Does a Controlled Fluid Resuscitation Strategy Decrease Mortality in Trauma Patients?

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Haemorrhage remains the biggest killer of major trauma patients

death
- Expected deaths will increase to 8 million/year by 2020

cuagulopaty
- 1/3 of pts are coagulopathic on admission

preventable
- Up to 20% of pts might be preventable

Stop
- The most important treatment is to stop haemorrhage

Wang et al,Critical Care Medicine.2014

Bleeding and damage control surgery

Roseny R. Rodrigues[a], *Maria José C. Carmona*[b], *and Jose Otavio C.A. Junior*[c]

Curr Opin Anesthesiol 2016, 29:229–233

Purpose of review
Bleeding is still a major cause of death in trauma patients. Damage control surgery is a strategy that aims to control bleeding and avoid secondary contamination of the cavity. This article checks the principles and indications of damage control surgery, bleeding management, and the role of the anesthesiologist in trauma context. The efficient treatment of severe trauma and exsanguinated patients includes a surgical approach to the patient performed as quickly as possible. Volemic resuscitation, hemostatic transfusion, prevention and/or treatment of coagulopathy, hypothermia, and acidosis are strategies that reduce bleeding, as well as permissive hypotension.

Specialized literature shows us that the adoption of all of these principles along with reduced surgical time has led to a broader concept called damage control resuscitation.

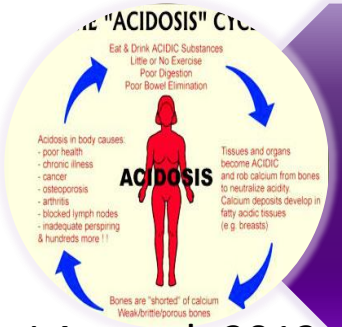
Summary
Damage control resuscitation is a treatment strategy in which the recovery of physiological variables is initially prioritized over anatomical variables and can be required in severe trauma patients.

Keywords
bleeding, damage control resuscitation, damage control surgery

Hemorrhagic shock is responsible for **30–40% of deaths from trauma**, and it is **believed** to be the most common cause of potentially **preventable deaths.**
The cause of death of approximately 50% of patients, who die within the first 24 h after trauma, is **bleeding**.

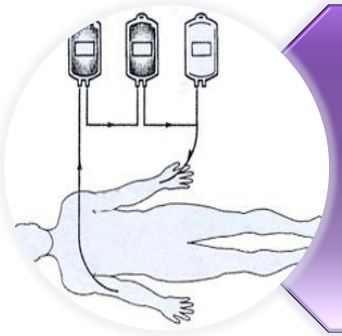
The mortality of coagulopathic pts is 3–4 times higher than pts without coagulopathy

Causes reduced platelet activation, aggregation and adhesion to von Willebrand factor on endothelial surfaces



Caused by tissue injury, hypoxia, hypoperfusion, platelet and coagulation protease dysfunction.

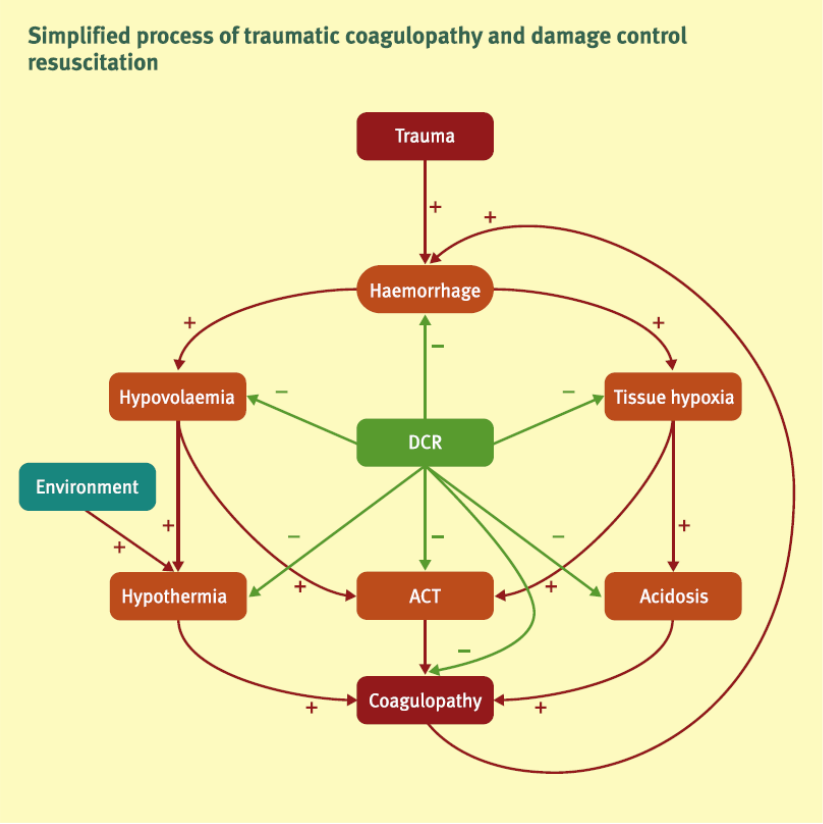
Aya HD, Br J Anaesth 2013



Fluid administered both in vitro and in vivo is an iatrogenic cause of traumatic coagulopathy

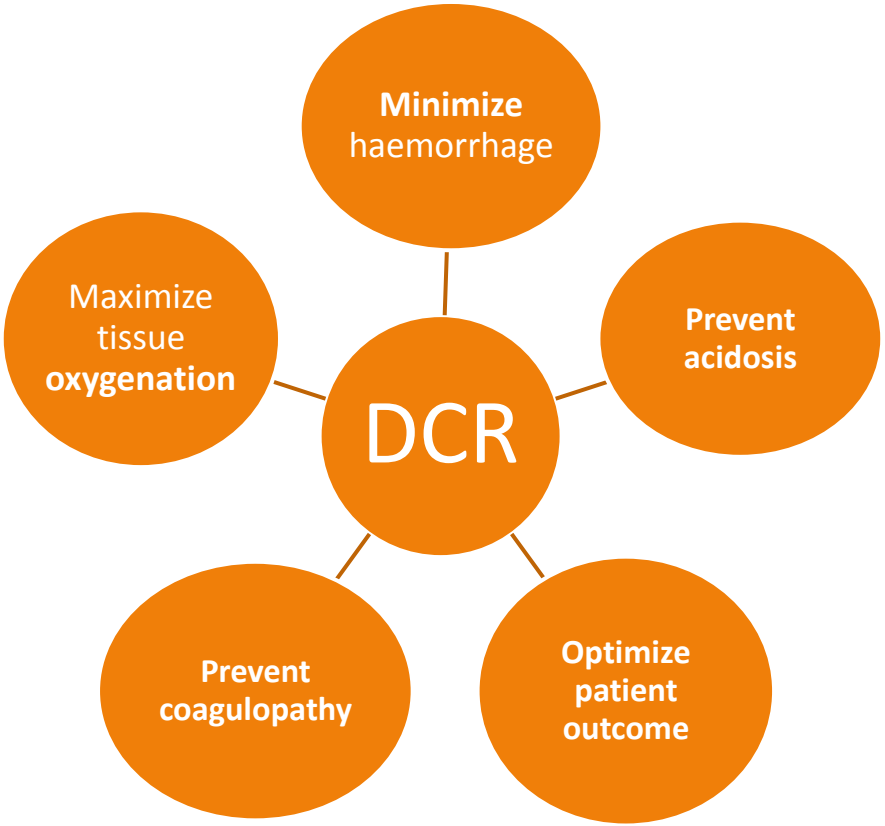
Bolliger D, Brit J Anaesth 2009;

