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Literature Review

FLUID RESUSCITATION IN TRAUMA

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ABSTRACT

Introduction: Trauma is a problem faced everyday in the emergency room of the hospital where the researcher works. The degree of trauma from the mildest to life threatening can be found in sufferers. The cause of death in trauma sufferers is hypovolemic shock due to bleeding. The amount of blood loss volume from the patient can be estimated by looking at the clinical signs of the patient. **Literature Review:** In the condition of tissue hypo-perfusion, it will cause a chain process which will eventually lead to cell death. Hypo-perfusion causes anaerobic metabolism, lactic acidosis (coagulopathy, enzyme dysfunction), Na-K pump malfunction (cellular swelling and cell death), there is hypothermia (increase of oxygen demand, coagulopathy). Hypo-perfusion will cause a vicious circle, in which processes that aggravate one another will occur. With the administration of fluids (crystalloid, colloid, transfusion) will improve the hypo-perfusion that occurs in the body. **Conclusion:** The management of hypovolemic shock due to bleeding requires an understanding of the physiology and pathophysiology that occurs due to bleeding. To get maximum results and improve outcome from sufferers, it needs solid team work. Treatment can be different depending on the conditions, equipment and facilities of the hospital / emergency room as well as the policies of each place.

Keywords: Fluid Resuscitation, Trauma, Emergency Room, Hypo-perfusion

ABSTRAK

Pendahuluan: Trauma merupakan masalah yang dihadapi sehari – hari pada ruang gawat darurat rumah sakit tempat kita bekerja. Derajat trauma mulai yang paling ringan sampai mengancam jiwa bisa kita temukan pada penderita. Penyebab kematian pada penderita trauma adalah syok hipovolemia karena perdarahan. Jumlah volume kehilangan darah dari penderita bisa diperkirakan dengan cara melihat tanda klinis dari penderita. **Review Literatur:** Pada kondisi hipoperfusi jaringan akan menyebabkan terjadinya proses berantai yang pada akhirnya akan menimbulkan kematian sel. Hipoperfusi menyebabkan metabolisme anaerob, asidosis laktat (coagulopathy, gangguan fungsi enzim), kegagalan fungsi pompa Na-K (cellular swelling dan kematian sel), terjadi hipotermia (peningkatan oxygen demand, coagulopathy). Hipoperfusi akan menyebabkan lingkaran setan, dimana akan terjadi proses yang saling memperberat satu sama lain. Dengan pemberian cairan (kristaloid, koloid, tranfusi) akan memperbaiki hipoperfusi yang terjadi pada tubuh. **Kesimpulan:** Penatalaksanaan syok hipovolemia akibat perdarahan diperlukan pemahaman tentang fisiologi dan patofisiologi yang terjadi akibat perdarahan. Untuk mendapatkan hasil yang maksimal dan memperbaiki *outcome* dari penderita dibutuhkan *team work* yang solid. Penanganan bisa berbeda tergantung kondisi, peralatan dan sarana rumah sakit / Unit Gawat Darurat, serta kebijakan dari masing – masing tempat.

Kata Kunci: Resusitasi cairan, Trauma, Ruang Gawat Darurat, Hipoperfusi

INTRODUCTION

Trauma is a problem faced everyday in the emergency room of the hospital where the researcher works. The degree of trauma from the mildest to life threatening can be found in sufferers. The causes of death in patients at the beginning were damage to the heart / large blood vessels and severe damage to the central nervous system which made it difficult to get help. The next cause is hypovolemic shock due to bleeding, death due to bleeding can still be prevented and get help quickly and precisely. The slowest causes of death are

infection and failure of organ, these can be prevented by adequate management at the onset of trauma and adequate intensive care facilities. (1)(2)(3) (Figure 1 & Figure 2)

