

Treatment of hemorrhagic shock in adults

KISS

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What's New in Trauma Resuscitation?



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Key points

- Trauma resuscitation continues to evolve over time as the understanding of the physiology of hemorrhagic shock changes.
- Existing literature supports rapid transport of traumatically injured patients to a trauma center for definitive care.
- Trauma-induced coagulopathy should be addressed early in resuscitation to improve outcomes.
- Further studies are needed to define the optimal prehospital care.
- Trauma team training and video review improve patient care quality.

RESOURCES

FOR OPTIMAL CARE
OF THE INJURED PATIENT

Reduce death and disability

Research

Quality improvement

Efficient resource use

Local solutions

Prevention

Optimal clinical treatment

COMMITTEE ON TRAUMA
AMERICAN COLLEGE OF SURGEONS



AMERICAN COLLEGE OF SURGEONS

Inspiring Quality:
Highest Standards, Better Outcomes

100+ years

REGIONAL TRAUMA SYSTEMS:
OPTIMAL ELEMENTS,
INTEGRATION,
AND ASSESSMENT
SYSTEMS CONSULTATION GUIDE

COMMITTEE ON TRAUMA
AMERICAN COLLEGE OF SURGEONS
TRAUMA SYSTEM
EVALUATION AND PLANNING COMMITTEE

A NATIONAL TRAUMA CARE SYSTEM

Integrating Military
and Civilian Trauma
Systems to Achieve

ZERO
Preventable
DEATHS
After Injury

The National Academies of
SCIENCES • ENGINEERING • MEDICINE



Infrastructure

Protocols

Communication

Leadership

Competence

KISS



Competence vs interior design
Context & resources

TRAUMEMANUALEN

SJEKKLISTE TRAUMEMOTTAK

1. Presentere team / innmeldt pasient og sjekk journal
2. Bestille 3 Octaplasma?
3. Tilkalle bakvakt / ressurser?
4. Traumeoperasjon / Varsle intervensjon?
5. Briller / blyfrakk /
6. Hette / munnbind / operasjon og brannskade
7. Dimmitere unødige
8. Blodprøver / Etasjer
9. Studieinkludering?
10. Urinkateter?
11. Smittestatus (MRSA)
12. Husk aktiv ledelse / PO/Intensiv

SJEKKLISTE

SENGEPOST

1. NEWS score
2. Plan observasjon i journal
3. Signere kurve
 - Vurdere analgetikabehov / plan / smeteteam
 - Rett antibiotika / plan seponere
 - Thromboseprofylakse / antikoagulasjon
4. Blodprøver
5. Væskeregnskap
6. Ernærings skjema / plan (KEF)
7. Drensregnskap / skylleprosedyrer / sår
8. Plan foley / dren / sonde
9. Vekt 2 ggr/uke
10. Mobiliseringsplan (brokkinde) / fysioterapi
11. Plan psykososialt / sosionom
12. Plan videre / tilsyn andre / rehab

NLA

English version

Kontakt oss

Logg inn

Bytt bok

Skriv inn søk



Protocols





Never better than the weakest link





'SICK PATIENT'

One on the floor and 4 more

Chest (3 cavities)

Abdomen / Pelvis

(intra/extraperitoneal)

Long bones

ATLS[®]

Advanced Trauma Life Support[®]



'SICK PATIENT' TO OR!

Penetrating injury

Define 'trajectory'

Decide which cavity

Be prepared to extend

DIFFERENT FROM BLUNT!



Don't underestimate!

GSW

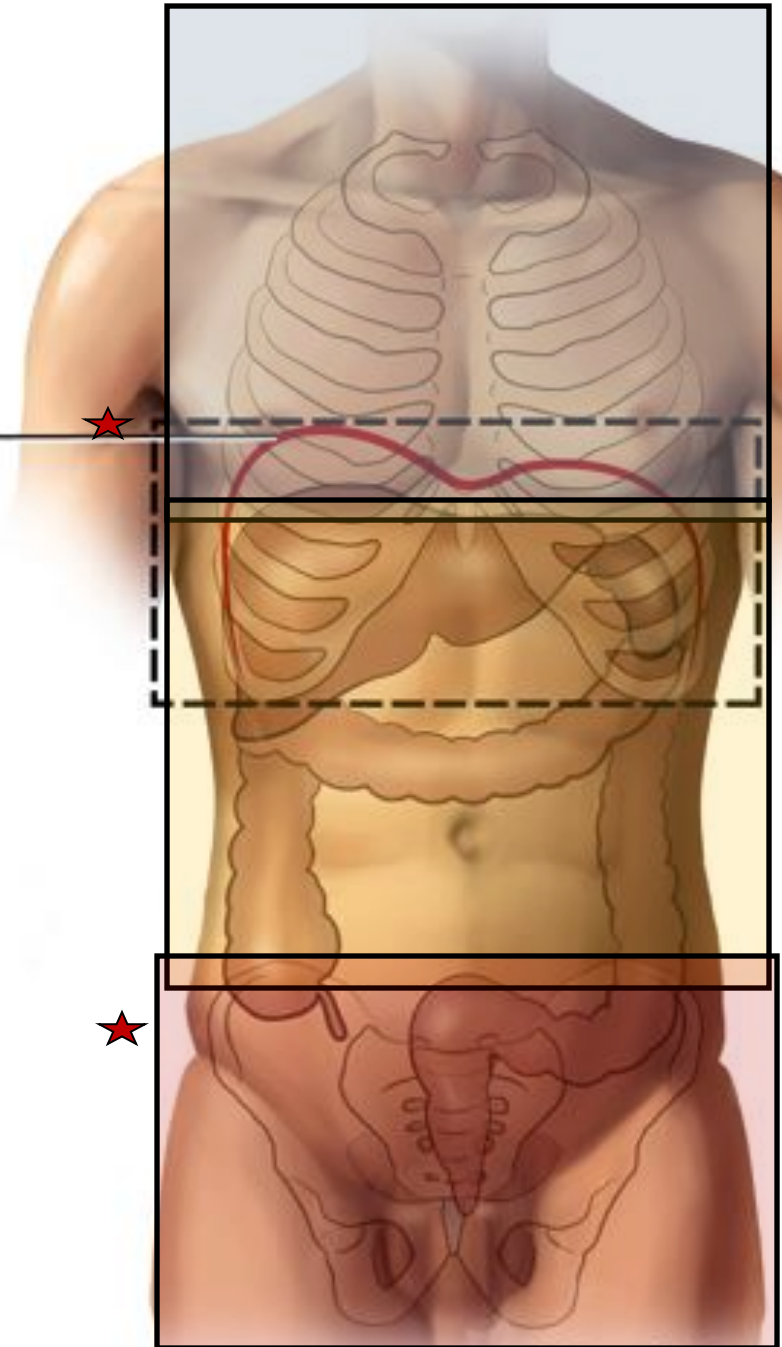
Find all holes

N of holes = N times shot

Til proven otherwise = xray

Holes + projectiles : 2

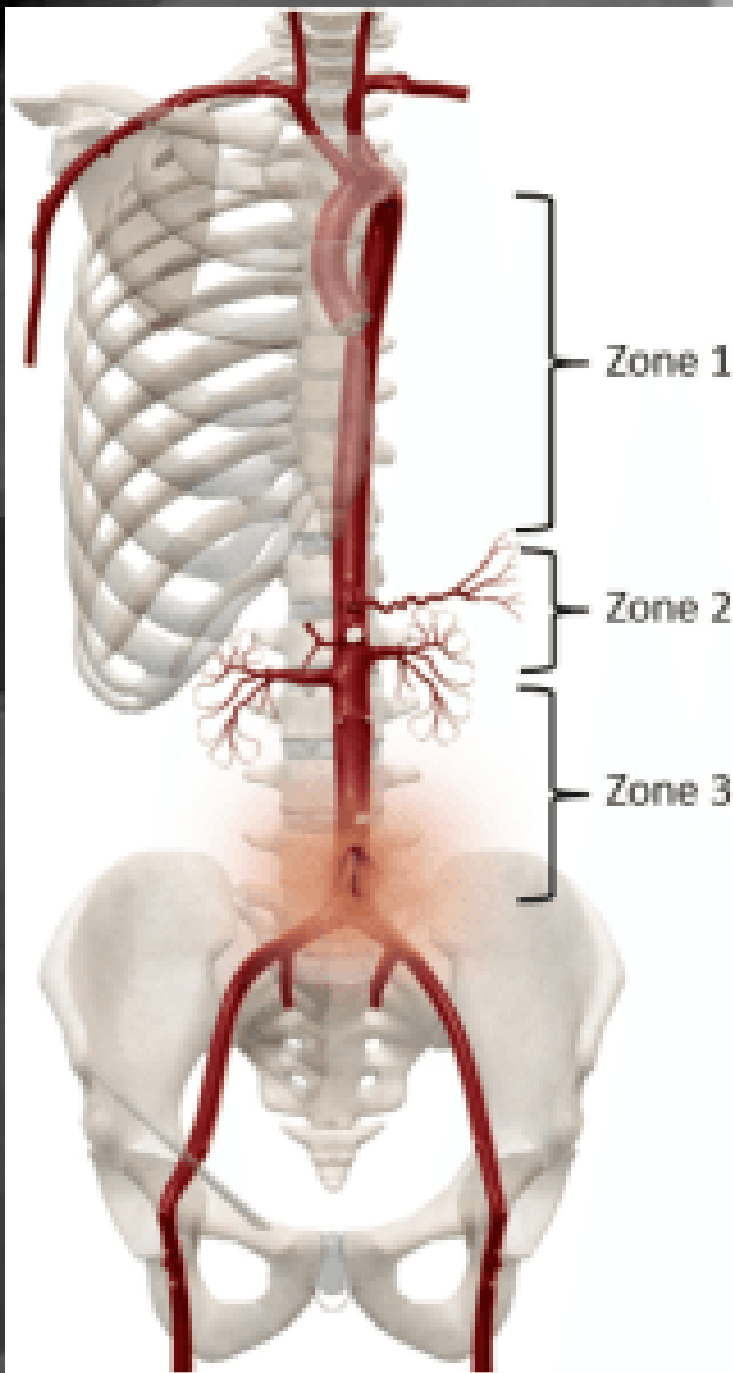
Diaphragm as high
as nipples during
full expiration