Pathophysiology of Acute traumatic coagulopathy



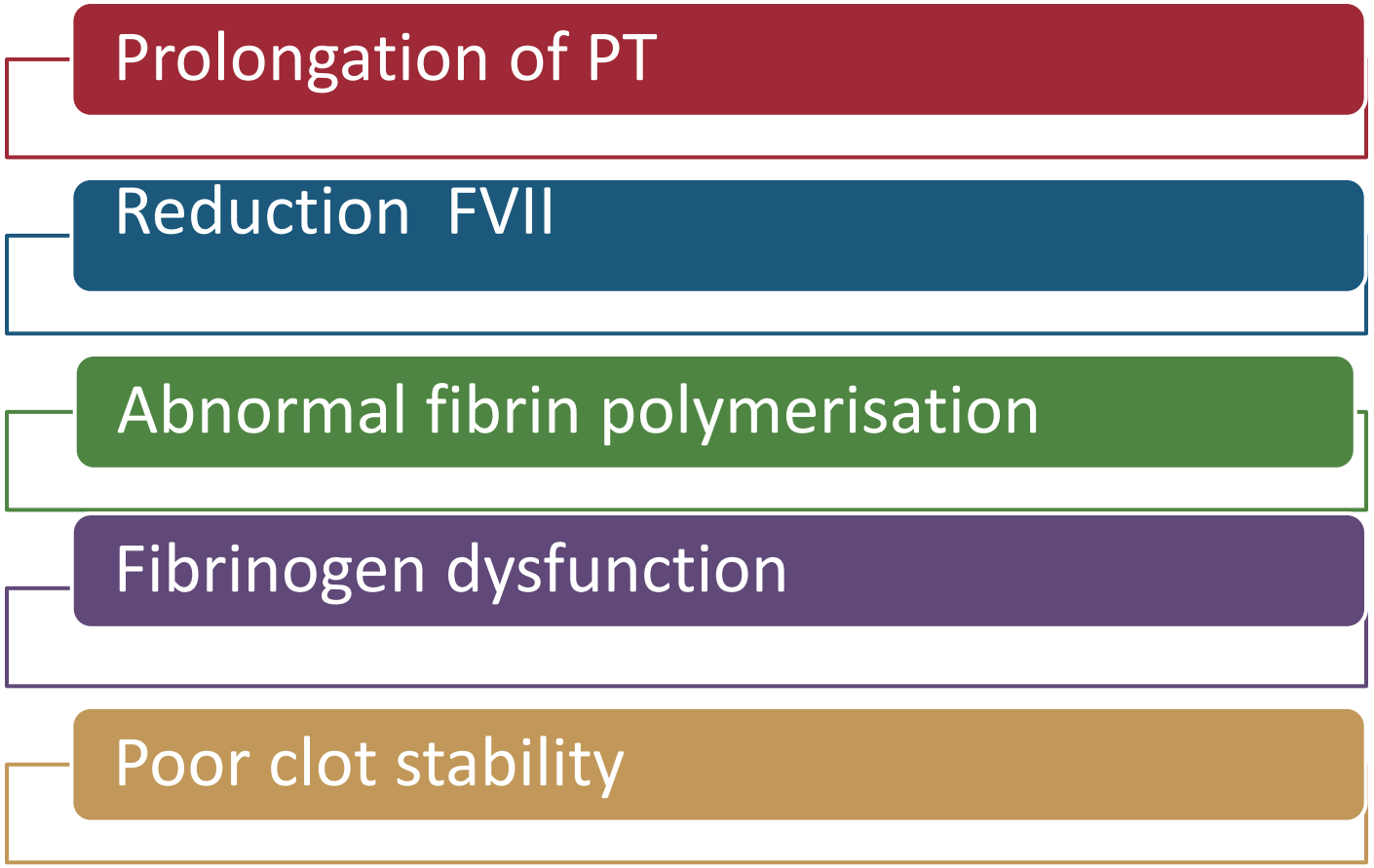
Cohen MJ, J Trauma Acute Care Surg 2013

Restoration of the physiological balance



DCR is current best practice for bleeding trauma patients

Haemodilution causes



Shaz BH, J Trauma 2011.
Fenger-Eriksen C, J Thromb Haem 2009

More than 40% of trauma patients develop a coagulopathy after >2 L of crystalloid,

- The more fluid replacement

Rising to >70% after >4 L

- The more coagulopaty

Maegele M. Injury 2007;

Up to 2003

- **Traditional concepts of polytrauma resuscitation**

ADVOCATED by ATLS long time

- Promote aggressive fluid administration aimed at restoring lost intravascular blood volume

Poor outcomes

- Approachment may contribute to continued bleeding by increasing the hydrostatic pressure on blood clots
- a dilution of coagulation factors, and an aggravation of hypothermia

Historical trends in resuscitation strategies

Era	Resuscitation approaches and other related issues	Outcomes
WWI	None	Early death
WWII/Korean War	Albumin, plasma, and blood use	Better early survival but organ failure resulting in late deaths (especially acute renal failure)
Vietnam War	Crystalloids and banked blood use. Improved rapid evacuation methods	Better early survival. Organ failure resulting in late deaths still a problem, with less acute renal failure and more ARDS
1970s-early 1980s	Goal-directed aggressive resuscitation, use of pulmonary artery catheters, and oxygen delivery calculations to deliver "supra-normal" resuscitation	Further improvement in early survival, increased MOF, and late deaths
Mid 1980s-1990s	Rapid field triage, maturation of civilian trauma systems, introduction of "damage control surgery," improved ICU care	Improved early survival in severely injured. More MOF but better survival in MOF patients due to improved ICU care
Afghanistan and Iraq wars	Dramatic improvement in triage and long distance transfers. Excellent in-transit ICU care. "Damage Control Resuscitation," permissive hypotension, limited use of crystalloids, early use of blood products, higher ratio of FFP and platelets, and fresh whole blood use. In field use of recombinant factor VII. Development and use of advanced hemostatic dressings. Significant improvements in injury prevention with better body armor, and protective gear. Adoption of battlefield strategies by civilian trauma centers	Lowest KIA rate in any major conflict. Decreased incidence of ARDS, MOF, and coagulopathy. Significant improvement in early and late survival and long-term outcomes compared to historical controls.

ARDS, acute respiratory distress syndrome; MOF, multiple organ failure; ICU, intensive care unit; FFP, fresh frozen plasma; KIA, killed in action.

The New England
Journal of Medicine

One of the first RCT

Volume 331 OCTOBER 27, 1994 Number 17

IMMEDIATE VERSUS DELAYED FLUID RESUSCITATION FOR HYPOTENSIVE PATIENTS

Results. Among the 289 patients who received delayed fluid resuscitation, 203 (70 percent) survived and were discharged from the hospital, as compared with 193 of the 309 patients (62 percent) who received immediate fluid resuscitation ($P = 0.04$). The mean estimated intra-

- This strategy reported an **8% reduction in absolute mortality** in for patients receiving delayed fluid resuscitation and experiencing a lower SBP pre-operatively.

Immediate versus Delayed Fluid Resuscitation for Hypotensive Patients with Penetrating Torso Injuries

VARIABLE	IMMEDIATE RESUSCITATION (N = 309)	DELAYED RESUSCITATION (N = 289)	P VALUE
Systolic blood pressure (mm Hg)	79±46	72±43	0.02
Hemoglobin (g/dl)	11.2±2.6	12.9±2.2	<0.001
Platelet count ($\times 10^{-3}$/mm^3)	274±84	297±88	0.004
Prothrombin time (sec)	14.1±16	11.4±1.8	<0.001
Partial-thromboplastin time (sec)	31.8±19.3	27.5±12	0.007

VARIABLE	IMMEDIATE RESUSCITATION	DELAYED RESUSCITATION	P VALUE
Survival to discharge — no. of patients/total patients (%)	193/309 (62)*	203/289 (70)†	0.04
Estimated intraoperative blood loss — ml‡	3127±4937	2555±3546	0.11
Length of hospital stay — days§	14±24	11±19	0.006

- Other RCTs, however, have not reported significant mortality benefits either from delaying fluid therapy or from targeting a lower SBP

Dutton RP, J Trauma 2002;

The concept of permissive hypotension represents a double-edged sword

Prolonged duration of shock may further aggravate the extent of postinjury coagulopathy

Hypotensive resuscitation may aggravate the incidence of secondary insults in patients with severe head injuries

Stahel PF, Intensive Care Med 2008

Prolonged Permissive Hypotensive Resuscitation Is Associated With Poor Outcome in Primary Blast Injury With Controlled Hemorrhage

Article *in* Annals of surgery 251(6):1131-9 . 2010

- But other models provide conflicting results; a study in pigs with blast injuries reported a poorer outcome (survival time) with permissive hypotension compared to normotensive resuscitation.

Garner J, Ann Surg 2010

Ideal Permissive Hypotension to Resuscitate Uncontrolled Hemorrhagic Shock and the Tolerance Time in Rats

Anesthesiology, 2011

Tao Li, Ph.D.,* Yu Zhu, M.S.,† Yi Hu, Ph.D.,‡ Lijie Li, B.A.,† Youfang Diao, M.S.,† Jing Tang, M.S.,† Liangming Liu, M.D., Ph.D.§

ABSTRACT

Backgro
sion for
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sion have
Methods
time for
rhagic shock rats, the effects of different target MAPs (40, 50, 60, 70, 80, and 100 mmHg) and 60-, 90-, and 120-min
permissiv
orrhagic
Results:
had incr
ume), de
kidney) and mitochondrial function, and decreased animal
survival
MAP gr
spectivel
drial fun
survival
mmHg t
loss (39%
animal su

sure of 50–60 mmHg was applied during a maximum period of 90 min.

vival (8 of 10 and 6 of 10) and vital organ function.

Used different levels of MAP to achieve volemic resuscitation (40, 50, 60, 70, 80, and 100 mmHg).
Approximately **80–100 mmHg** exhibited **more bleeding, mortality, and organ dysfunction** than those subjected to **permissive hypotension (50 and 60mmHg).**
40 mmHg showed less bleeding but **increased organ dysfunction and mortality**.

Caution for patiens have head trauma:
Lower pressure levels can cause a reduction in cerebral perfusion pressure, and hence, contribute to the introduction or deterioration of secondary brain injury.

- **A target MAP of 50–60 mmHg** conferred most survival benefit
- Ninety minutes of permissive hypotension was the tolerance limit.

Hypotensive Resuscitation Strategy Reduces Transfusion Requirements and Severe Postoperative Coagulopathy in Trauma Patients With Hemorrhagic Shock: Preliminary Results of a Randomized Controlled Trial

C. Anne Morrison, MD, MPH, Matthew M. Carrick, MD, Michael A. Norman, MD, Bradford G. Scott, MD, Francis J. Welsh, MD, Peter Tsai, MD, Kathleen R. Liscum, MD, Matthew J. Wall, Jr., MD,

Data from an RCT (man), with 90 pts, in which target MAP of 50 mmHg (LMAP) and 65 mmHg (HMAP) were compared.

The LMAP group
-Received significantly fewer blood products,
-Need smaller volumes of fluids intra-operatively,
-Were less likely to develop post-operative coagulopathy and
Had a significantly lower all cause early mortality rate ($p = 0.03$).

Morrison CA, J Trauma 2011;

Doran CM, Trauma Acute Care Surg 2012; 72: 835e43.

Targeted resuscitation improves coagulation and outcome

Target MAP?

BACKGROUND: Acute trauma coagulopathy in seriously injured casualties may be initiated by tissue hypoperfusion. A targeted (or novel hybrid [NH]) resuscitation strategy was developed to overcome poor tissue oxygen delivery associated with prolonged

- **However, extended hypotension increases tissue hypoperfusion and adds to ATC.**

1.87 ± 0.15 times presurgery, groups 2 and 4) compared with NH (1.44 ± 0.09 and 1.36 ± 0.06, groups 1 and 3, $p = 0.001$). Blast versus sham had no significant effect on prothrombin time ($p = 0.56$). Peak levels of interleukin 6 were significantly lower in NH groups. Arterial base excess was significantly lower with hypotension (−18.4 mmol/L ± 2.7 mmol/L and −12.1 mmol/L ± 3.2 mmol/L) versus NH (−3.7 mmol/L ± 2.8 mmol/L and −1.8 mmol/L ± 1.8 mmol/L, $p = 0.0001$). Hematocrit was not significantly different between groups ($p = 0.16$).