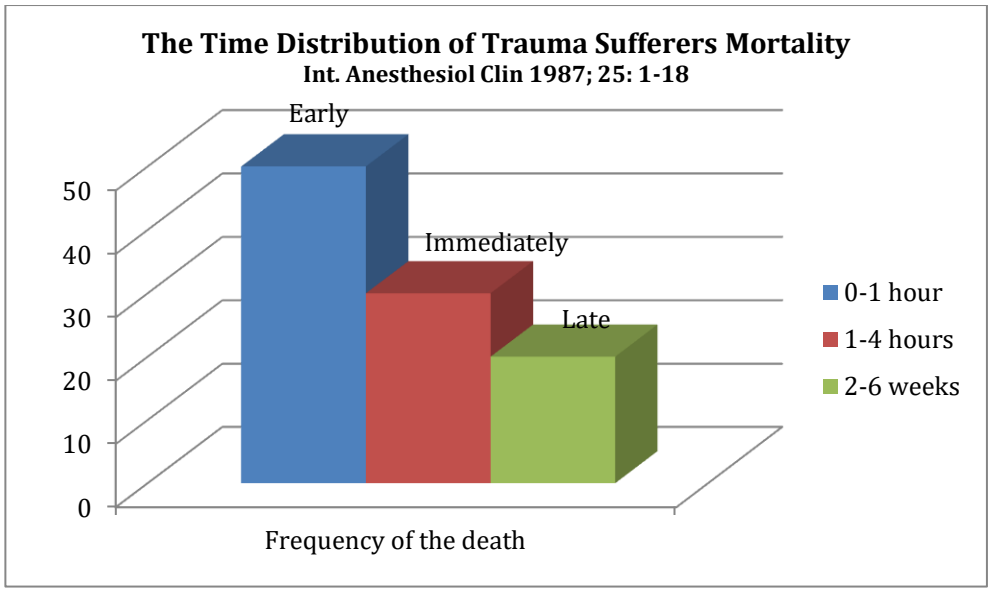

Figure 1. The Time Distribution of Trauma Sufferers Mortality

Table. Causes of death by timing category

Immediate and early deaths	Late deaths	Postdischarge
Brain injury	Infection	Cardiovascular disease
Hemorrhage	Multiple-organ failure	Second major trauma
	Brain injury	Neurologic disease
	Hemorrhage	Malignancy

Figure 2. Table of the Cause Death by Timing Category

LITERATURE REVIEW

The cause of death in trauma sufferers is hypovolemic shock due to bleeding. The amount of blood loss volume from the patient can be estimated by looking at the clinical signs of the patient. The trauma score classified hypovolemic shock into 4 classes of bleeding with different clinical signs. (4) (Table 1) Hypovolemic shock decreases oxygen supply to tissues resulting in an imbalance between demand and oxygen supply, leading to an oxygen deficit. The more severe the shock that occurs, the greater the oxygen deficit and at some point will cause the irreversible damage of cells / tissues. (5) (Figure 3) Thus, the condition of hypovolemic shock / tissue perfusion disorders must be addressed immediately to prevent further damage. In patients with hypovolemic shock due to trauma there is an oxygen delivery decrease, due to the decline of stroke volume / cardiac output (drop preload) and decreased Hb. Initially, this condition could be compensated for by increasing the other components from oxygen delivery (raise heart rate, vasoconstriction, intravascular fluid shift), but if the process of hypo-volemia continues, there will be a condition of greater damage. The target of given fluid resuscitation is to prevent tissue hypo-perfusion, avoiding "trias of death" (coagulopathy, hypothermia, acidosis) and avoid organ failure. (6)(7)

In the condition of tissue hypo-perfusion, it will cause a chain process which will eventually lead to cell death. Hypo-perfusion causes anaerobic metabolism, lactic acidosis (coagulopathy, enzyme dysfunction), Na-K pump malfunction (cellular swelling and cell

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death), there is hypothermia (increase of oxygen demand, coagulopathy). Hypo-perfusion will cause a vicious circle, in which processes that aggravate one another will occur. With the administration of fluids (crystalloid, colloid, transfusion) will improve the hypo-perfusion that occurs in the body.(7)