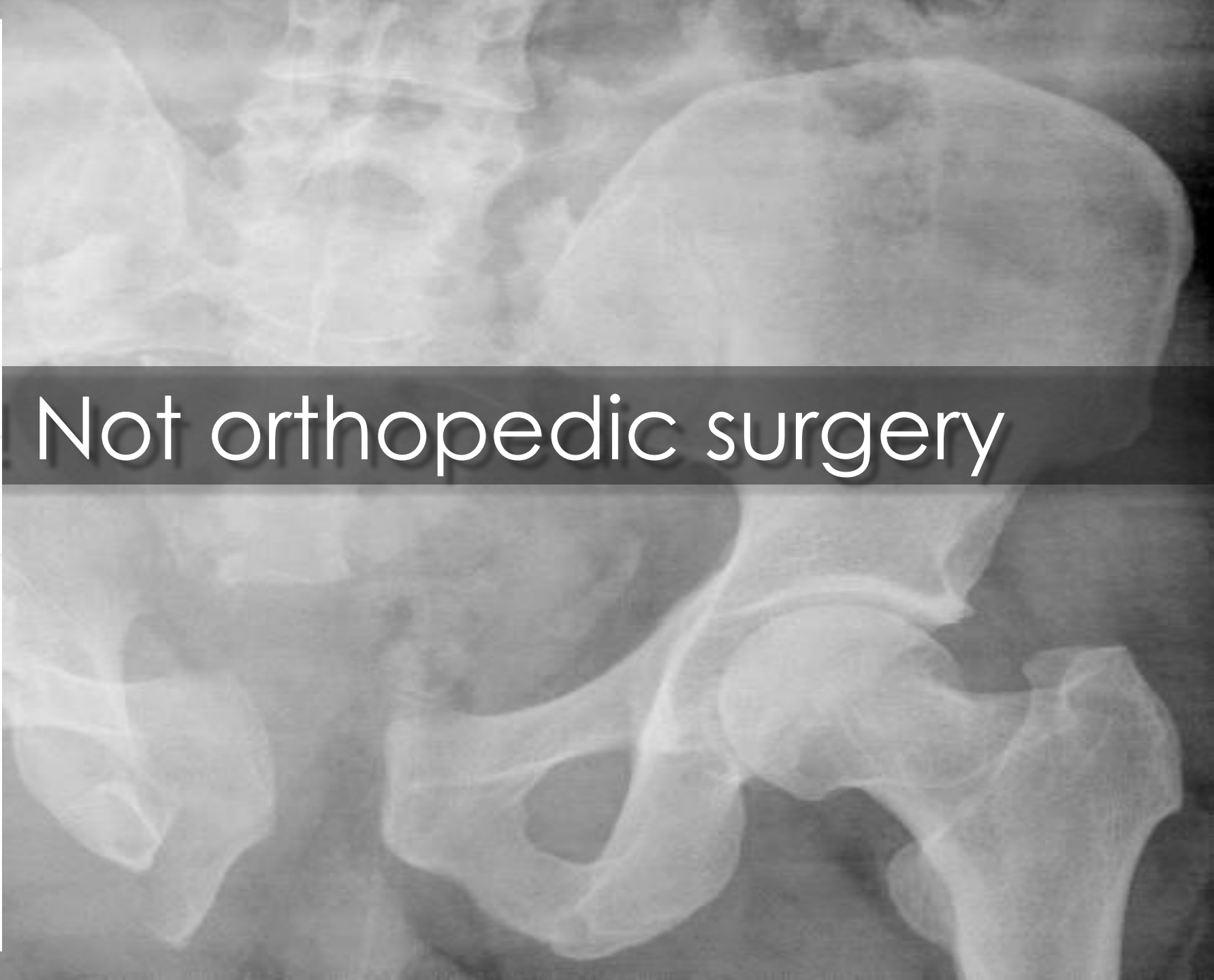
A grayscale chest X-ray showing the ribcage, spine, and lung fields. A dark horizontal band is overlaid across the center of the image, containing white text. The text reads "Not cardiothoracic surgery".

Not cardiothoracic surgery





Not orthopedic surgery

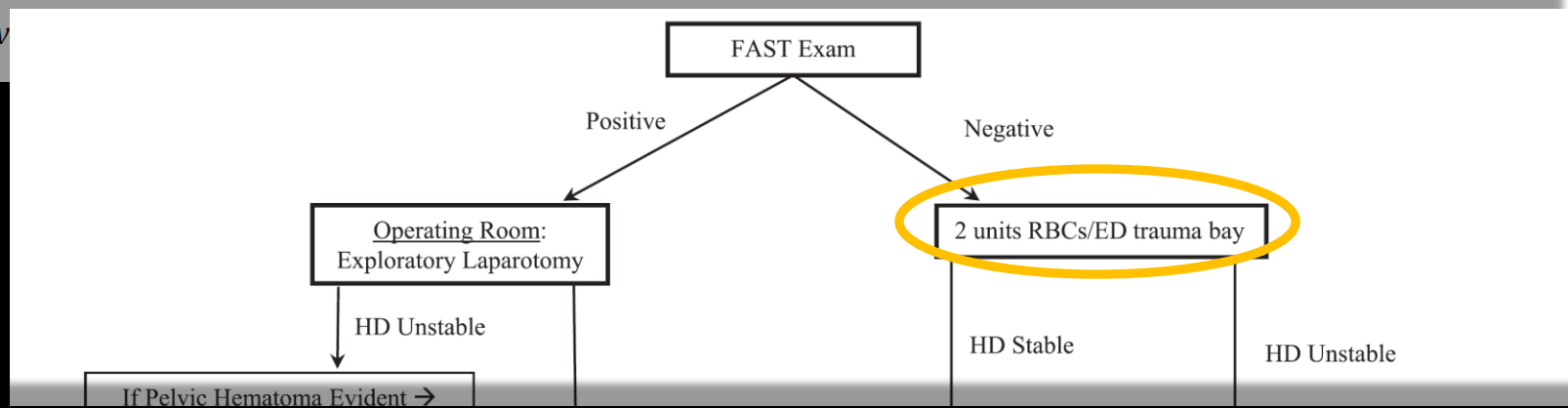


Preperitoneal pelvic packing is effective for hemorrhage control in open pelvic fractures

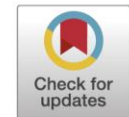


Eliza E. Moskowitz, Clay Cothren Burlew*, Ernest E. Moore, Fredric M. Pieracci, Charles J. Fox, Eric M. Champion, Ryan A. Lawless, Mitchell J. Cohen

Department of Surgery, Denver



Pre-peritoneal pelvic packing for early hemorrhage control reduces mortality compared to resuscitative endovascular balloon occlusion of the aorta in severe blunt pelvic trauma patients: A nationwide analysis ☆



Sarah Mikdad¹, Inge A.M. van Erp¹, Mohamad El Moheb, Jason Fawley, Noelle Saillant, David R. King, Haytham M.A. Kaafarani, George Velmahos, April E. Mendoza*

Division of Trauma, Emergency Surgery and Surgical Critical Care, Massachusetts General Hospital, Boston, MA, USA

Nationwide Analysis of Resuscitative Endovascular Balloon Occlusion of the Aorta in Civilian Trauma

