

Lifesaving procedures in hemostatic resuscitation for the future battlefield

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THE MASSIVE BLEEDING

The massive bleeding is

- the 2nd most common cause of death in polytraumatic patients
- the most common cause of death in young people
- **the most of death in war injuries**

Up to 60% mortality rate death in cases with massive bleeding occurs within 6 hours.

High morbidity and mortality causes by „lethal trias“, which represent hypothermia, acidosis and coagulopathy (Fig 1).

Only early and aggressive treatment and application of **hemostatic resuscitation** principles may correct coagulopathy, control bleeding, has positive effect to survival and improve outcomes and in many cases the fatal outcome can be avoided, when are applied within RDCR (Remote Damage Control Resuscitation) procedures and in the shortest possible time after the onset of bleeding (Fig 2, Fig 3) The main goal of hemostatic resuscitation is to stop the development of coagulopathy, therefore the view of blood transfusion at massive bleeding has shifted from the mere substitution of blood volume and missing cells (RBCs) to an important part of the prevention or therapy of coagulopathy

Fig. 1 – Lethal trias

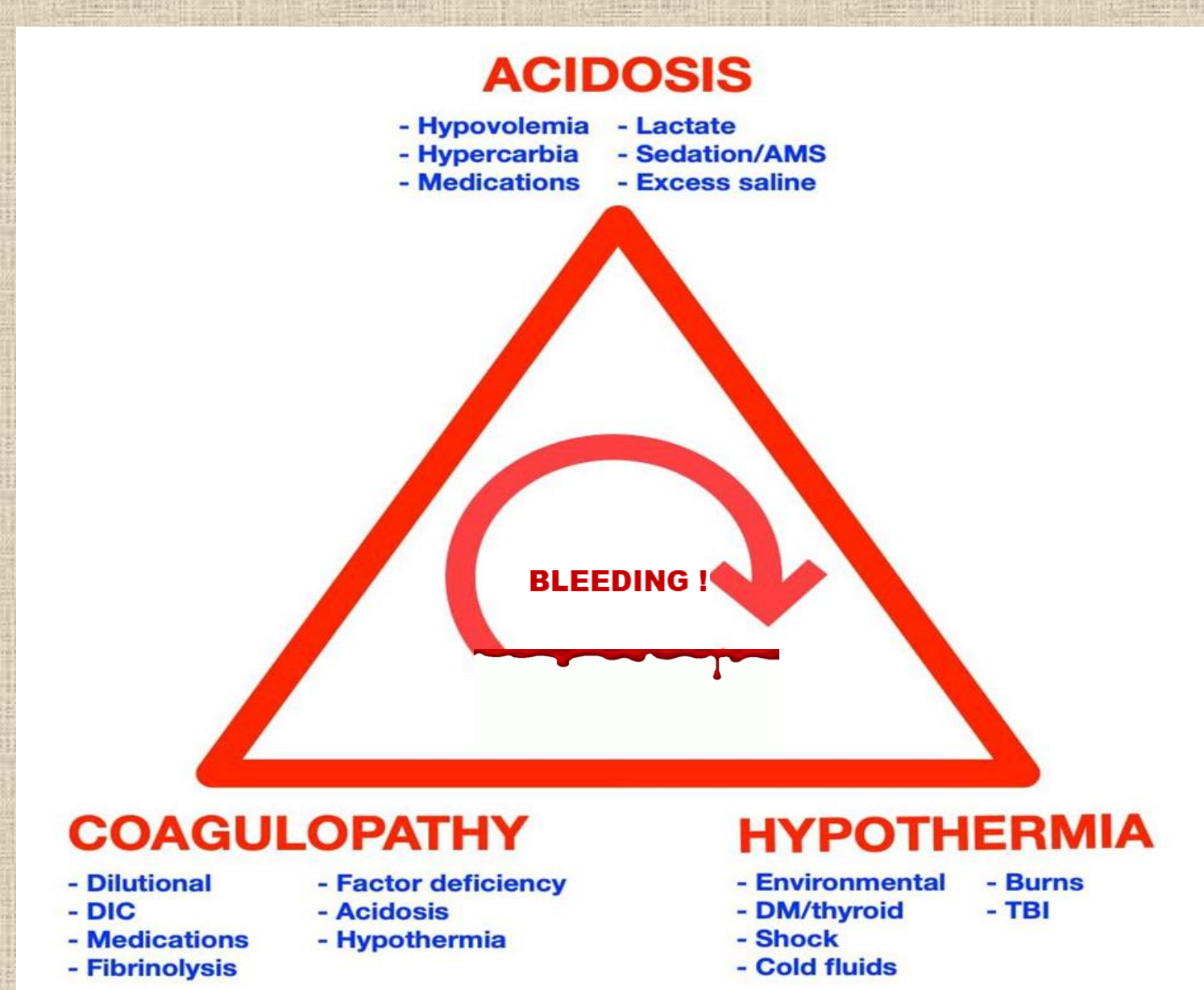
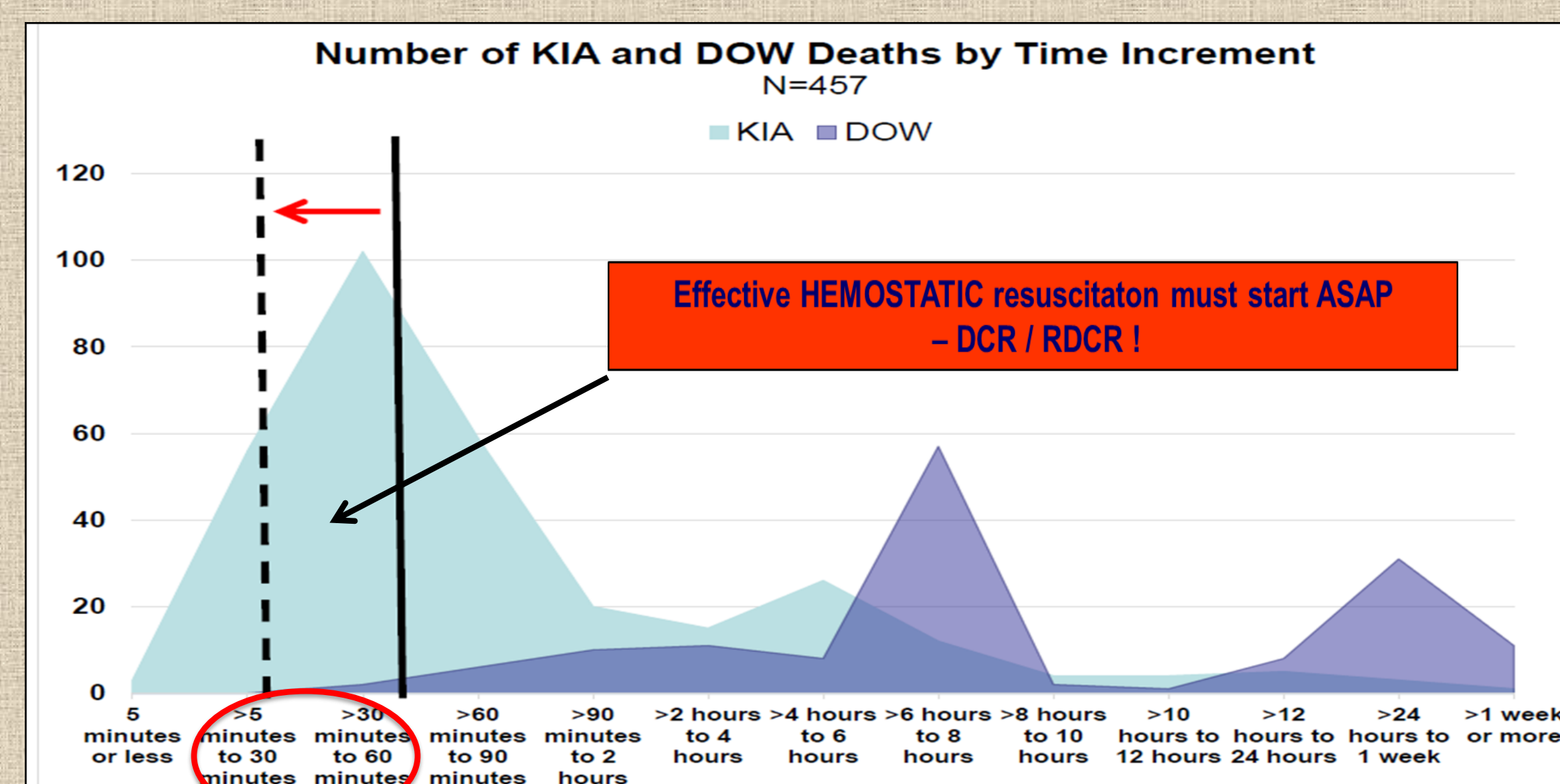
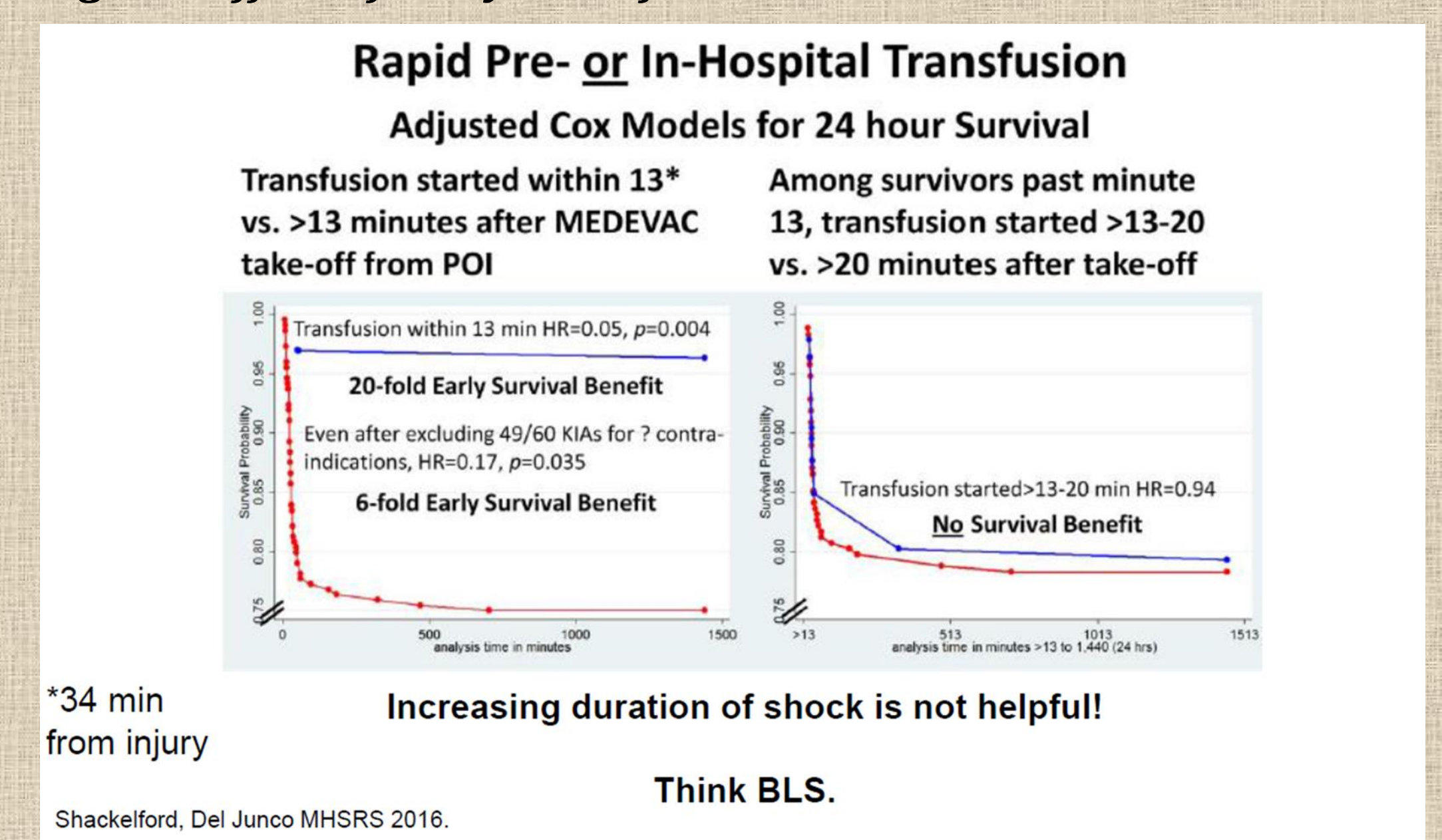


