20 years – from routine intubation in most severely injured patients to an intubation based on clearer indications – resulted in an improved quality of care. However, the prerequisites for intubation during the further course in the hospital and in the emergency trauma room, respectively, are still unclear. Generally, the same indications certainly apply in the hospital as well. However, essential diagnostic measures (such as CT scans) may be required in agitated and constantly moving patients, in order to prevent life-threatening conditions or severe functional damages.

Advancements in volume and coagulation management

Uncontrollable bleeding following trauma is considered as the most common preventable death cause [17]. The immediate effects of bleeding and shock may result in direct and indirect sequelae in surviving patients. 20% of patients develop multi-organ failures during hospitalisation and 20% experience septic episodes. Multi-organ failures and septic conditions – besides thromboembolic complications – lead to a significant increase of mortality following polytrauma [18]. The fastest possible and targeted substitution of blood and coagulation products has high priority when treating patients in the initial phase following trauma. However, this treatment must be meaningful and take into account the preclinical treatment, e.g. preceding fluid therapy [19].

Unfortunately, there is no worldwide consistency with regard to a structured treatment of haemorrhages. However, it has been established for the preclinical management following trauma that a rather restrictive volume substitution seems to be beneficial for both, adults and most severely injured children [20–23]. Recent studies based on TraumaRegister DGU® have also demonstrated for blunt traumas that non-indicated preclinical volume therapy may be associated with worsened outcomes and with increased mortality. The same studies also suggest that the patient's baseline characteristics upon reaching the hospital (e.g. coagulation or initial haemoglobin value) are significantly worse compared to a control group with identical baseline characteristics [20–23]. Furthermore, it was shown that the administration of higher volumes (>1500 ml) has been associated with an extended scope of therapy (e.g. insertion of thoracic catheter). And this resulted in an increase of the preclinical emergency treatment time. It must be emphasised in this context that patients with blunt trauma, in particular, only benefit from in-hospital therapy, while mortality increases by 1% with every 3 min of time to emergency surgery, as shown by Clarke et al. [2] in a study with patients following abdominal trauma. A more restrictive volume therapy is widely established in Anglo-American countries and has recently been supported by Haut et al. [24]. This article will not contribute to the discussion of the "stay and play" and "load and go" approaches, because the positive experiences and arguments regarding the emergency medical system in German-speaking countries – well functioning for decades – do not need to be repeated. However, it should be emphasised that the factor time is crucial to the therapy, and that any extensive and possibly non-indicated therapy in individual cases may harm the patient. The recommendations for patients with penetrating trauma, however, are clear: rapid transfer into an appropriate hospital, and no extensive volume therapy.

The current algorithms (that are used in hospitals for coagulation and transfusions) range from undirected treatment and strict transfusion protocols to the ROTEM-based substitution of single components depending on the clinical bleeding tendency. In the US, the concept of administering red blood cells packs and fresh frozen plasma in a ratio of 1:1–1:1.5 has been favoured. This resulted in significantly reduced mortality rates in some studies [25]. In contrast, a point-of-care-based, calculated, targeted coagulation management using coagulation factor concentrates – which was shown to be extremely efficiently – has been established in some European centres [26]. In addition to the more targeted use of coagulation factors, fibrinogen substitution seems to play a decisive role. In trauma patients, this is the first factor that drops down to critical levels, e.g. after increased consumption. Therefore, the early and efficient administration of fibrinogen (e.g. 2–6 g for adult patients) in the emergency trauma room is as useful as the administration of single factors.

Another important factor of the coagulation management is the administration of tranexamic acid. A controlled randomised