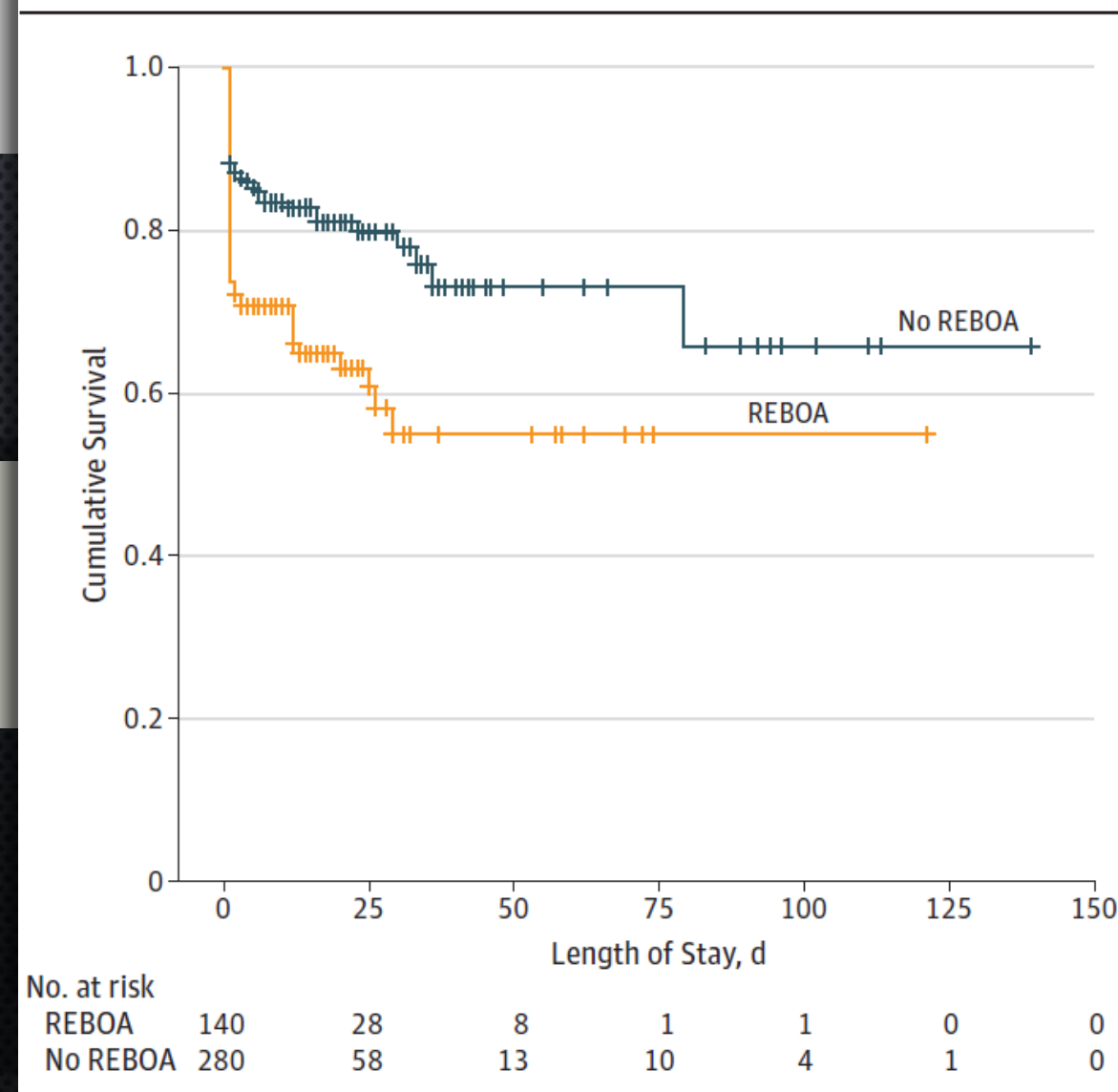
Bellal Joseph, MD; Muhammad Zeeshan, MD; Joseph V. Sakran, MD, MPH; Mohammad Hamidi, MD; Narong Kulvatunyou, MD; Muhammad Khan, MD; Terence O’Keeffe, MD; Peter Rhee, MD

JAMA Surg. 2019;154(6):500-508. doi:10.1001/jamasurg.2019.0096
Published online March 20, 2019.

Table 2. Postmatch Demographics and Injury Parameters of the 2 Groups

Variables	Patients, No. (%)		P Value
	No-REBOA Group (n = 280)	REBOA Group (n = 140)	
Age, mean (SD), y	43 (19)	44 (20)	.88

Figure. Survival Curve Analysis



CONCLUSIONS AND RELEVANCE Placement of REBOA in severely injured trauma patients was associated with a higher mortality rate compared with a similar cohort of patients with no placement of REBOA. Patients in the REBOA group also had higher rates of acute kidney injury and lower leg amputations. There is a need for a concerted effort to clearly define when and in which patient population REBOA has benefit.

Published in final edited form as:

J Trauma Acute Care Surg. 2021 November 01; 91(5): 790–797. doi:10.1097/TA.0000000000003265.

Increased mortality with REBOA only mitigated by strong unmeasured confounding: an expanded analysis using the National Trauma Data Bank

George C. Linderman, PhD^{1,2}, Winston Lin, PhD³, Robert D. Becher, MD, MS¹, Adrian A. Maung, MD, FACS¹, Bishwajit Bhattacharya, MD, FACS¹, Kimberly A. Davis, MD, MBA, FACS¹, Kevin M. Schuster, MD, MPH, FACS¹

Conclusion—There is no evidence in the TQIP dataset to suggest that REBOA causes amputation, and the evidence for its effect on AKI is considerably weaker than previously reported. The increased mortality effect of REBOA is confirmed and could only be nullified by a potent confounder.

Contents lists available at [ScienceDirect](https://www.sciencedirect.com)



	Total N = 1002	REBOA ≤ 4 h N = 339	No REBOA N = 663	P value
Deep vein thrombosis (%)	89 (8.9)	37 (10.9)	52 (7.8)	.106
Pulmonary embolism (%)	36 (3.6)	18 (5.3)	18 (2.7)	.037
Venous thromboembolism (%)	116 (11.6)	50 (14.7)	66 (10.0)	.025
Acute kidney injury (%)	89 (8.9)	42 (12.4)	47 (7.1)	.005
Acute respiratory distress syndrome (%)	38 (3.8)	16 (4.7)	22 (3.3)	.272
In-hospital mortality (%)	142 (14.2)	77 (22.7)	65 (9.8)	<.001
	Total N = 819	REBOA ≤ 2h N = 278	No REBOA N = 541	P value
Deep vein thrombosis (%)	71 (8.7)	31 (11.2)	40 (7.4)	.070
Pulmonary embolism (%)	32 (3.9)	15 (5.4)	17 (3.1)	.115
Venous thromboembolism (%)	94 (11.5)	42 (15.1)	52 (9.6)	.019
Acute kidney injury (%)	76 (9.3)	37 (13.3)	39 (7.2)	.004
Acute respiratory distress syndrome (%)	41 (5.0)	12 (4.3)	29 (5.4)	.517
In-hospital mortality (%)	117 (14.3)	59 (21.2)	58 (10.7)	<.001

A



Original Research Article

REBOA in trauma and the matched-cohort study

Yu-Tung Wu^{a,b}, Chance Nichols
Demetrios Demetriades^{a,*}

^a Division of Trauma, Emergency Surgery, and Surgical Critical Care, Chang Gung Memorial Hospital, Taoyuan, Taiwan
^b Department of Trauma and Emergency Surgery, Chang Gung Memorial Hospital, Taoyuan, Taiwan
^c Department of General Surgery, Chang Gung Memorial Hospital, Taoyuan, Taiwan

Yu-Tung Wu^{1,2} • Meghan R.

UK REBOA TRIAL

UK Resuscitative Endovascular Balloon Occlusion of the Aorta Trial



- INCREASED MORTALITY AT 90 DAYS AND ALL INTERIM TIME POINTS
- INCREASED DEATHS DUE TO BLEEDING AT 3 HOURS AND 90 DAYS
- SUBSTANTIALLY DELAYED TIME TO DEFINITIVE HEMORRHAGE CONTROL



Salvageable? Replace tourniquet asap...

A woman with dark hair, wearing a grey lab coat with purple trim, is looking intently at a blue computer monitor. She is in a clinical or hospital setting, with other people in white coats visible in the background. The word "Limitations" is overlaid in white text on a semi-transparent grey bar across the middle of the image.

Limitations



CT TAKES TIME

CT MUST BE INDICATED

THE PATIENT MUST TOLERATE CT

CT CANNOT EXCLUDE HVI

Damage Control Resuscitation: Directly Addressing the Early Coagulopathy of Trauma

John B. Holcomb, MD, FACS, Don Jenkins, MD, FACS, Peter Rhee, MD, FACS, Jay Johannigman, MD, FS, FACS, Peter Mahoney, FRCA, RAMC, Sumeru Mehta, MD, E. Darrin Cox, MD, FACS, Michael J. Gehrke, MD, Greg J. Beilman, MD, FACS, Martin Schreiber, MD, FACS, Stephen F. Flaherty, MD, FACS, Kurt W. Grathwohl, MD, Phillip C. Spinella, MD, Jeremy G. Perkins, MD, Alec C. Beekley, MD, FACS, Neil R. McMullin, MD, Myung S. Park, MD, FACS, Ernest A. Gonzalez, MD, FACS, Charles E. Wade, PhD, Michael A. Dubick, PhD, C. William Schwab, MD, FACS, Fred A. Moore, MD, FACS, Howard R. Champion, FRCS, David B. Hoyt, MD, FACS, and John R. Hess, MD, MPH, FACP

The Evolving Science of Trauma Resuscitation



Tim Harris, BM BS, BMed Sci, Dip O&G, DipIMC, FFAEM^a, Ross Davenport, PhD^b,
Matthew Mak, BSc, MSc, MBBS, FRCEM, FHEA^c, Karim Brohi, FRCS, FRCA^{d,e,*}

KEYWORDS

- Trauma resuscitation • Hypovolemia • Trauma-induced coagulopathy
- Viscoelastic hemostatic assays • Endothelial damage • Hemostasis

KEY POINTS

- Future research should inform clinicians on the role of permissive hypotension; long this should be maintained, and how/if this should be applied to patients with traumatic brain injury.
- Our understanding of trauma-induced coagulopathy (TIC) is evolving and targeted blood component therapy incorporated early in trauma shock resuscitation.
- The role of viscoelastic hemostatic assays in assessing TIC and directing resuscitation requires further study.
- There is increasing understanding of endothelial damage as a driver of TIC; the possibility of targeting repair to improve hemostasis and reduce organ failure.
- More work is required to identify the most appropriate goals for posthemorrhagic resuscitation balancing the risks of fluid overload and underresuscitation.