Classification of hypovolaemic shock and changes in physiological variables

	Class I	Class II	Class III	Class IV
Blood loss				
%	<15	15-30	30-40	>40
ml	750	800-1500	1500-2000	2000
Blood pressure				Very low
Systolic	Normal	Normal	Decreased	Barely
Diastolic	Normal	Decreased	Decreased	recordable
Pulse (beats/min)	Normal	100-120	120 (thready)	120 (very thready)
Capillary refill	Normal	Slow (>2 seconds)	Slow (>2 seconds)	Undetectable
Respiratory rate	Normal	Tachypnoea	Tachypnoea (>20/min)	Tachypnoea (20/min)
Extremities	Normal	Pale	Pale	Clammy, cold
Mental state	Alert	Restless or aggressive	Anxious, drowsy, aggressive	Drowsy, confused or unconscious

Figure 3. Table of Classification of Hypo-volaemic Shock and Changes in Physiological Variables

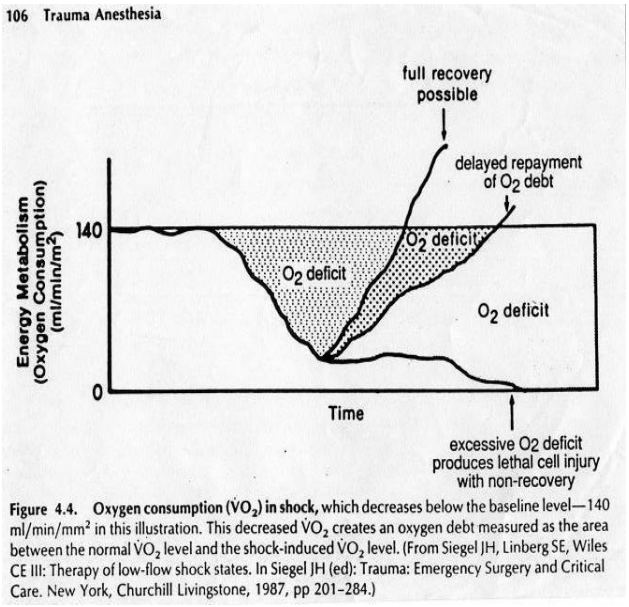

Figure 4.4. **Oxygen consumption ($\dot{V}O_2$) in shock,** which decreases below the baseline level—140 ml/min/mm² in this illustration. This decreased $\dot{V}O_2$ creates an oxygen debt measured as the area between the normal $\dot{V}O_2$ level and the shock-induced $\dot{V}O_2$ level. (From Siegel JH, Linberg SE, Wiles CE III: Therapy of low-flow shock states. In Siegel JH (ed): Trauma: Emergency Surgery and Critical Care. New York, Churchill Livingstone, 1987, pp 201–284.)

Figure 4. Oxygen Consumption (VO_2) in Shock

The choice of resuscitation fluid ideally meets the following criteria: filling intravascular volume quickly, accurately predicting the amount, having the same composition as extracellular fluid, perfectly metabolized / excreted, does not cause negative metabolic or systemic side effects, is cheap, and gives "outcome" which is good for sufferers. For now, the type of fluid that can meet all of the above criteria is still not available, so medical personnel must be able to choose which fluid is the most suitable for the patient's condition, the availability of tools and fluids and the policies of the hospital. The composition of resuscitation fluids commonly used in daily practice can be seen in Table 1. (8)(9)

Resuscitation fluids have their respective advantages and disadvantages (Figure 5). At the start of resuscitation it is most important to restore the volume of bleeding lost to maintain oxygen supply. Currently, the hemodilution technique with blood replacement fluids is still considered a fairly effective way to fill the volume lost due to bleeding. Where we work crystalloids are still the first choice with consideration: cheap, fast availability, safe and beneficial in the hemodilution technique. If the bleeding continues, or it is predicted that it cannot be stopped quickly (surgery / referral facility) then damage control resuscitation is an option to prevent further damage.

Apart from restoring the lost blood volume, it is important to stop bleeding as soon as possible. If you perform fluid resuscitation but on the other hand the bleeding continues, resuscitation becomes useless. The more the patient loses blood and the more fluids that are not physiological for bleeding, the worse outcome of the patient, aggravated if the patient experiences prolonged hypo-perfusion.

