



Goal-Directed Massive Bleeding Management Principles in the Perioperative Setting.

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MASSIVE TRANSFUSION IN TRAUMATIC SHOCK

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Case report 1.

- An 84-year-old woman fall down six steps while walking to the bathroom.
- Initial BP 77/51 mm Hg, - 1 L of normal saline during transport.
- Hypertension, hyperlipidemia, and paroxysmal atrial fibrillation - diltiazem, carvedilol, rosuvastatin, and warfarin.
- Hemodynamically stable, CT scan of the head, neck chest, abdomen, and pelvis - large retroperitoneal hematoma
- Initial lab: hematocrit of 29.1%, INR of 2.4, serum calcium of 9.8 mg/dL.
- In the ED - 2 units of packed red blood cells (PRBCs), 4 units of fresh frozen plasma (FFP), 10 U vitamin K, and 3 L of normal saline, patient complained only of right flank pain.
- Initial evaluation revealed an alert, elderly woman who was awake, temperature 35.78C, heart rate 77 beats/min, blood pressure was 144/77 mm Hg.
- Physical examination was significant for an 10 cm ecchymosis on the right flank, mild right-sided abdominal tenderness without peritoneal findings, and cool extremities.
- Laboratory in the ED - hemoglobin of 8.3 mg/dL, an INR of 1.7, a serum calcium of 8.6 mg/dL, and a base deficit of 6.3 mmol/L.
- The trauma surgical service was consulted - initial plans were for volume resuscitation, supportive care, and observation in the surgical intensive care unit.
- Her anticoagulation was further reversed with 2 additional units of FFP, and 2 units of PRBCs. A radial arterial line was placed for close BP monitoring, and a subclavian venous introducer sheath was placed.



Figure 1. Computed tomography scan of the abdomen and pelvis demonstrating a large retroperitoneal hematoma tracking into the mesentery (arrows), shown in the transverse (A) and coronal (B) planes.

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- Approximately 2 h after, patient complained of an acute increase in her abdominal pain, and became minimally responsive.
- Her arterial line-measured BP decreased to the 40/20 mm Hg.
- The surgical team was notified, and exploratory laparotomy was planned urgently.
- While awaiting transfer to the operating room, she received 7 additional units of PRBCs, 4 additional units of FFP, and one platelet-apheresis product.
- She required low-dose norepinephrine infusion for additional hemodynamic support, and received 2 g intravenous calcium gluconate empirically for presumed hypocalcemia.
- An arterial blood gas: a pH 7.20, ionized calcium of 0.58 mmol/L, hemoglobin of 8.2 g/dL, and a base deficit of 12.7 mmol/L.

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Case report 1.

- Exploratory laparotomy was performed with evacuation of intra-abdominal and retroperitoneal hematomas. A lacerated mesenteric vein was identified as the primary source of bleeding.
- The abdomen was packed and left open.
- Intraoperatively, the EBL was 5 L and 15 units of PRBCs, 10 units of FFP, 12 units of platelets, 1 L of her own whole blood via a cell saver, 3 g calcium chloride were transfused.
- She was transferred to the surgical intensive care unit, where she was noted to have diffuse “medical” oozing from her incision and persistent hemodynamic instability with escalating vasopressor requirements.
- She died approximately 15 h after arrival to hospital.



Case report 2.

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Postpartum hemorrhage (PPH) remains one of the primary causes of maternal morbidity and mortality worldwide





Case report 2

- A 37-year-old woman, gravida 3 para 1, at 39+3 weeks of gestation with insulin-controlled gestational diabetes, a history of endometriosis, and previous cervical conization for CIN2–3, was admitted on June 25 for an elective vaginal delivery.
- Labor induction with vaginal misoprostol on June 28.
- On June 29, the patient delivered a baby via vaginal delivery assisted with vacuum extraction.
- The delivery was complicated by a tight nuchal cord, meconium-stained amniotic fluid, first-degree perineal tear (sutured) and **uterine atony**.