Early haemorrhage control and management of trauma-induced coagulopathy: the importance of goal-directed therapy

Jakob Stensballe^{a,b,c}, Hanne H. Henriksen^b, and Pär I. Johansson^{b,d,e}

Purpose of review

The aim of this study was to discuss the recent developments in trauma-induced coagulopathy and the evolution of goal-directed therapy.

Recent findings

Mortality from major trauma continues to be a worldwide problem, and massive haemorrhage is a major cause in 40% of potentially preventable trauma deaths. Development of trauma-induced coagulopathy challenges 25–35% of the patients further increasing trauma mortality. Coagulopathy in trauma reflects at least two distinct mechanisms: Acute traumatic coagulopathy consisting of endogenous heparinization, activation of the protein C pathway, hypofibrinolysis, and resuscitation associated coagulopathy. Clear fluid resuscitation with crystalloids is associated with dilutional coagulopathy and poor outcome in trauma. Goal-directed resuscitation is now the backbone of trauma resuscitation using a ratio-driven strategy aiming at maintaining haemostasis with red blood cells, plasma and platelets while applying goal-directed therapy early and repeatedly to control trauma-induced coagulopathy.

Summary

Trauma resuscitation should focus on early goal-directed therapy with use of viscoelastic hemostatic assays while initially applying a ratio 1:1:1 driven transfusion therapy (with red blood cells, plasma and platelets) in order to sustain normal haemostasis and control further bleeding.

Balanced Resuscitation in Trauma Management



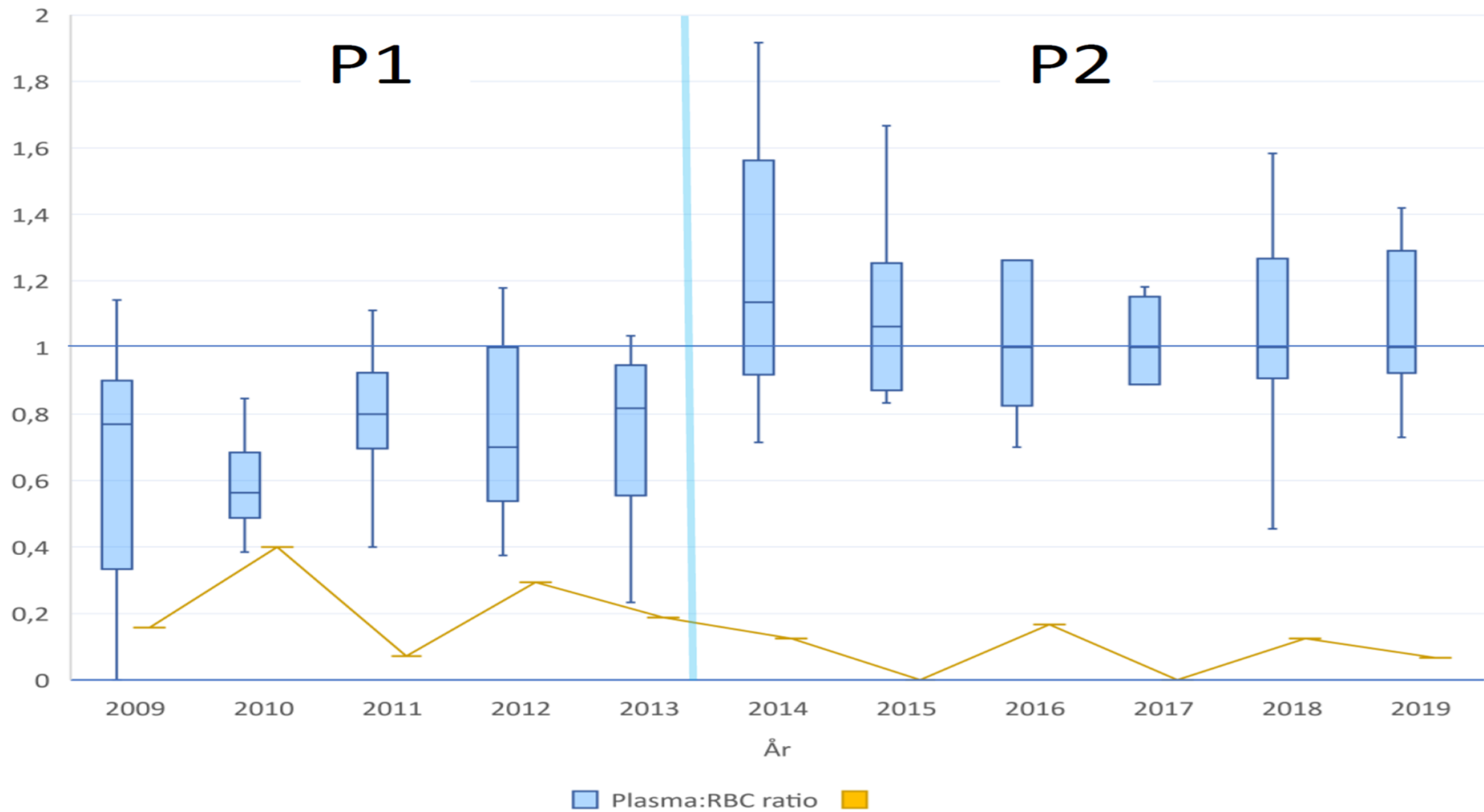
Paul M. Cattle, MD, MBT, FRCSC, Bryan A. Cotton, MD, MPH, FACS^{*}

KEYWORDS

- Balanced resuscitation • Trauma • Coagulopathy • Hemorrhagic shock
- Damage control

KEY POINTS

- Crystalloid, once considered central to the resuscitation of traumatic hemorrhagic shock, leads to numerous complications and increases patient morbidity and mortality.
- Trauma-induced coagulopathy is frequent in injured patients at the time of hospital presentation and is worsened by aggressive crystalloid use.
- Balanced resuscitation minimizes coagulopathy through permissive hypotension, restrictive crystalloid use, and high ratios of plasma and platelet to red blood cell transfusion.
- Balanced resuscitation with plasma, platelets, and red blood cells in a 1:1:1 ratio improves outcomes and should be initiated early, including prehospital, when possible.
- Balanced resuscitation can be achieved through the use of preplanned, matured massive transfusion protocols, specifically designed to be continued until actively turned off.





Mortality $ISS > 15$ & MTP

A photograph of an operating room. Several surgeons in green scrubs and masks are gathered around a patient on a table. In the background, there are medical monitors and equipment. A large monitor on the right displays a CT scan of a pelvis. The scene is brightly lit by overhead surgical lamps.

2008-2012: 31.1%

2014-2019: 17.7%

Whole blood transfusion versus component therapy in adult trauma patients with acute major haemorrhage

Pascale Avery ^{1,2} Sarah Morton ³ Harriet Tucker,^{2,4,5} Laura Green,^{2,6,7} Anne Weaver,^{2,8,9} Ross Davenport^{2,10}



What this study adds

In this systematic review, we found six studies directly addressing WB versus component therapy.

Overall level of evidence was very low to moderate with only one randomised controlled trial.

- ▶ No studies reported worse survival with WB, however, there is insufficient evidence to support or reject the use of WB transfusion compared with component therapy for adult trauma patients with acute major haemorrhage.
- ▶ Larger prospective, randomised or adaptive trials are required to better understand if WB improves survival in adult trauma patients with acute major haemorrhage compared with component therapy.