To stop or at least reduce bleeding can be done by damage control resuscitation in a way: damage control surgery (surgery/angiography), permissive hypotension, and hemostatic resuscitation .

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a. Stopping bleeding immediately (pressure dressing, fracture immobilization, applying C-clamp/ pelvic sling) or surgery and angiography.

Table 1. Table of Characteristic of Resuscitation Fluids

Solute	Plasma	Colloids				Crystalloids			
		4% albumin	6% HES 130/0.4	Dextran	Gelatin	Normal saline	Ringer's lactate	Hartmann's solution	Plasma-Lyte
Na^+	135 to 145	148	154	154	154	154	130	131	140
K^+	4.0 to 5.0	0	0	0	0	0	4.5	5	5
Ca^{2+}	2.2 to 2.6	0	0	0	0	0	2.7	4	0
Mg^{2+}	1.0 to 2.0	0	0	0	0	0	0	0	1.5
Cl^-	95 to 110	128	154	154	120	154	109	111	98
Acetate	0	0	0	0	0	0	0	0	27
Lactate	0.8 to 1.8	0	0	0	0	0	28	29	0
Gluconate	0	0	0	0	0	0	0	0	23
Bicarbonate	23 to 26	0	0	0	0	0	0	0	0
Osmolarity	291	250	286 to 308	308	274	308	280	279	294
Colloid	35 to 45	20	60	100	40	0	0	0	0

Osmolarity (mOsm/L); colloid (g/L); all other solutes (mmol/L).

Isotonic Crystalloids		
0.9% saline	Inexpensive Compatible with blood	Dilutes blood composition Hyperchloremic metabolic acidosis
Lactated Ringer's	Inexpensive Physiologic electrolyte mix	Dilutes blood composition Contains calcium, may clot blood
Plasmalyte-A	Inexpensive Physiologic electrolyte mix	Dilutes blood composition
Colloids		
Albumin	Rapid volume expansion	Expensive No proved benefit Dilutes blood composition
Starch solutions	Rapid volume expansion	Coagulopathy with first-generation products No proved benefit Dilutes blood composition
Hypertonic saline	Rapid volume expansion Improved outcomes in TBI patients	Rapid increase in blood pressure m exacerbate bleeding Dilutes blood composition
Red blood cells	Rapid volume expansion Increased oxygen delivery	Expensive, limited resource Requires cross-matching TRALI Viral transmission
Plasma	Rapid volume expansion Clotting factor replacement	Expensive, limited resource Cross-matching required TRALI Viral transmission
Fresh whole blood	Rapid volume expansion Carries oxygen Includes clotting factors and platelets Ideal fluid for early resuscitation	Unavailable in civilian practice – Logistics (low demand) – Time required for viral testing

Figure 5. Respective Advantages and Disadvantages Resuscitation Fluids

b. *Permissive hypotension* :
- Not giving too much fluid and making blood pressure "normal"
- Done if the possibility of bleeding continues
- Target blood flow to meet the vital organs of the heart and brain
- Clinical: palpable radial artery pulsation (systolic> 80 mmHg)
  Drawdown
- Not suitable for head trauma
- Secondary organ hypo-perfusion
- Causes organ failure and sepsis

c. *Hemostatic Resuscitation* by providing

tranexamic acid and transfusion of blood clotting components: *Fresh Frozen Plasma*: *Packed Red Cell* = 1: 1, *Fresh Whole Blood* , Platelets, Cryoprecipitate, *Recombinant Factor VII* .