CONCLUSION: Targeted resuscitation (NH) attenuates the development of acute trauma coagulopathy and systemic inflammation with improved tissue perfusion and reduced metabolic acidosis in a model of complex injury. This emphasizes the challenge of choosing a resuscitation strategy for trauma patients where the needs of tissue perfusion must be balanced against the risk of rebleeding during resuscitation. (*J Trauma.* 2012;72: 835–843. Copyright © 2012 by Lippincott Williams & Wilkins)

KEY WORDS: Coagulation; resuscitation; trauma; blast; hemorrhage; inflammation.

- Animal models of uncontrolled haemorrhagic shock with trauma have demonstrated benefit using targeted lower mean arterial pressures

  (**MAP) of 60-70 mmHg** whilst bleeding is ongoing.

- Human data have added further weight to this approach and suggested both shorter bleeding times and improved mortality.

The comparision of MAP of 40 mm Hg, as opposed to 80 mm Hg
Results: LMAP

İncreased/better

- -Splanchnic perfusion and
- -Tissue oxygenation

Improved survival

Decreased/less

- **-Blood loss,**
- **-Apoptotic cell death and**
- **-Tissue injury,**

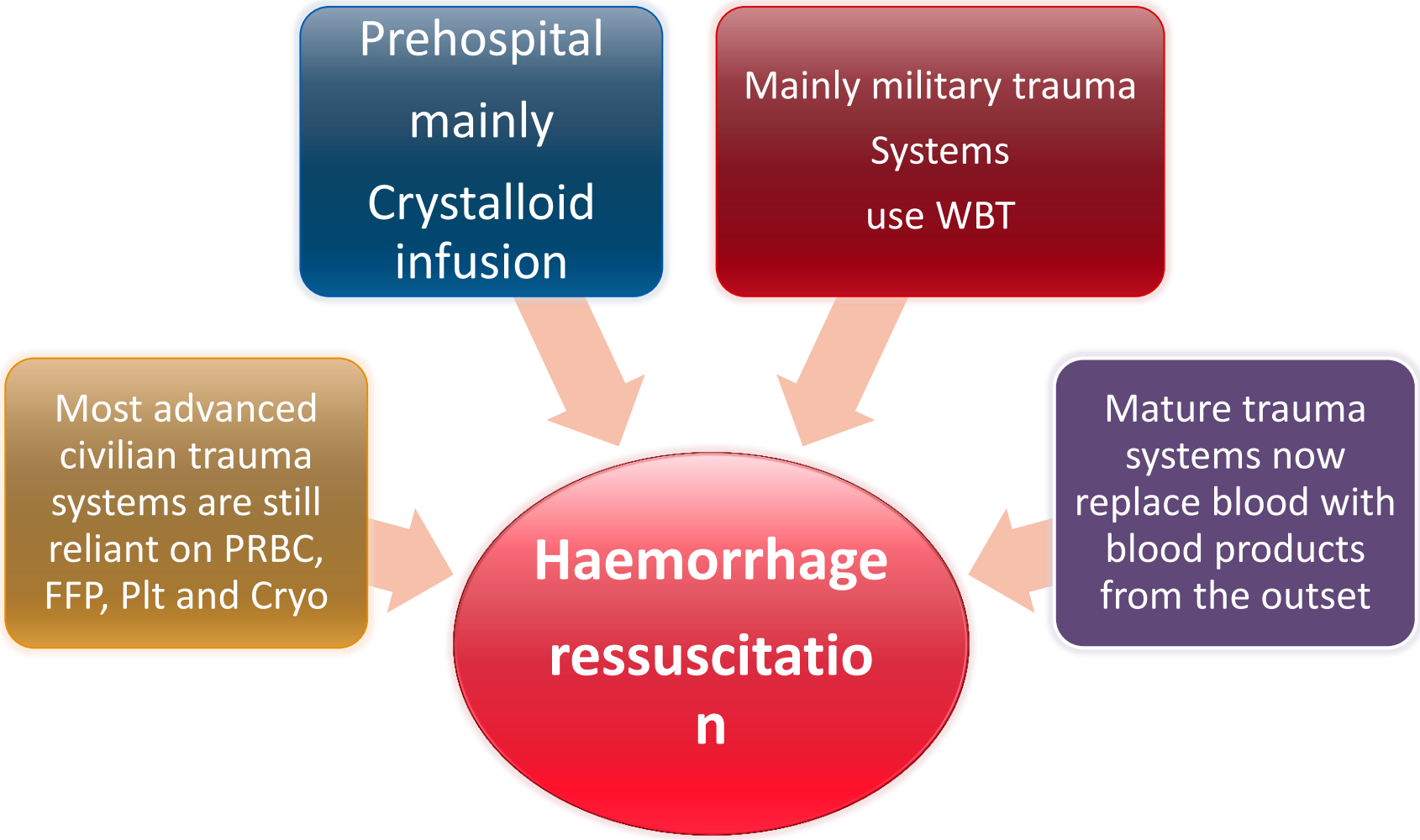
  -Acidemia,
- **-Hemodilution**
- **-Tthrombocytopenia,**
- **-Coagulopathy,**

Lu YQ, J Trauma 2007;

Owens TM,. *J Trauma 1995* Bickell WH, *Surgery 1991;* Kowalenko T *J Trauma 1992*	Several animal studies (1980-1990) have shown a reduced risk of death using a lower-than-normal blood pressure as a guide to fluid resuscitation in a strategy **referred to as hypotensive resuscitation**
Mapstone J, *J Trauma 2003*	Fluid resuscitation strategies in animal models revealed a **consistent improvement in mortality** with employment of **hypotensive resuscitation**
Geeraedts LM Jr, *Injury 2009*	Furthermore, **aggressive resuscitation** might also result in dilutional coagulopathy, which **may worsen bleeding**
Ley EJ, Clond MA, Srour MK, et al. J Trauma 2011	Crystalloid infusion of 1.5 litres or more in trauma patients was an independent risk **factor for mortality**

Many studies between 190-2011 show the benefit of hypotensive resuscitation

Who uses what?

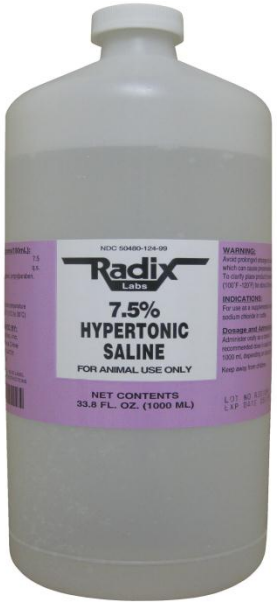


These are typically given in an empirical manner initially, according to local policy.

Other considerations

Hypertonic saline

- Clinical studies however do not provide compelling evidence to support the use of HTS either for TBI or for haemorrhagic shock.
- Many RCTs have not demonstrated mortality benefit



Jousi M, World J Emerg Surg 2010

Review Articles

Critical Care Medicine,2014

Liberal Versus Restricted Fluid Resuscitation Strategies in Trauma Patients: A Systematic Review and Meta-Analysis of Randomized Controlled Trials and Observational Studies*

Chih-Hung Wang, MD[1]; Wen-Han Hsieh, MS[2]; Hao-Chang Chou, MD[1]; Yu-Sheng Huang, MD[1]; Jen-Hsiang Shen, MS[3]; Yee Hui Yeo, MS[4]; Huai-En Chang, MS[5]; Shyr-Chyr Chen, MD, MBA[1]; Chien-Chang Lee, MD, MSc[6,7]

Meta-Analyses guidelines of RCT and the Meta-analysis Of Observational Studies in Epidemiology guidelines were used for this study

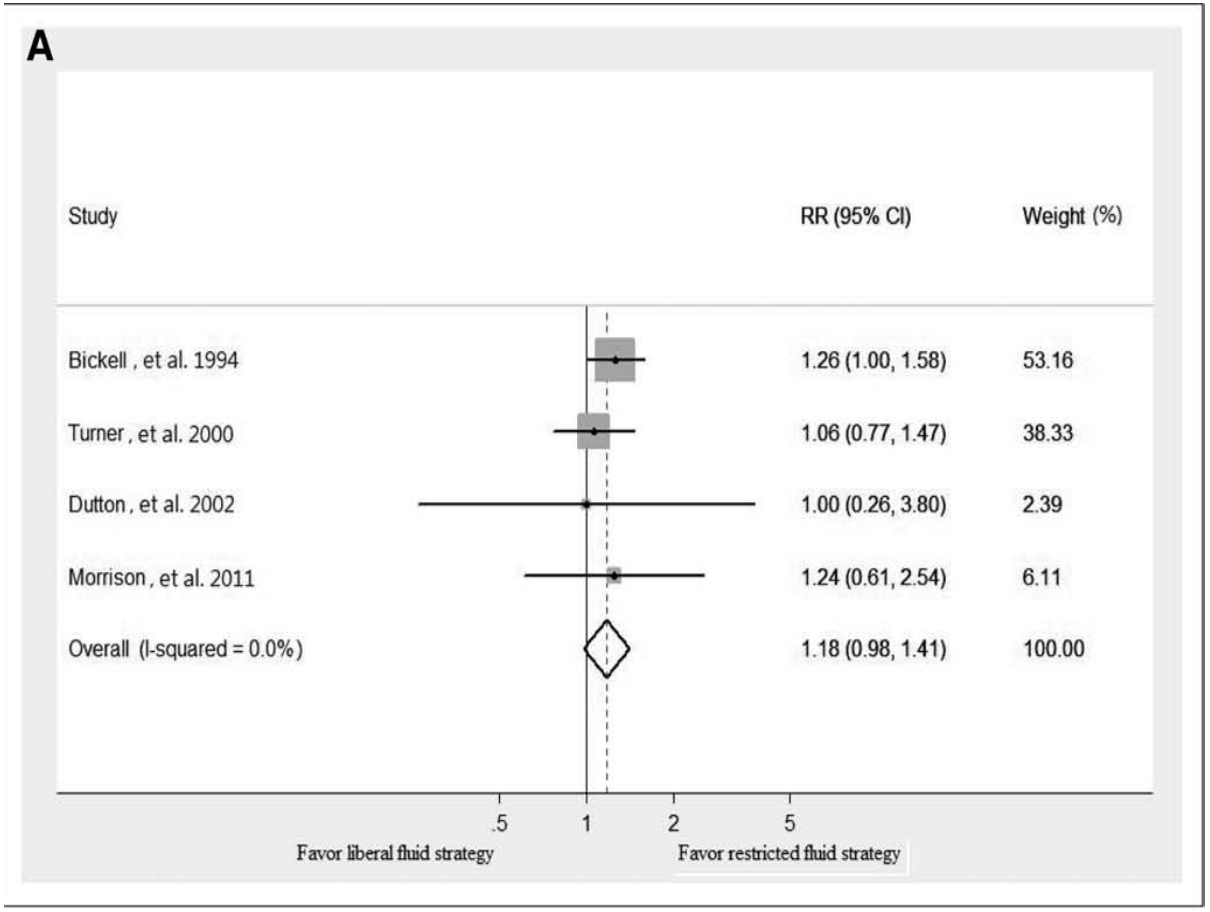
The terms for hypotensive resuscitation, small/limited/restricted volume resuscitation, and delayed resuscitation; trauma, hemorrhagic shock, hypovolemic shock, and shock were searched