ORIGINAL ARTICLE

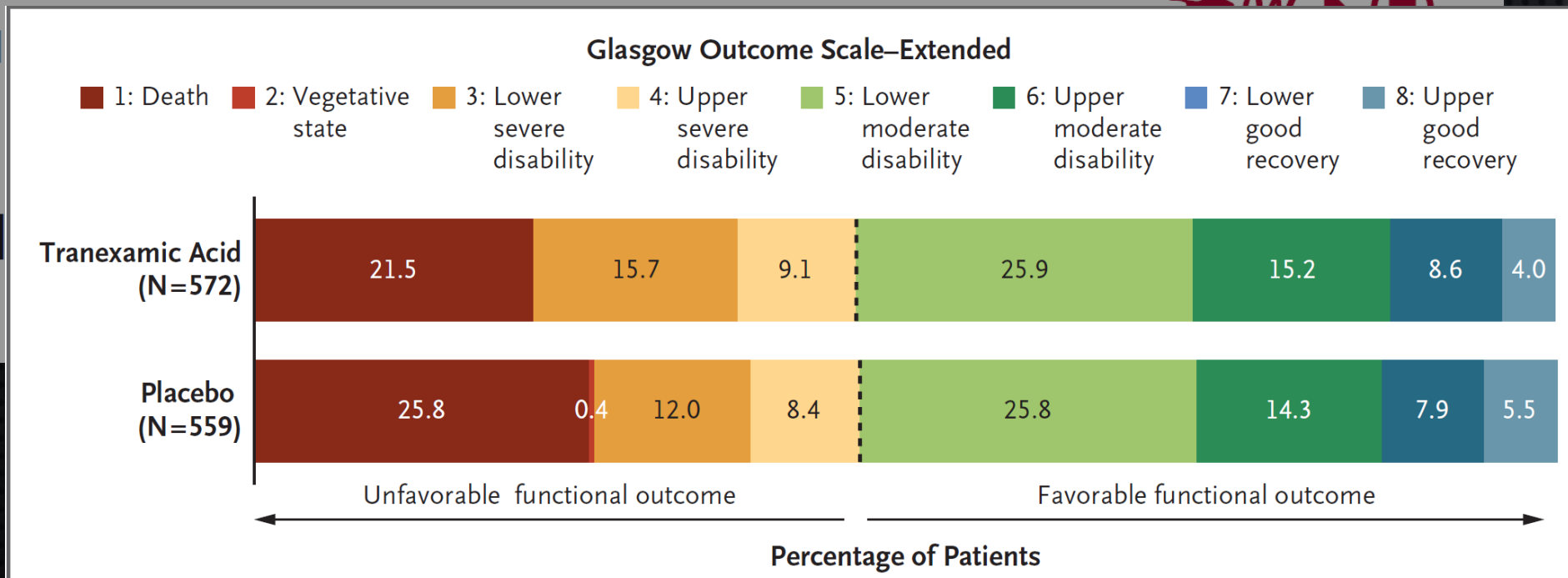


Articles

Prehospital Tranexamic Acid for Severe Trauma

The PATCH-Trauma I
acute traumatic
placebo-control

The CRASH-3 trial collaborators*



Goal-directed Hemostatic Resuscitation of Trauma-induced Coagulopathy

A Pragmatic Randomized Clinical Trial Comparing a Viscoelastic Assay to Conventional Coagulation Assays

Eduardo Gonzalez, MD, Erin
Theresa L. Chin, MD,* Arshad
Denis D. Bensard, MD,*†
Fredric M. Pieracci,
Christopher*

Michael P. Chapman, MD,
Earlton C. Barnett, MD,*†
Jeffrey L. Johnson, MD,*†
Anirban Banerjee, PhD,*
David, PhD*¶*

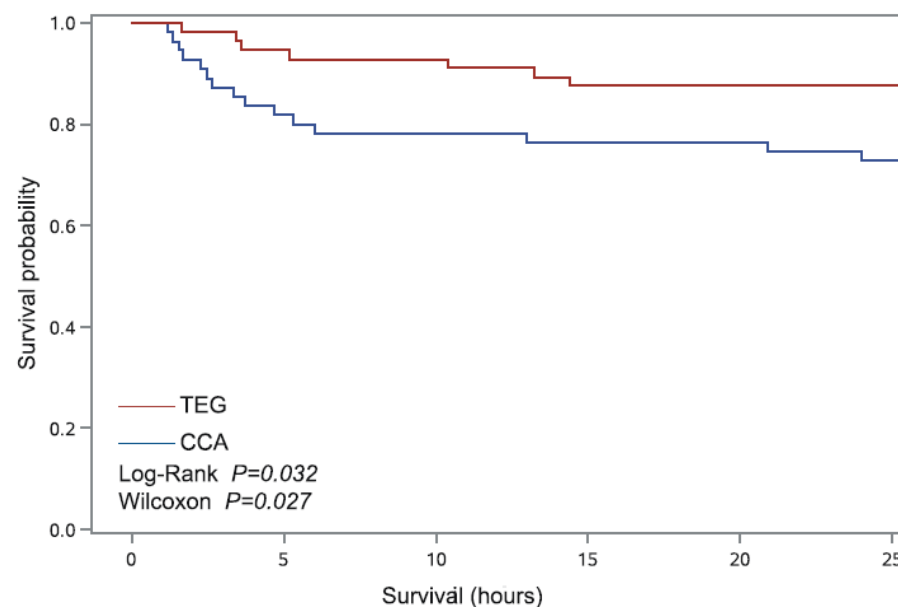
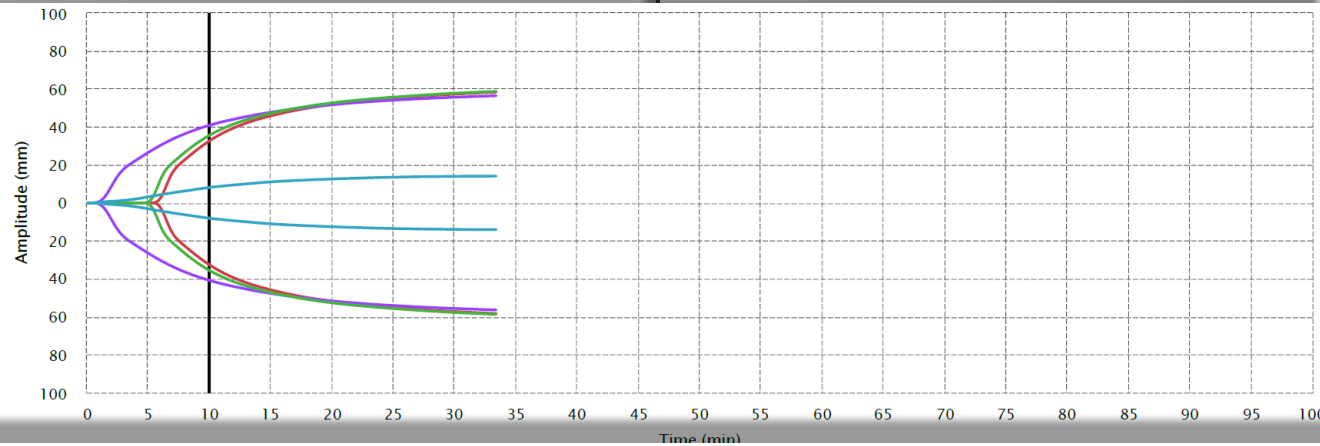


FIGURE 1. Kaplan-Meier estimates of survival by randomization group for patients analyzed as intention-to-treat. Survival in the TEG group was significantly higher than the CCA group (log-rank $P = 0.0324$, Wilcoxon $P = 0.0275$).



Intensive Care Med

<https://doi.org/10.1007/s00134-020-06266-1>

ORIGINAL

Viscoelastic haemostatic assay augmented protocols for major trauma haemorrhage (ITACTIC): a randomized, controlled trial



K. Baksaas-Aasen¹, L. S. Gall², J. Stensballe³, N. P. Juffermans⁴, N. Curry⁵, M. Maegele⁶, A. Brooks⁷, C. Rourke², S. Gillespie², J. Murphy⁸, R. Maroni⁸, P. Vulliamy², H. H. Henriksen³, K. Holst Pedersen³, K. M. Kolstadbraaten¹, M. R. Wirtz⁴, D. J. B. Kleinvelde⁴, N. Schäfer⁶, S. Chinna⁷, R. A. Davenport², P. A. Naess¹, J. C. Goslings⁴, S. Eaglestone², S. Stanworth^{5,9}, P. I. Johansson³, C. Gaarder¹ and K. Brohi^{2*}



Fibrinogen in traumatic haemorrhage

James Winearls^{a,b,c,d}, Michael C. Reade^{e,f}, Zoe McQuilten^{g,h}, and Nicola Curry^{i,j}

Purpose of review

Recent advances in the understanding of the pathophysiological processes of haemorrhage and trauma-induced coagulopathy (TIC) have resulted in improved outcomes for injured trauma patients. However, a significant number of trauma patients still die from haemorrhage. This article reviews the role of fibrinogen in normal haemostasis, the effect of low fibrinogen levels and current evidence for fibrinogen replacement in the management of severe trauma.

Recent findings

Fibrinogen is usually the first factor to reach critically low levels in trauma. Hypofibrinogenaemia after severe trauma is associated with increased risk of death. It is postulated that the early replacement of fibrinogen in severely injured patients may improve outcomes. There is, however, a paucity of evidence to support this. There is also evidence to support or refute the effects of cryoprecipitate or fibrinogen concentrate replacement.

Summary

The important role fibrinogen plays in haemostasis and effective clot formation has been highlighted. Several trials have investigated different strategies for fibrinogen replacement in severe trauma. These trials have formed the basis of several large-scale phase III trials, which, cumulatively, will provide a strong evidence base to harmonise worldwide clinical management of severely injured trauma patients with haemorrhage.