In patients with hypovolemic shock, a vicious circle can occur trias of death. Shock causes anaerobic metabolism and causes decreased contractions myocard as well as hypothermia. Hypothermia causes coagulopathy, which causes more bleeding and causes the shock to get worse. Cause coagulopathy from bleeding shock caused by tissue damage, fibrinolysis, shock, hypothermia, hemodilution, acidosis, inflammation, and hypocalcemia (Figure 6). (6)(7)

Causes of acute coagulopathy of trauma-shock

Causes	Effects
Tissue trauma	Exposing the subendothelial matrix with platelet activation Liberation of Factor VII and thrombin
Fibrinolysis	Tissue thromboplastin increases in the resence of thrombin
Shock	Mechanism unknown; related to depletion of Protein C
Hypothermia	Inhibits coagulation serinases. Decreases platelet function
Haemodilution	Dilution of clotting factors. Incorporation of colloids into clot.
Acidosis	Reduction of Xa-Va prothrombinase complex activity Platelet form spheres which are devoid of aggregating tendency
Inflamation	Activated by neutrophils with platelet dysfunction Monocyte adherence to platelets
Hypocalcaemia	Due to citrate in blood and blood components

Figure 6. Table of the Causes of Acute Coagulopathy of Trauma Shock

Blood transfusions are considered given in order to prevent *oxygen delivery* decline and prevent *coagulopathy* . The administration of transfusions in patients with bleeding shock can use PRC/WB/FWB and plasma components (FFP, platelets, cryoprecipitate and *recombinant factor VII*). Management of trauma and shock due to bleeding is primarily to stop bleeding, improve hemodynamics, and not worsen coagulation function. (Figure7). (7)(10)(11)

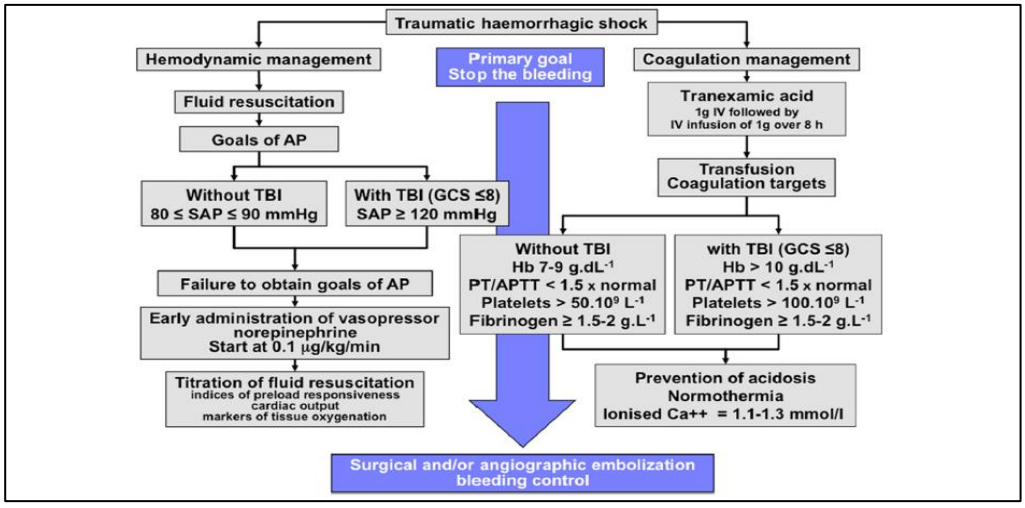

Figure 7. Flowchart of Initial Management of Traumatic Hemorraghic Shock

There are three results of therapy in shock due to bleeding, namely:

a. *good response* (circulation improves, normovolemia and bleeding stops)
b. *transient response* (circulation improves then falls again, still hypovolemia and bleeding continues)
c. *no response* (circulation does not improve with fluid resuscitation, hypovolemia still remains and bleeding continues) (4)

At *transient response* or *no response* consider for *damage control resuscitation* (*damage control surgery*, *permissive hypotension*, *hemostatic resuscitation*) to reduce blood loss and provide excess blood replacement fluids.

CONCLUSION

The management of hypovolemic shock due to bleeding requires an understanding of the physiology and pathophysiology that occurs due to bleeding. To get maximum results and improve *outcome* from sufferers, it needs solid *team work* . Treatment can be different depending on the conditions, equipment / facilities for the hospital / emergency room as well as the policies of each place.

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