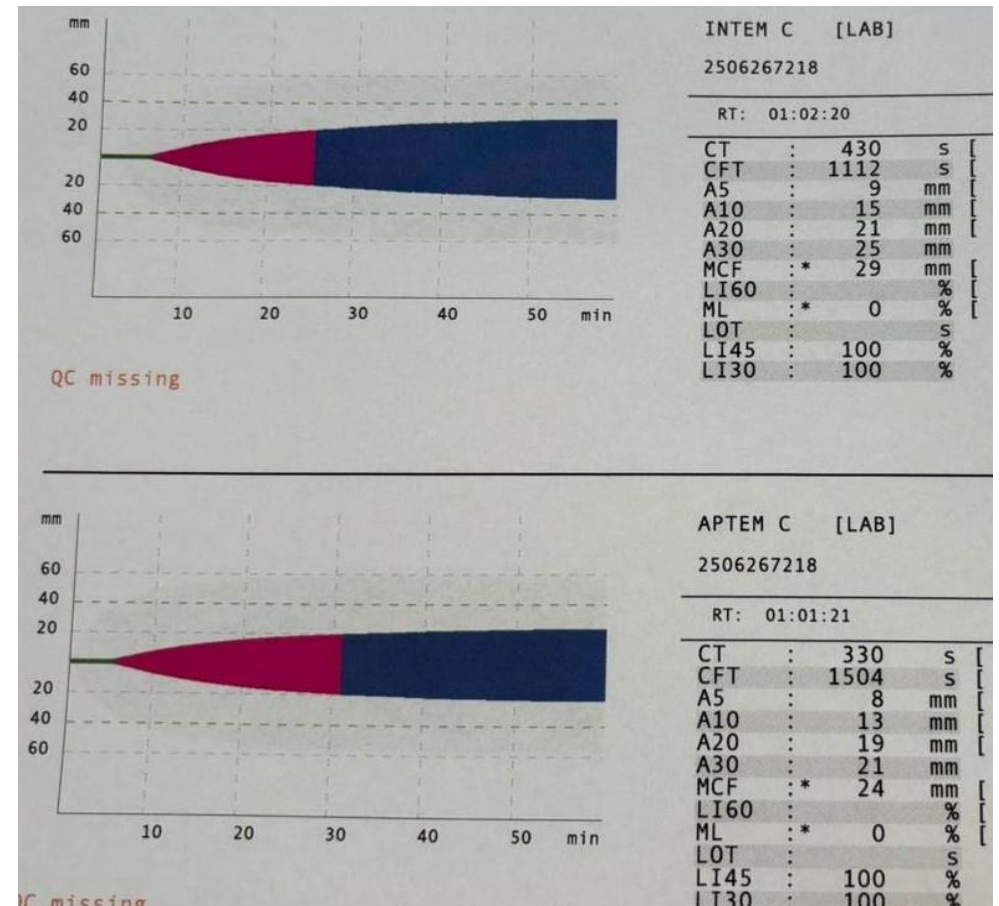
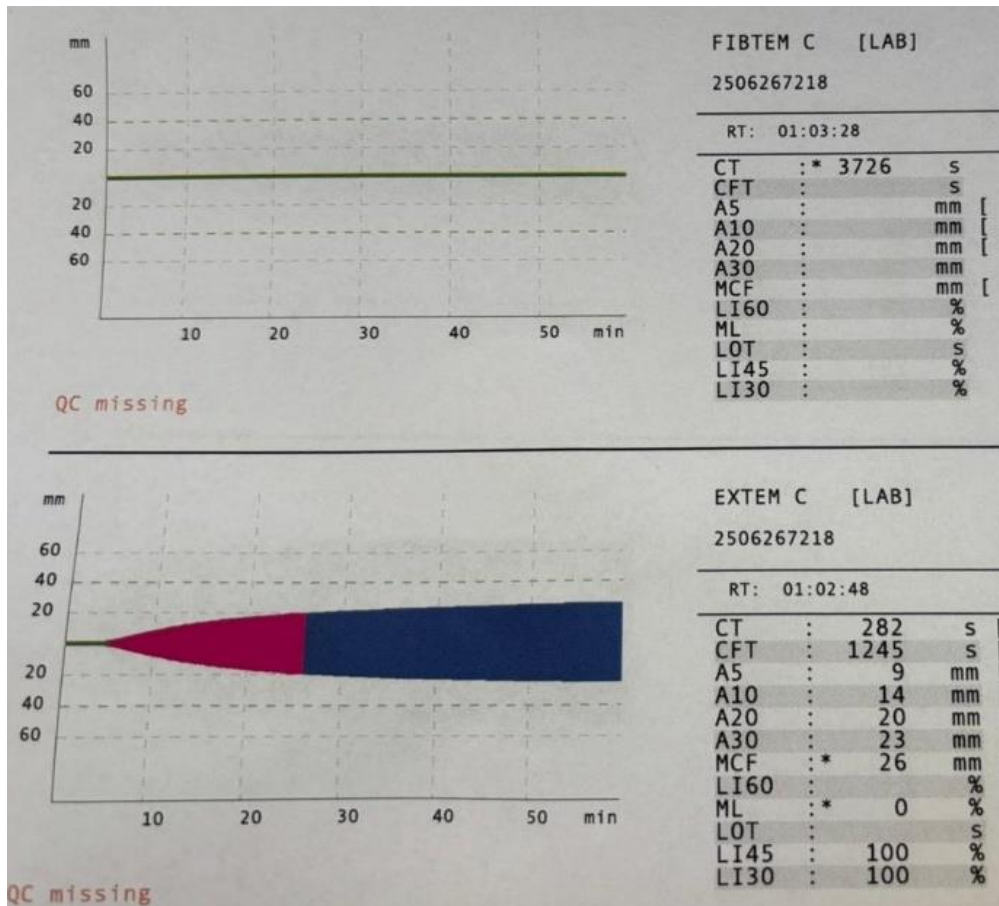