KEY POINTS

- Fibrinogen plays an important role in clot formation in severe traumatic haemorrhage.
- Hypofibrinogenaemia in severe trauma is associated with worse patient outcomes.
- There is a paucity of evidence regarding fibrinogen replacement in severe trauma.
- Several large trials investigating fibrinogen replacement are underway or planned.
- These trials will provide firm evidence on which clinical decisions can be based.

Primary Outcome: All cause 28-day mortality

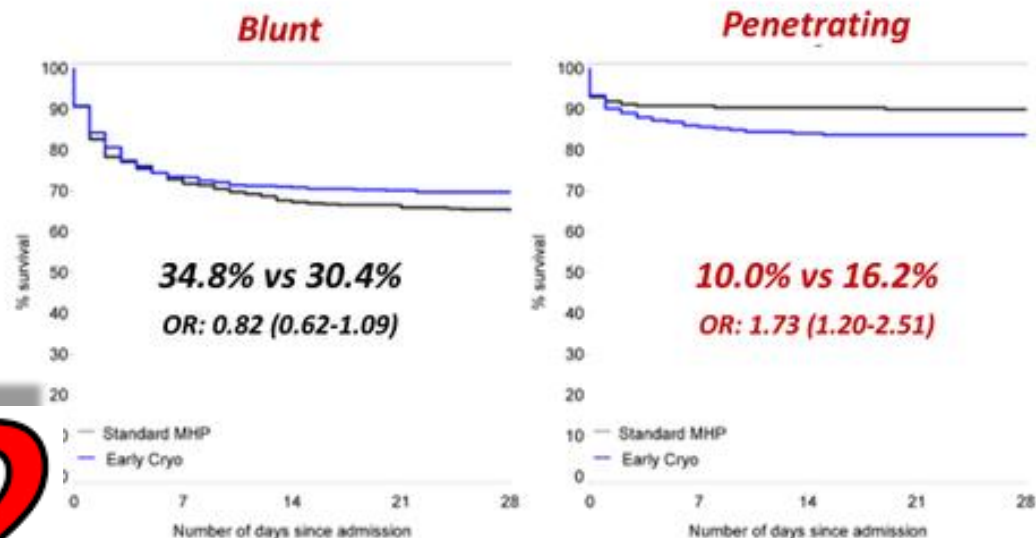
28-day Mortality

Missing primary outcome

Primary Outcome by timing of Cryoprecipitate

n	28-day Mortality	OR
Penetrating		
ISS		
SBP	10	

Primary Outcome by Subgroup: Mechanism



REPEAT ABG - CALCIUM



Cyklokapron® Injection.
tranexamic acid

100 mg/ml

10 x 5 ml ampoules
Sterile solution for intravenous injection or infusion


PHARMACIA



BLUNT vs PENETRATING
PREVENTION CURE

ICU POST BLEEDING

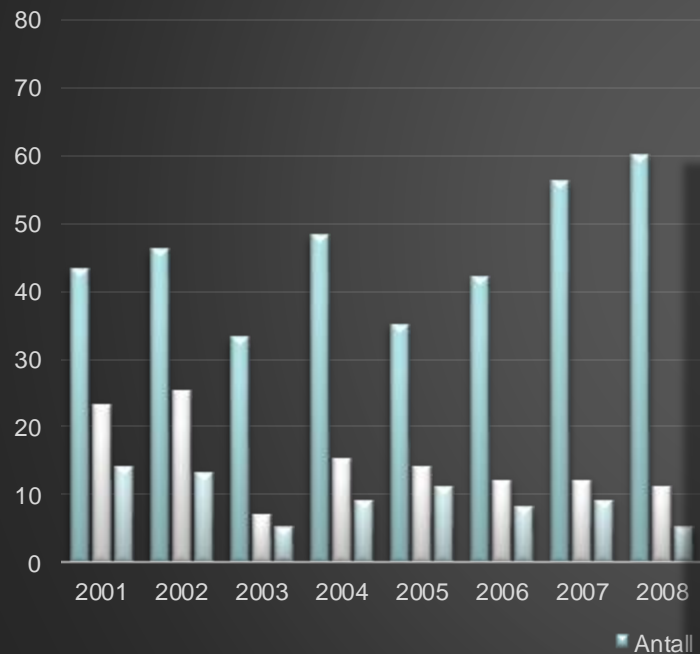
CT/ANGIO/OR? – DAMAGE CONTROL?

- 
- INCREASING SUBSPECIALIZATION
 - WORK HOUR RESTRICTIONS – PRIORITIES
 - OUTSIDE COMFORT ZONE – RECRUITMENT ISSUES?
 - EDUCATION – COMPETENCY REQUIREMENTS

SURGICAL UNTIL PROVEN OTHERWISE, BUT...

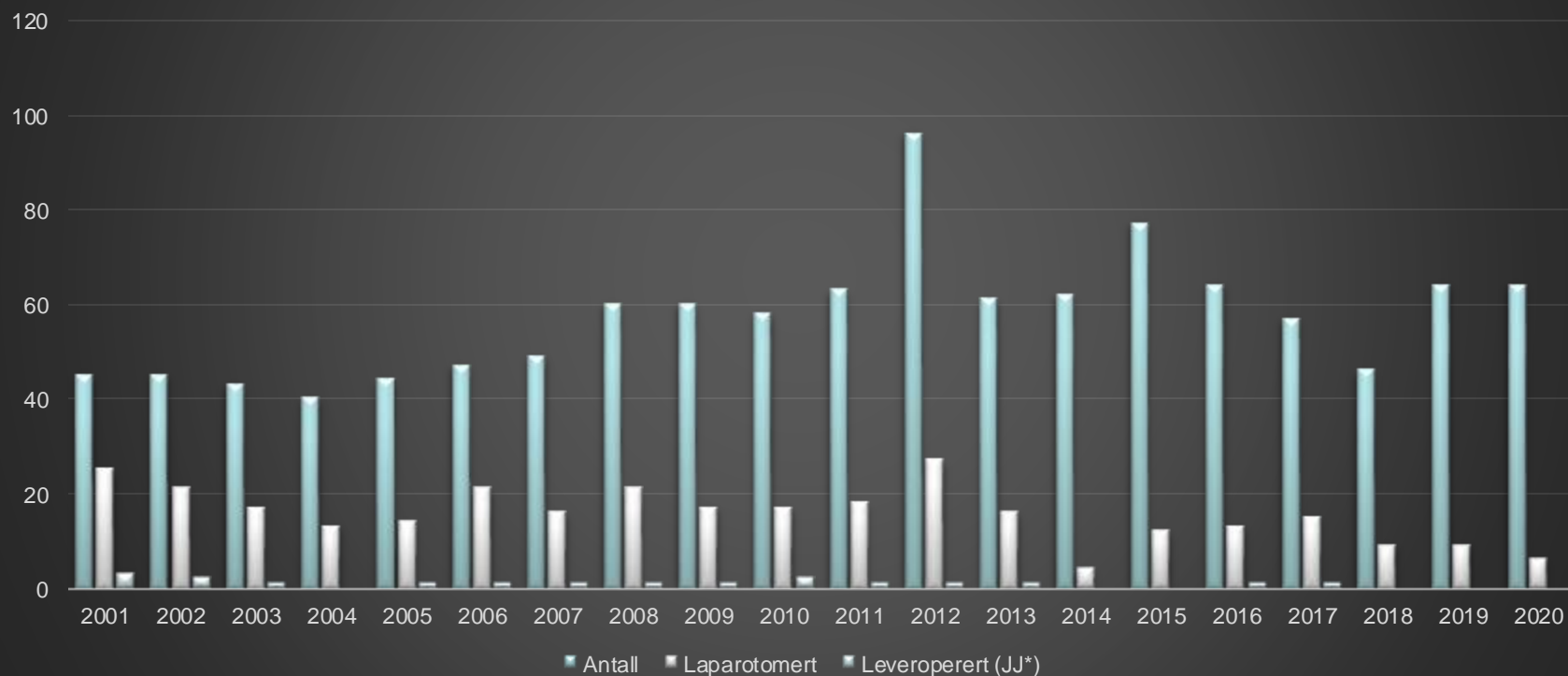
Splenic injuries 2001 - 20, laparotomies and splenectomies