RESULTS

- 11 studies, including four RCTs, and seven observational studies were identified.
- Available studies from 1990 to 2012 were selected.

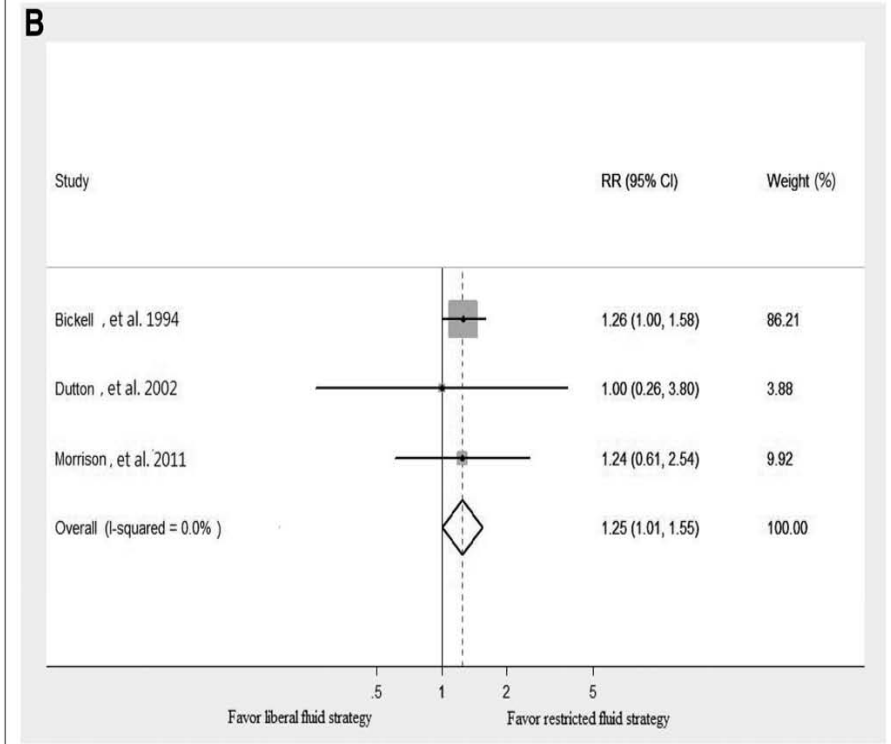
- Bickell WH. *N Engl J Med 1994.*
- Turner J,*Health Technol Assess 2000.*
- Dutton RP, *J Trauma* 2002,
- Morrison CA, *J Trauma* 2011.
- Kaweski SM, *J Trauma 1990.*
- Sampalis JS, *J Trauma 1997.*
- Dula DJ,. *Prehosp Emerg Care 2002.*
- Talving P. *Prehosp Disaster Med 2005.*
- Ley EJ, *J Trauma 2011;*
- Huβmann B, *J Emerg Trauma Shock 2011.*
- Duke MD, *J Trauma Acute Care Surg 2012*

- ***RCTs. For the four RCTs, there was no significant difference in*** overall mortality between liberal and restricted fluid resuscitation strategies (RR, ***1.18; 95% CI, 0.98–1.41; I2, 0%).***



Forest plot for randomized controlled trials. Comparison of the effects of liberal versus restricted fluid resuscitation on overall mortality, expressed as risk ratio (RR) and 95% CI.

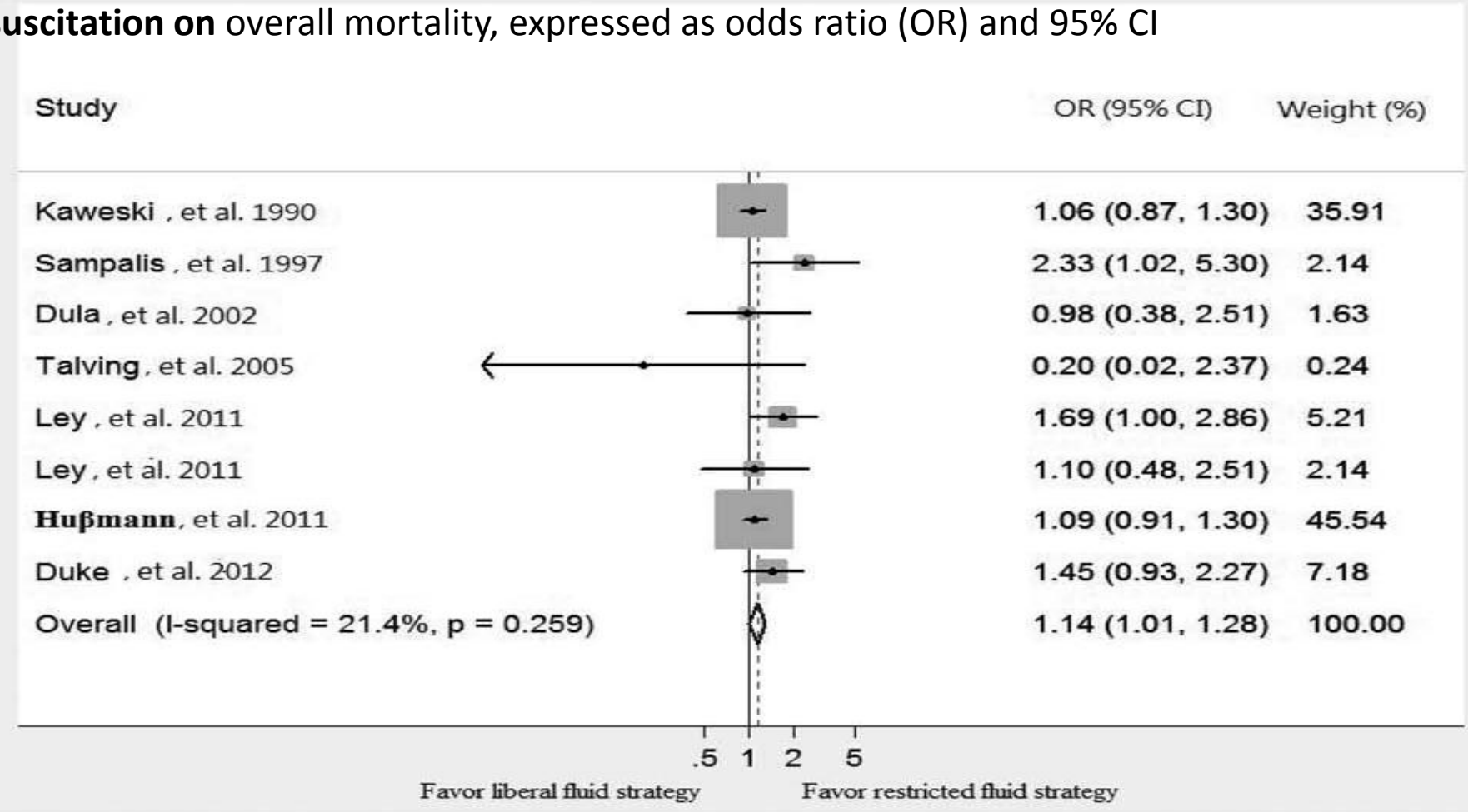
After excluding the trail which included a drastically different study population and a high protocol violation rate, the summary estimates showed that the liberal fluid resuscitation strategy was associated with significantly higher overall mortality (RR, 1.25; 95% CI, 1.01–1.55; *I2, 0%)*



Comparison of the effects of liberal versus restricted fluid resuscitation on overall mortality, expressed as RR and 95% CI.