Fig. 2 - Mortality at Battelfields



90% preventable injury-related death is associated with hemorrhage (Shackelford, et al. JTS 2016)

Fig. 2 - Effect of early transfusion on survival



RDCR (REMOTE DAMAGE CONTROL RESUSCITATION)

THOR Position Paper on Remote Damage Control Resuscitation: Definitions, Current Practice and Knowledge Gaps

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Life Saving Intervention and Evacuation Location and Duration Definitions

A *lifesaving intervention* is defined as a medical procedure that if not performed conveys a high probability of increased morbidity or death. The terms *remote* and *forward* both are to be defined as the pre-hospital setting or phase of resuscitation. The terms *far-forward* and *austere* are defined as the environment where professional health care providers normally do not operate and basic equipment and capabilities necessary for resuscitation are often not available. Typically the austere environment poses challenges like limited access to power supply, sheltered treatment facilities, exposure to different light conditions, weather, altitude and ongoing threat from the enemy in military scenarios. To describe the duration of evacuation times, the term *delayed* evacuation will be defined as >60 minutes from wounding until reaching a medical treatment facility (MTF) that is capable of providing Damage Control Surgery (DCS) and DCR. The term *prolonged* evacuation will be defined as >6 hours from point of wounding until arrival at an MTF capable of providing DCS. These definitions apply equally to both civilian and military environments. While they could be considered somewhat arbitrary, they are commonly used definitions with evidence to support their use in literature. (31)

Hemostatic Adjuncts

Hemostatic adjuncts are either mechanical or injectable. Both have advantages in different scenarios and can ideally be combined to best affect hemorrhage control.

Mechanical hemostatic adjuncts include: extremity tourniquets, junctional tourniquets, abdominal tourniquets and gauzes impregnated with pro-coagulants. More invasive types of mechanical devices to stop bleeding have recently gained increased interest. Resuscitative Endovascular Balloon Occlusion of the Aorta is an example of an emerging technique that might be considered for use in the prehospital environment. (32) *Injectable hemostatic adjuncts* include manufactured/derived hemostatic agents like plasma derivatives such as solvent detergent treated plasma or lyophilized plasma products, fibrinogen, prothrombin complex concentrates (PCC), Recombinant human Factor VIIa (rFVIIa), other factor concentrates, calcium, magnesium, and tranexamic acid (TXA).

Labile Blood Products and Biologics derived from Plasma

Several therapeutic products are derived from human blood, which in most countries, are divided into two primary categories: 1) Labile blood products and; 2) biological medications derived from plasma by fractionation and concentration techniques.

CONCLUSION

Emphasizing **TIMING** as a key factor for successful hemostatic resuscitation and the use of all options achieve this:

- **prehospital care** – concept RDCR and „Blood far forward“
 - LTWB (Low Titre Whole Blood)
 - Dried plasma
 - Fibrinogen
- **PLTs must be** part of early ratio-based tranfusion therapy and MTP, their easy accessibility can be achieved with (moreover hyperfunctional)
 - Cold stored PLTs
 - Frozen PLTs
- **LTOWB** - the advantages over individual components include the absence of the RBC preservative, the provision of cold stored platelets, simplification of the logistics of the resuscitation by providing balanced resuscitation in one bag instead of three, fewer donor exposures and more
- **WBB (Walking Blood Bank)** = procedure for collection and transfusion WB in pre-hospital care
- **Dried plasma** (freeze dried or spray dried)
 - provides an alternative for early plasma transfusion in the resuscitation of hemorrhagic shock when blood or fresh frozen plasma are not immediately available.
 - is shelf-stable for prolonged periods, can be stored at room temperature, is easy to transport, reconstitute, and administer
 - The NATO COMEDS Blood Panel has identified a critical deficiency for DP provision across the multi-national force and advised all nations to stock up.