Trauma registry OUH Ullevål



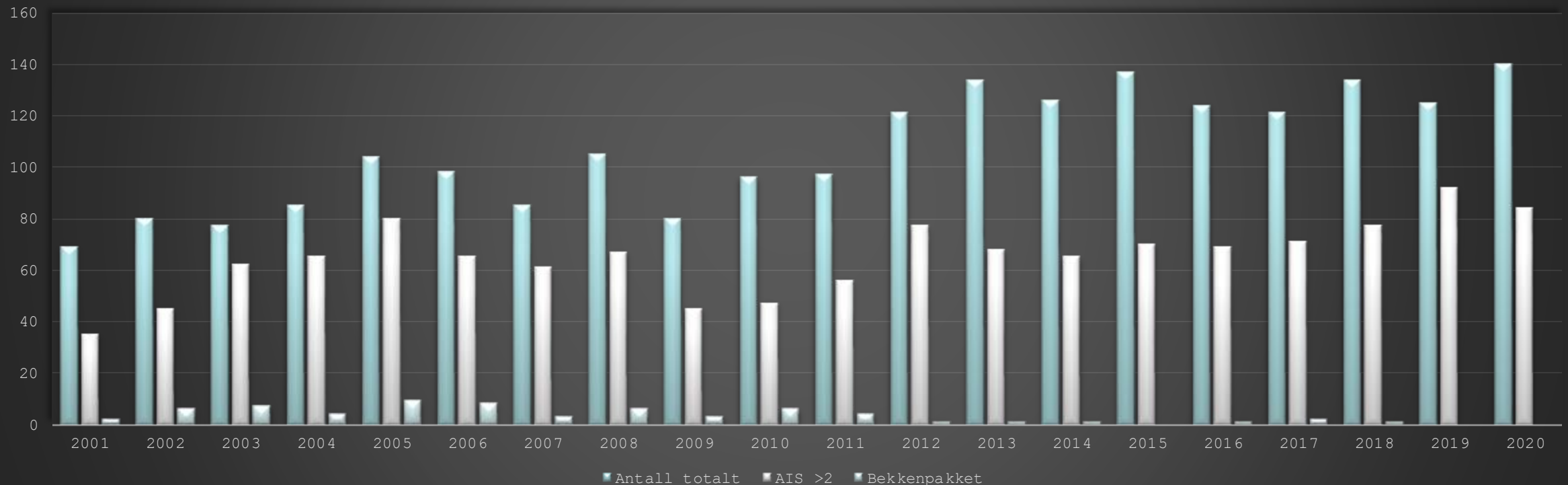
Iver injuries 2001 - 20 laparotomies/therapeutic

Trauma registry OUH Ullevål



Reduced need for extraperitoneal pelvic packing for severe pelvic fractures is associated with improved resuscitation strategies

Pelvic injuries 2001 - 20, AIS pelvis >2 and PPP.
Trauma registry OUH, Ullevål



PREPARED...