- Twenty-four-hour mortality was not significantly different between two strategies (RR, 1.29; 95% CI, 0.58–2.88; *I2, 0%; two studies).*

3.A, Forest plot for observational studies. Comparison of liberal versus restricted fluid resuscitation on overall mortality, expressed as odds ratio (OR) and 95% CI



- ***Observational Studies***
- The summary estimate showed that **liberal fluid resuscitation was associated with significantly higher mortality** in patients with trauma-related hemorrhage conditions (OR, 1.14; 95% CI, 1.01–1.28; *I2, 21.4%)*

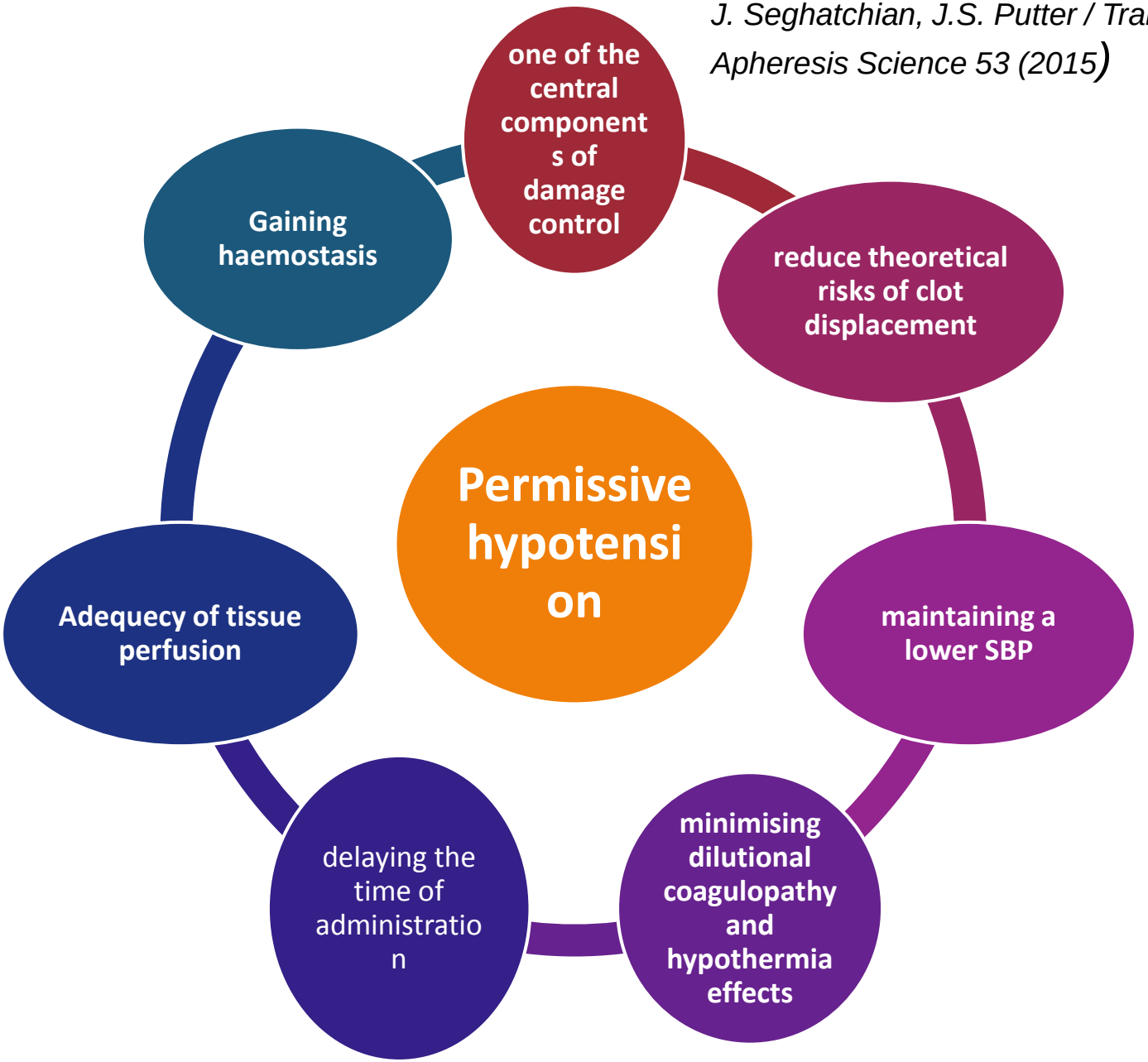
DISCUSSION

	The liberal fluid resuscitation strategy	Restricted fluid resuscitation strategy
RCTs	associated with higher mortality **(RR, 1.25; 95% CI, 1.01–1.55; I2, 0%)**	Lower mortality
Obsv studies	associated with higher mortality **(OR, 1.14; 95% CI, 1.01–1.28; I2, 21.4%).**	Lower mortality

Wang et al. *Crit Care Med,*2014

- RCTs suggest that a restricted fluid strategy might be useful in trauma patients with penetrating injury but without TBI.
- The observational studies, the use of restricted fluid resuscitation strategies could be expanded to include those with blunt injury or TBI.
- Further confirmation in prospective RCTs is needed.

J. Seghatchian, J.S. Putter / Transfusion and Apheresis Science 53 (2015)



There has been limited, but evolving evidence for the role of permissive hypotension in trauma resuscitation

Reduced crystalloid volumes are

Less likely to create dilutional coagulopathy

reduced pressures are less likely to dislodge formed clots

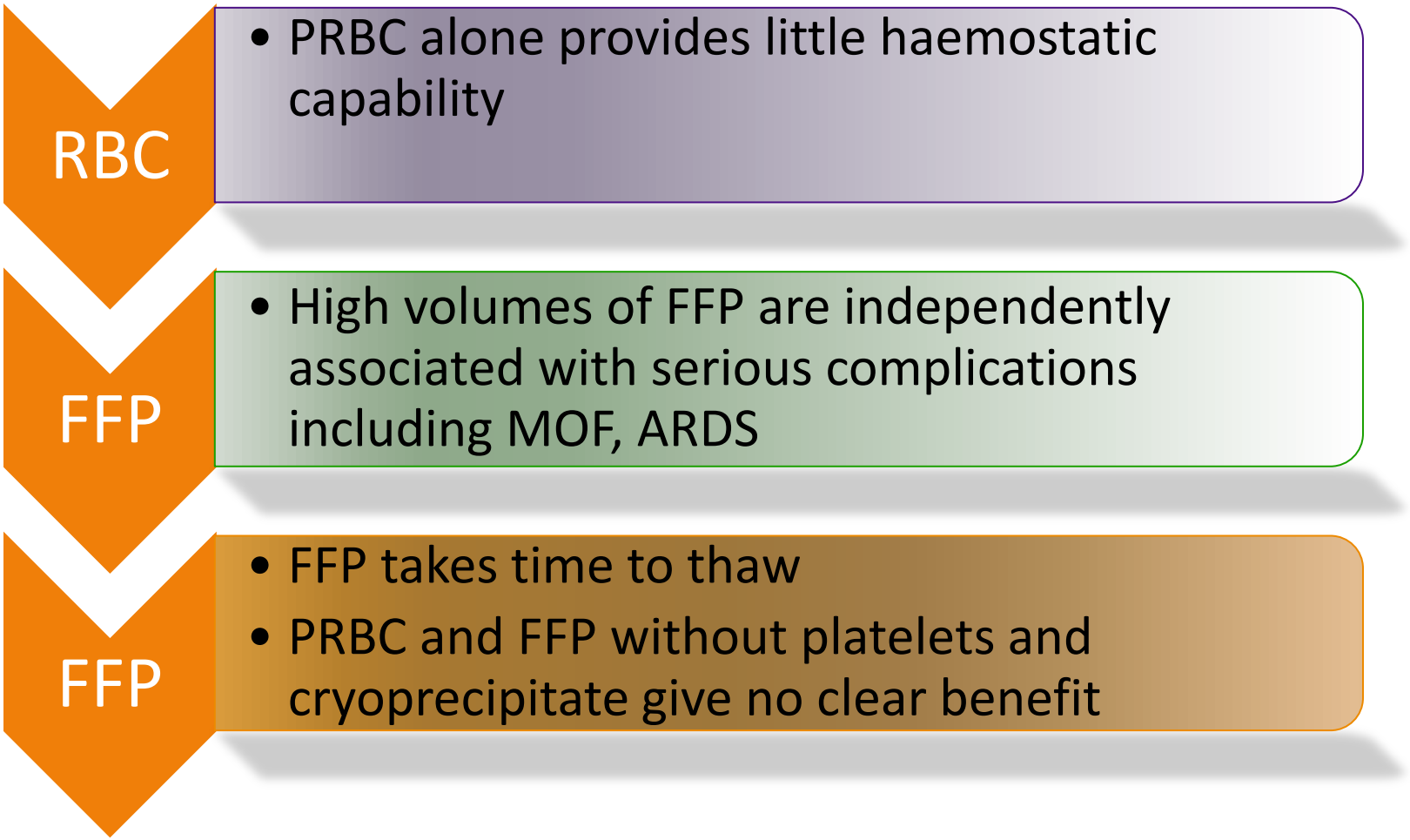
Tissue oxygen delivery and clearance of metabolic waste must, however, be maintained at a level compatible with life

Haemostatic resuscitation and transfusion strategies

- One of the central tenets of haemostatic resuscitation is the early use of ‘balanced transfusion’; aiming to deliver red blood cells (RBC) and fresh frozen plasma (FFP) in a ratio approaching 1 unit of RBC to 1 unit of FFP with the aim of attenuating coagulopathy.

Jansen JO. Br Med J 2009;

Why an incorporating equivalent ratios?