with OR nurses

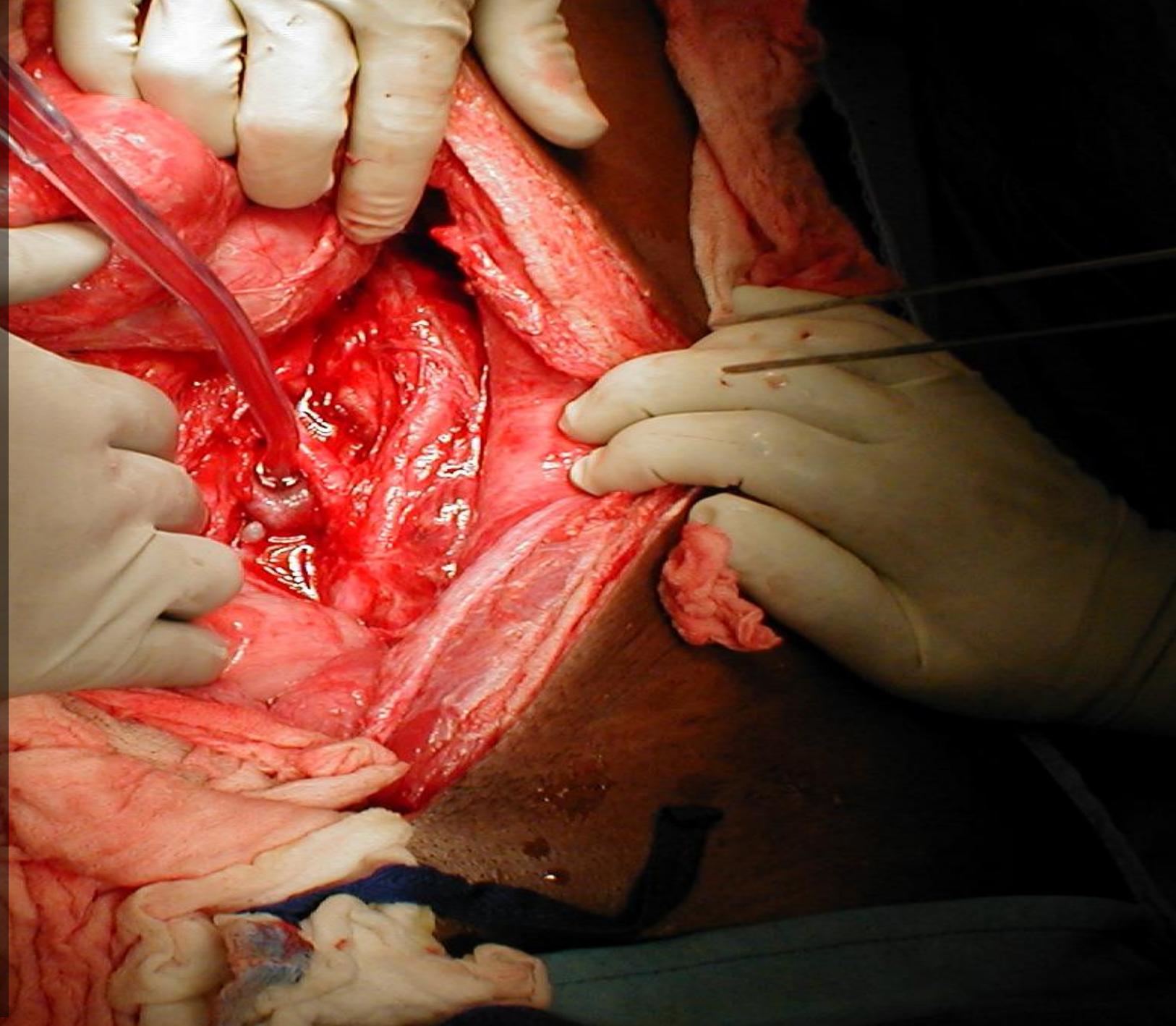
Instruments

Access

Assistance

Competence

Communication



'SICK' PATIENT

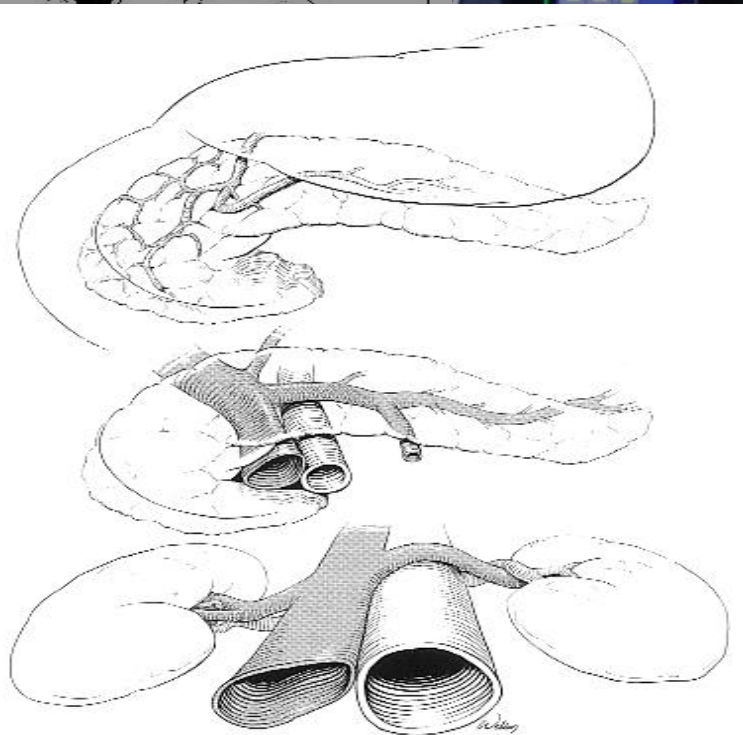
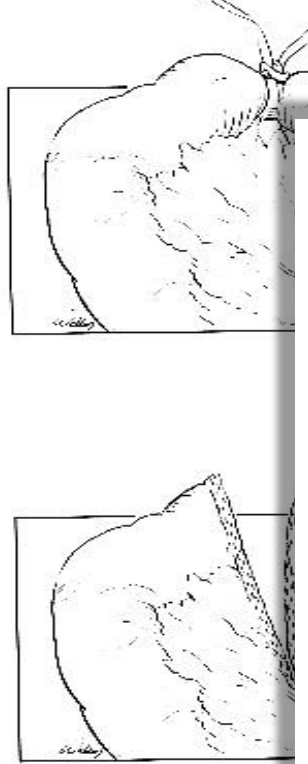
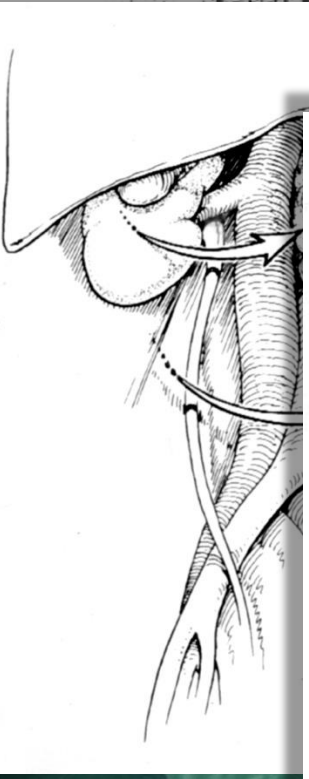
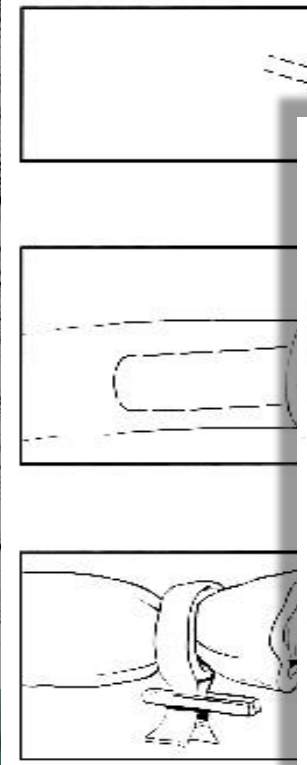
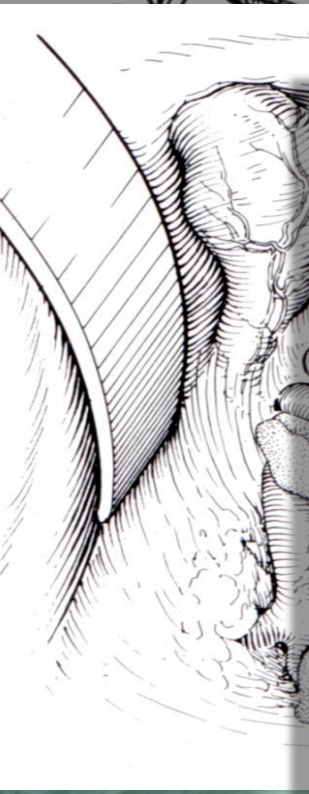
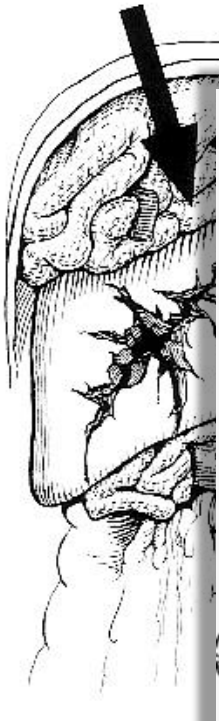
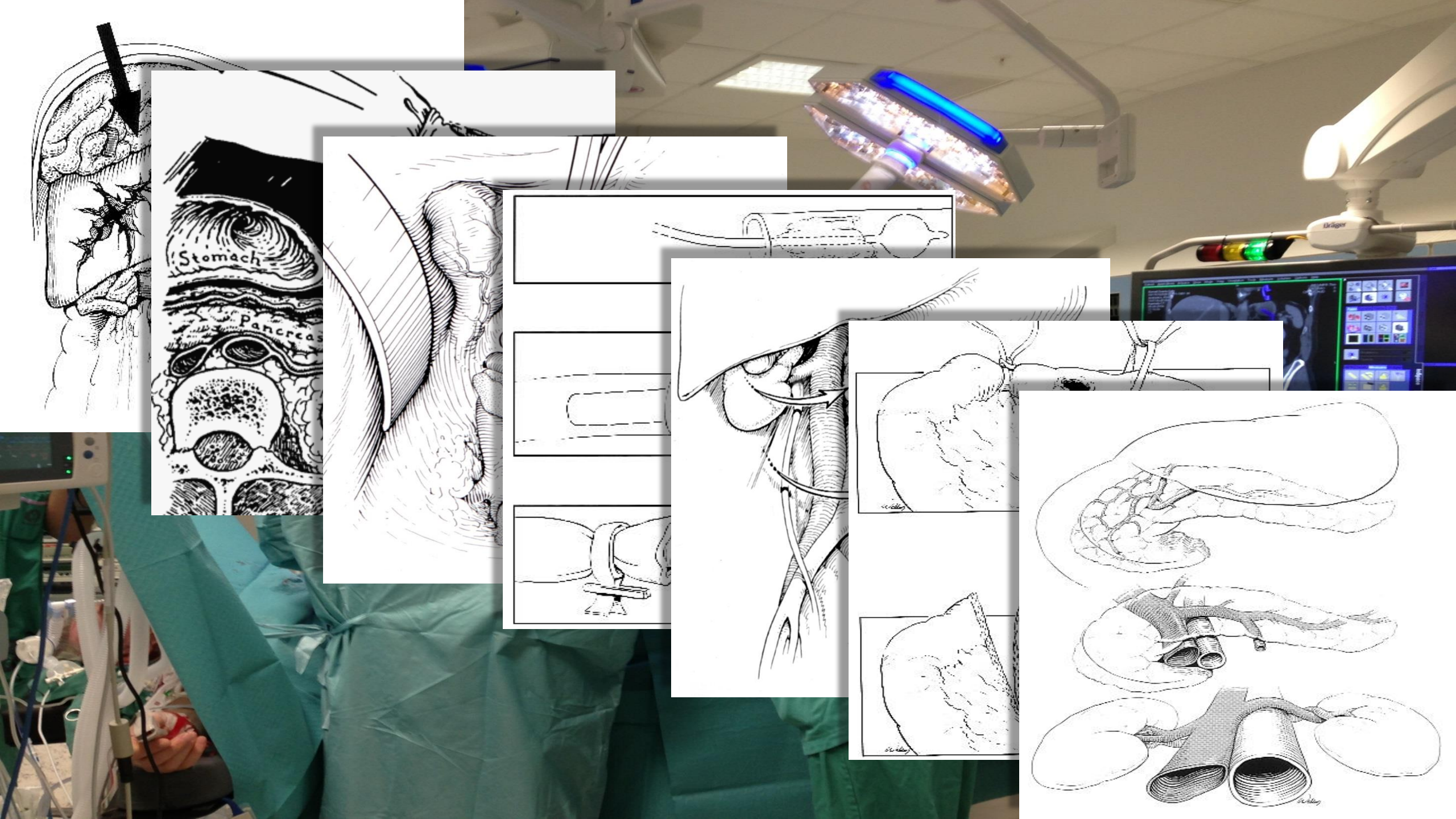


Midline (with knife)

Xiphoid to symphysis

Be prepared to extend

If wrong cavity – new incision





Review Article

ASSESSING SHOCK RESUSCITATION STRATEGIES BY OXYGEN DEBT REPAYMENT

Resuscitation of Endotheliopathy and Bleeding in Thoracic Aortic Dissections: The VIPER-OCTA Randomized Clinical Pilot Trial

Jakob Stensballe, PhD,*† Annette G. Ulrich, MD,‡ Jens C. Nilsson, PhD,‡ Hanne H. Henriksen, MD,* Peter S. Olsen, DMSc,§ Sisse R. Ostrowski, DMSc,* and Pär I. Johansson, DMSc, MPA*||¶

CONCLUSIONS: In this randomized, clinical pilot trial of patients undergoing emergency surgery for thoracic aorta dissections, we found that OctaplasLG reduced glycocalyx and endothelial injury, reduced bleeding, transfusions, use of prohemostatics, and time on ventilator after surgery compared to standard FFP. An adequately powered multicenter trial is warranted to confirm the clinical importance of the findings. (Anesth Analg 2018;127:920–7)

*Christopher K. Bjerkvig,^{1,2} Geir Strandenes,^{1,3} Håkon S. Eliassen,³ Philip C. Spinella,^{4,5}
Theodor K. Fosse,^{1,2} Andrew P. Cap,⁷ and Kevin R. Ward⁶*

MULTIDISCIPLINARY CONTINUITY REQUIRED

- Resuscitation – bleeding – role of plasma
- Pain management
- Anticipate need for early RRT
- Ventilation failure vs IAP
- Infectious sources vs antibiotics
- Nutrition – when TPN
- Plan for definitive surgery/closure
- Thromboprophylaxis vs risk of bleeding

SJEKKLISTE TRAUMEVISITT INTENSIV V/ KIRURG:

Skadedato: _____

Tertiary survey utført (dato/sign.): _____

Nakke avklart (dato/sign.): _____

ID-TAG

DATO:									
INITIALER KIRURG									
HB-GRENSE									
TRANSFUSJONSSTATUS									
VÆSKEBALANSE									
MAP-GRENSE									
PRESSOR									
ICP/ CPP									
VENTILASJON									
SEDASJONSLETTE									
THROMBOSEPROFYLAKSE									
TED STRØMPER									
BUKSTATUS / IAP									
ERNÆRING PLAN									
ULCUSPROFYLAKSE									
ANTIBIOTIKA PLAN									
INNGANGER / KATETER / DREN PLAN									
KIRURGI PLAN									
RØNTGEN (KOORDINERING)									
MOBILISERINGSGRAD									
PSYKOSOSIALT									
ANSVARLIG SUBSPES.									
OVERFLYTTING PLAN									

AKUTTKLINIKKEN, AVDELING FOR TRAUMATOLOGI

TRAUMA SYSTEMS VITAL

Outside comfort zone!

Multidisciplinary teamwork

Not better than weakest link

Surgical until proven otherwise

Context and resources matter

Protocols protect

Aggressive resuscitation

Blunt ≠ penetrating

Evidence before change