So incorporating equivalent ratios at an early stage appears vital

Borgman MA. J Trauma 2007	High ratios of FFP:RBC reduce death rate by 46%
Zehtabchi S, Acad Emerg Med 2009	No absolute agreement as to which specific FFP:RBC ratio (i.e. 1:1, 2:3, etc.) improves mortality
Duchesne JC, J Trauma 2008	Advocated the aggressive transfusion strategy of preemptive plasma substitution at a 1:1 ratio
Kashuk JL, Trauma 2008	Advocating the 1:1 concept have significant shortcomings (retrospective)
Scalea TM, Ann Surg 2008	Prospective but not controlled showed no benefit of a standardized 1:1 transfusion protocol
N. Curry, / Injury, Int. J. Care Injured 2012	The survival threshold appeared to be in the range of 1:2 to 1:3 FFP:RBC, and data did not support the use of a routine 1:1 transfusion
Gunter OL J Trauma 2008	Demonstrated that a 1:5 (plt:RBC) transfusion strategy for coagulopathic pts with massive transfusions was associated with increased survival.
Holcomb JB,J Am Med Assoc 2015; 313: 471e82	**High Plt:FFP:PRBC ratios confer a survival advantage, But whether that is at 1:1:1 or 1:1:2 is not clear despite recent investigation.**

Inaba K, J Am Coll Surg 2010	FFP has been reported of little benefit in patients receiving fewer than 10 units of RBC, with higher incidence of ARDS and no improvement to survival
Inaba KJ. Am Coll Surg 2010;	Supported the idea of higher than standard doses of platelets and fibrinogen in massively transfused trauma patients
Phan HH, Vox Sang 2010;	No high quality evidence to confirm that platelets:RBC should be given at a 1:1 ratio
Magnotti LJ, J Trauma 2011	İncreased of FFP has no benefit on mortality
de Biasi AR, Transfusion 2011	High number of RBC administration (instead of FFP:RBC ratio=1:1) was significantly associated with worse mortality in the first 2 h of resuscitation, and was a more sensitive marker of mortality
Spinella PC, J Trauma 2009;	Fresh whole blood (FWB) is argued by many to be the optimum transfusion product for patients in need of MT
West MA, J Trauma 2006	A target Hb level of 7−10 g/dl may be recommended as a safe transfusion strategy in polytrauma

Hemostatic Effects of Fresh Frozen Plasma May be Maximal at Red Cell Ratios of 1:2

J Trauma. 2011

Ross Davenport, BSc, MD, MRCS, Nicola Curry, MD, MRCP, Joanna Manson, MD,
Henry De'Ath, MD, MRCS, Amy Coates, BSc, Claire Rourke, BSc, Rupert Pear
Simon Stanworth, MD, MRCP, and Karim Brohi, MD, FR

Background: Damage control resuscitation targets
lopathy with the early administration of high-dos
FFP is administered empirically and as a rati
blood cells (PRBC). There is controver ratio
with respect to outcomes, and their n studied.
We report preliminary finding P:PRBC ratios
on coagulation.
Methods: This is a pr study of trauma patients
requiring >4 U before and after each 4-U
PRBC interv alysis by rotational thromboelas-
tometry parameters were compared with the
FFP ach interval.
ntervals from 50 patients
coagulation deteriorated with low
nostatic effect was observed in the
prothrombin time ($p = 0.006$), 56% de
.047), and 38% increase in maximum clot firm
sion with ≥1:1 ratio did not confer any additio
There was a marked variability in response to FFP, and h
deteriorated in some patients exposed to 1:1 ratios. The b
plasma were confined to patients with coagulopathy.
Conclusions: Interim results from this prospective study suggest that FFP:PRBC ratios of ≥1:1 do not confer any additional advantage over ratios of 1:2 to 3:4. Hemostatic benefits of plasma therapy are limited to patients with coagulopathy.

However, the optimum FFP : RBC ratio is still under discussion

Resuscitation 83 (2012) 459–464

Contents lists available at SciVerse ScienceDirect

Resuscitation

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

Clinical paper

Coordination and management of multicenter clinical studies in trauma: Experience from the PRospective Observational Multicenter Major Trauma Transfusion (PROMMTT) Study☆

Results: Between July 2009 and October 2010, PROMMTT screened 12,561 trauma admissions and enrolled 1245 patients who received one or more blood transfusions within 6 h of Emergency Department (ED) admission. A total of 297 massive transfusions were observed over the course of the study at a combined rate of 5.0 massive transfusion patients/week.

Injury, Int. J. Care Injured 44 (2013) 581–586

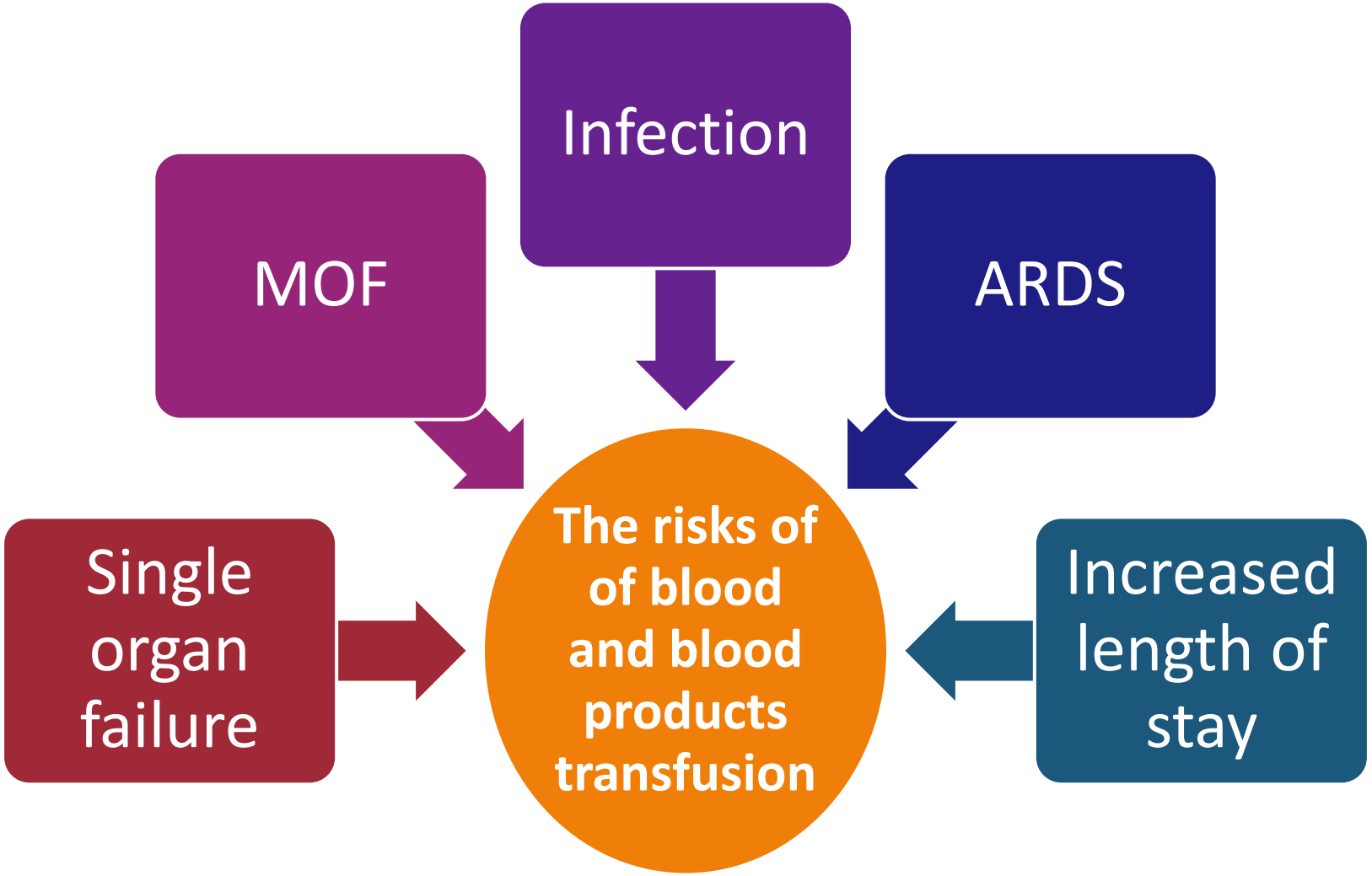
- **Mortality, ICU admission, length of stay, need for emergent surgery were outcomes.**

Acute transfusion practice during trauma resuscitation: Who, when, where and why?

Krisztian Sisak [a], Michael Manolis [b], Benjamin M. Hardy [a], Natalie Enninghorst [a], Cino Bendinelli [a], Zsolt J. Balogh [a,*]

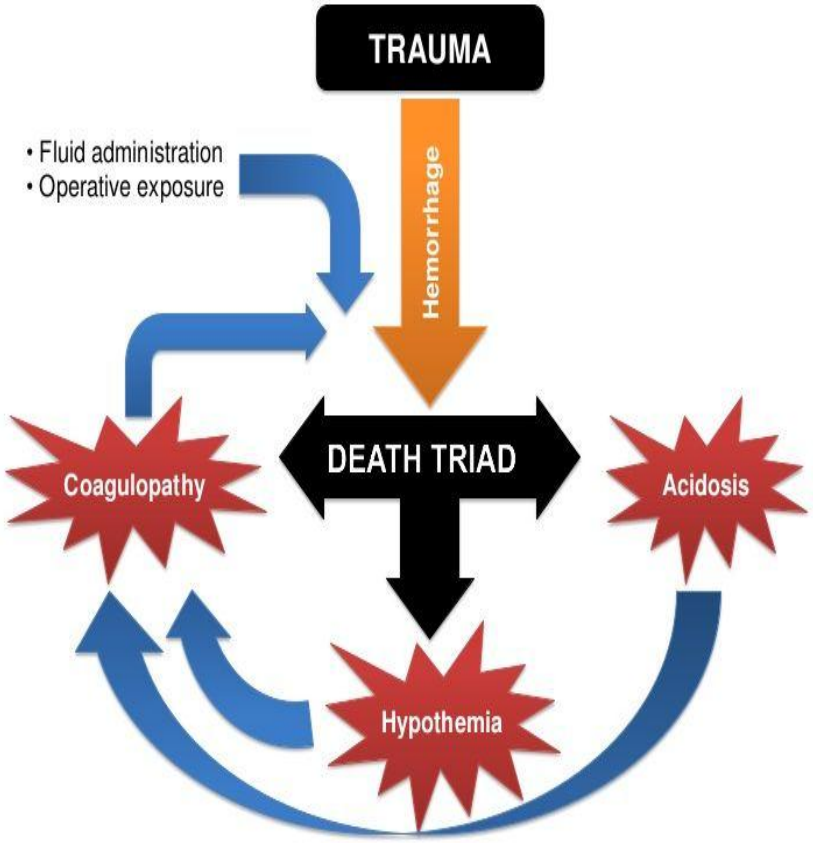
[a] *Department of Traumatology, Division of Surgery, John Hunter Hospital and University of Newcastle, Newcastle, NSW, Australia*
[b] *Hunter Area Pathology Service, John Hunter Hospital, Newcastle, NSW, Australia*

Aim: to describe the patterns, indications and timing of ET at level 1 trauma centre.
Methods: A 12-month prospective study was performed on all trauma admissions requiring ET. Demographics, mechanism, injury severity (ISS) were collected. Timing, location, volume, the clinician initiating first unit of transfusion, reason for transfusion was recorded, with corresponding blood gas results and p[illegible] ission, length of stay, need for emergent surgery were outcom[illegible]es.
Results: Fro[illegible] 965 trauma admissions 91 (9%) required ET (76% male, median age: 38 (10–88, IQR: 22–59), blunt m[illegible]echanism: 87%, ISS: 25 (4–66, IQR: 16–34). 43% (39/91) had massive transfusion protocol (MTP) activation. ET was initiated in ED (52%), OR (38%) or ICU (10%). MTP transfusions were started at a median of 0.5 h (0.5–4, IQR: 0.5–1.5), whilst non-MTP transfusions were initiated at a median 3 h (0.5–23, IQR: 2–9). The first unit of ET was initiated by trauma surgeon (35%), anaesthetist (30%), ED (19%), ICU (13%) and general surgeon (3%). Transfusions triggers at the first unit of transfusion were 'expected or ongoing bleeding' 29%, dropping haemoglobin 26%, haemorrhagic shock 24%, hypotension 10%, tachycardia 8%. Median systolic blood pressure was 90 (45–125, IQR: 80–100), heart rate was 100 (53–[illegible] 2.7, IQR: −7.2 to 2.4) mmol/l at the time of transfusion. Emergency surgery was required in 86% (78/91). ICU admission rate was 69% (63/91). Mortality was 14%. Low volume transfusion (1–2 units) was more likely to lead to overtransfusion (Hb > 110 g/l).



Lelubre C, Transfusion 2009;
Zehtabchi S, Acad Emerg Med 2009;

Damage control resuscitation



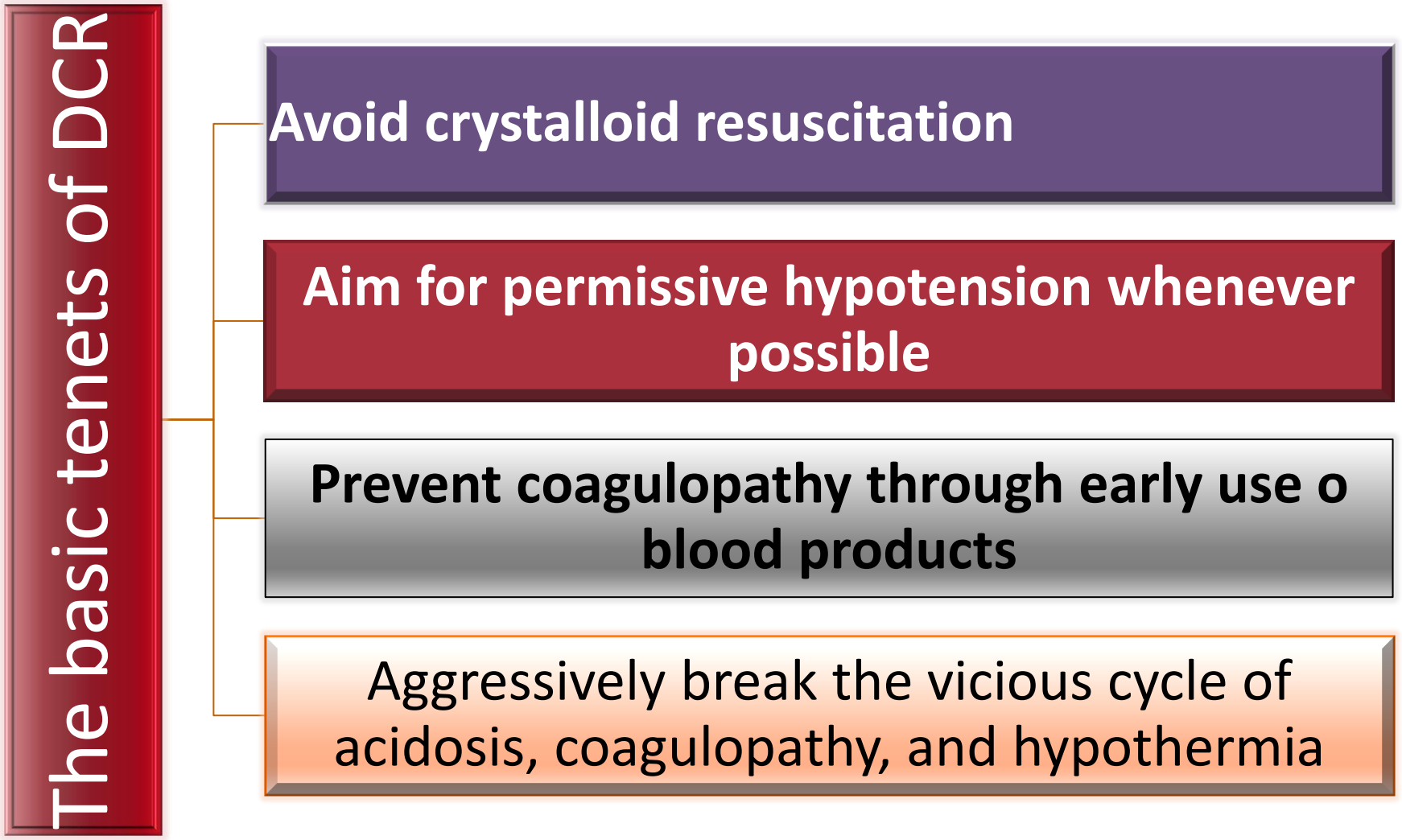
Control bleeding

Haemostatic resuscitation

Hypotensive or Novel hybrid resuscitation

Massive transfusion

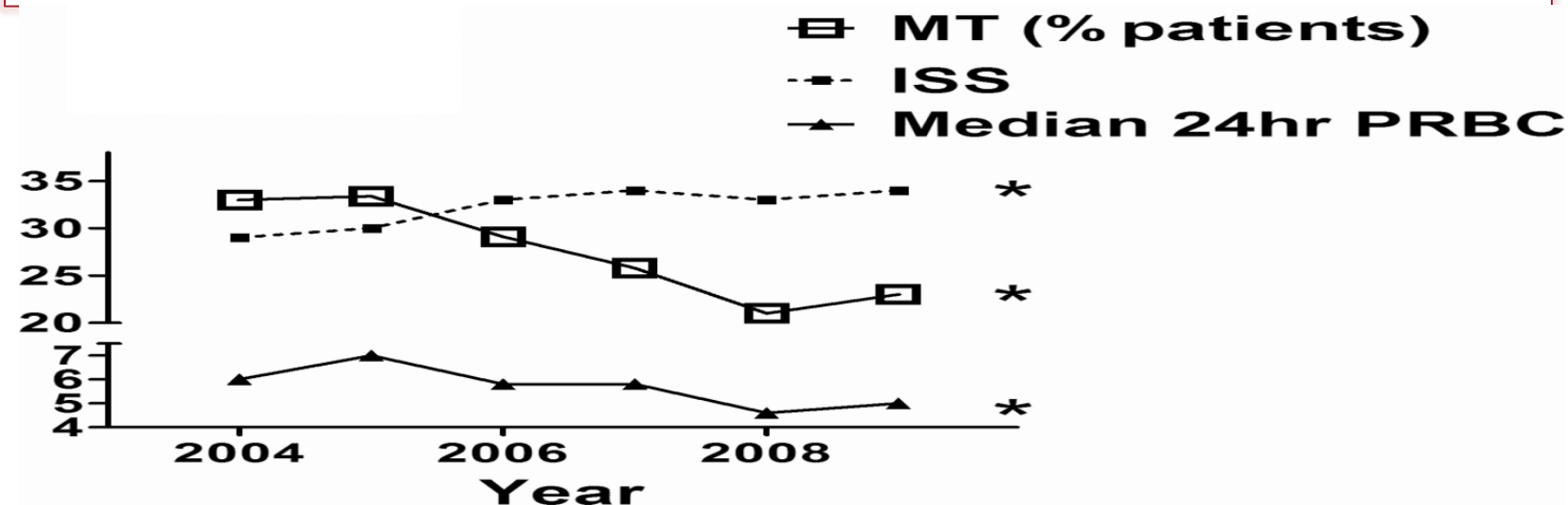
- 2011, Ann Surg


The basic tenets of DCR
Avoid crystalloid resuscitation
Aim for permissive hypotension whenever possible
Prevent coagulopathy through early use o blood products
Aggressively break the vicious cycle of acidosis, coagulopathy, and hypothermia

DAMAGE CONTROL RESUSCITATION IS ASSOCIATED WITH A REDUCTION IN RESUSCITATION VOLUMES AND IMPROVEMENT IN SURVIVAL IN 390 DAMAGE CONTROL LAPAROTOMY PATIENTS

- 2011, Ann Surg

RESULTS—390 patients underwent DCL. Of these, 282 were pre-DCR and 108 were DCR. Groups were similar in demographics, injury severity, admission vitals and laboratory values. DCR patients received less crystalloids (median 14 L vs. 5 L), RBC (13 U vs. 7 U), plasma (11 U vs. 8 U) and platelets (6 U vs. 0 U) in 24-hr; all $p<0.05$. DCR patients had less evidence of the lethal triad upon ICU arrival (80% vs. 46%, $p<0.001$). 24-hour and 30-day survival were higher with DCR (88% vs. 97%, $p=0.006$ and 76% vs. 86%, $p=0.03$). Multivariate analysis controlling



Transfusion triggers

- Definition of haemorrhagic shock
- Low BE
- Expected and ongoing bleeding
- Coagulopathy and hypovolaemia
- Low Hb with severe traumatic brain injury
- Persistent hypotension and tachycardia despite fluid replacement
- Dropping Hb (Hb drop to below 80 g/l or below 100 g/l and 30 g/l drop within 2 h

Use of Hemoglobin-based oxygen carriers (HBOC) for hemorrhagic shock compare with normal saline.

Sloan EP, JAMA 1999

- Has higher mortality rate (*P 0.015)*

Kerner T, Intensive Care,Med 2003

- *Similar mortality* rates.

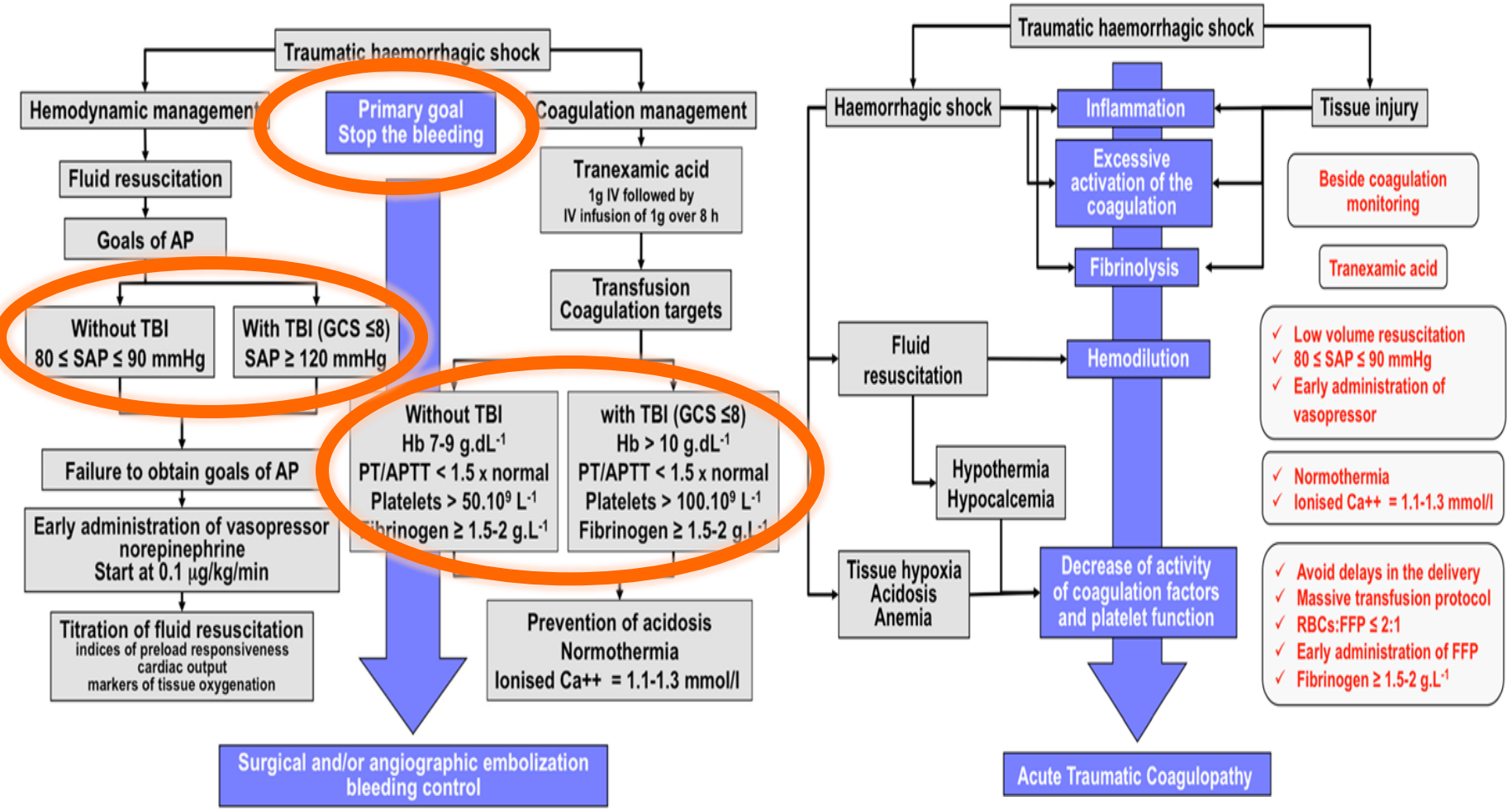
Jahr JS. J Trauma 2008

- Lower need for PRBC transfusion but a significant increase in serious adverse events

Moore EE, J Am Coll Surg 2009

- Similar mortality and a higher rate of adverse events (*P 0.041).*

Resuscitative strategies in traumatic hemorrhagic shock



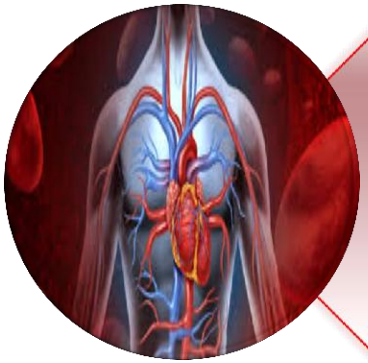
Conclusions

In appropriate patients limiting the rate and volume of fluid resuscitation is becoming the new norm and standard practice

Drugs are being aggressively investigated

Permissive hypotension is the new buzz word

The concept of “damage control resuscitation” with early use of blood components in appropriate pts became cornerstone

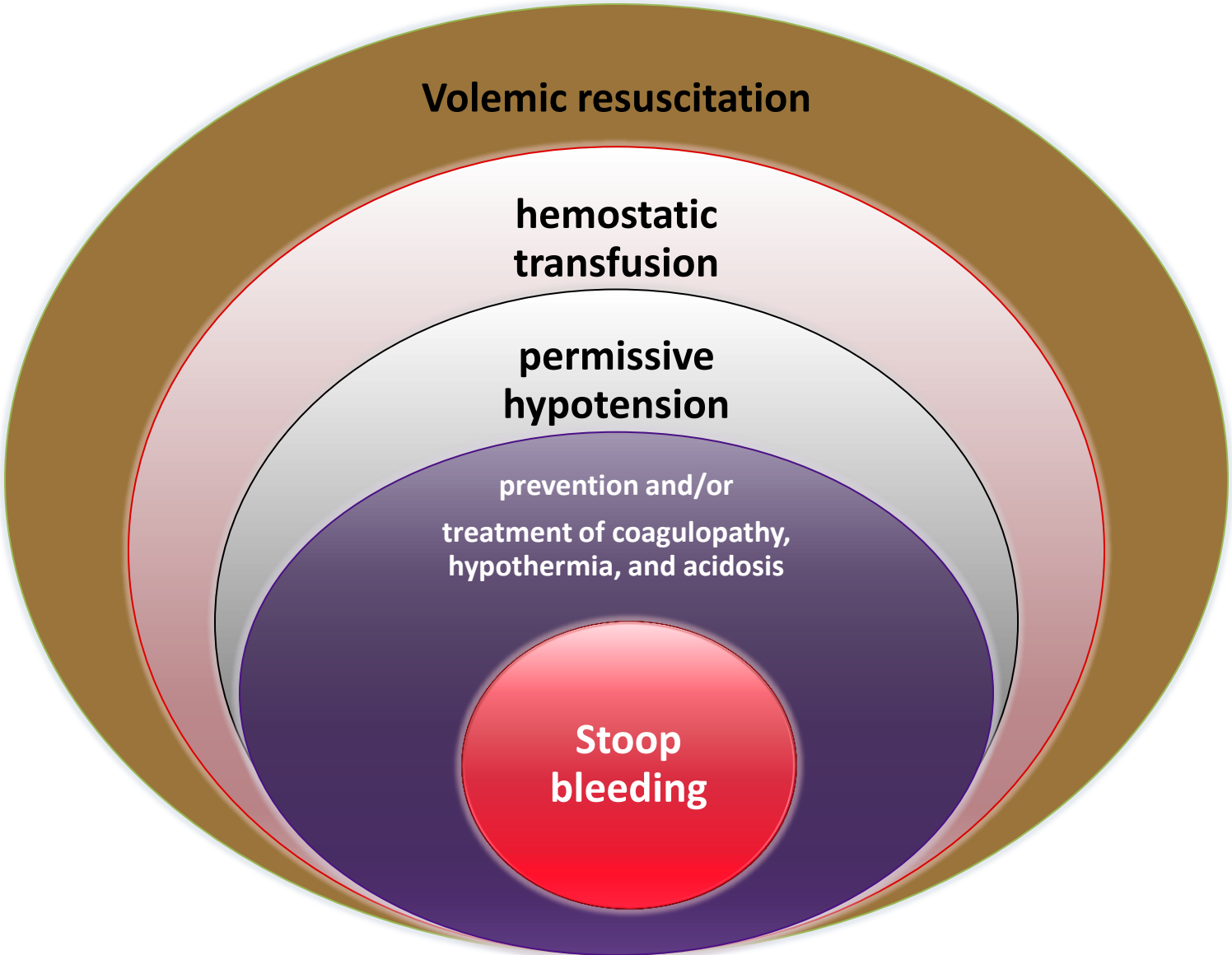


Provide physiological balance, rather than anatomic repair damage

patients who are actively bleeding should have their losses initially restored with fluids to replace the extracellular space.

This approach should, however, be conducted according to criteria

Yes, a Controlled Fluid Resuscitation Strategy can Decrease Mortality in Trauma Patients



Indications	Phases
Rapid control of bleeding	Reduced surgical time
Control and prevention of cavity contamination	Resuscitation phase
----------	Definitive surgical correction

Damage control surgery
Prevention and treatment of hypothermia
Prevention and correction of acidosis
Prevention and treatment of coagulopathy
Hemostatic transfusion
Permissive hypotension

KEY POINTS

- DCR can be required in severe trauma victims.
- Hypothermia, coagulopathy, and acidosis should be aggressively treated.
- Strategies such as permissive hypotension can be used to decrease the loss of blood.
- Hemostatic therapy may also contribute to a better outcome for these patients.