Case report 2



- Early postpartum hemorrhage was estimated to be around 850 mL but quickly progressed.
- Bedside laboratory tests at that time showed hemoglobin 108 g/L, platelets $102 \times 10^9/\text{L}$, INR 1.0, and fibrinogen 0.6 g/L.
- Despite fluid resuscitation, oxytocin i/v and rectal misoprostol, the bleeding progressed and the estimated blood loss reached 6 liters in 2 hrs
- ROTEM

Prolonged clotting times - EXTEM CT 282 s, INTEM CT 430 s
 Reduced clot firmness EXTEM MCF 26 mm, FIBTEM CT 3726 s, MCF 0-24 mm
 Hypofibrinogenemia and factor depletion



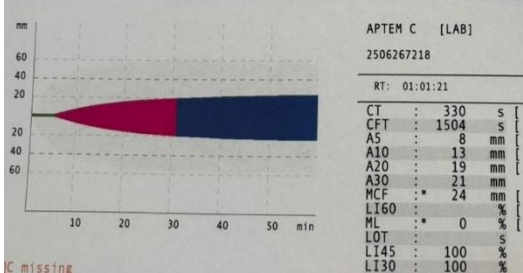
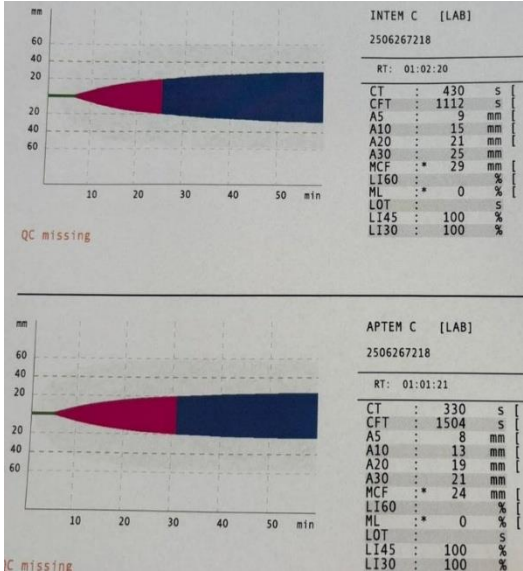
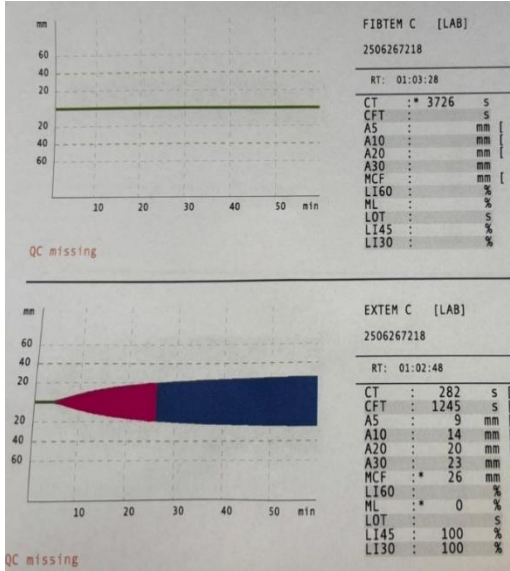


A massive transfusion protocol was activated as the patient was being transferred to operating room.

- General anesthesia → emergency laparotomy with hysterectomy and pelvic packing was performed using a damage-control approach
- Goal directed ROTEM guided massive blood product transfusion:
 - 8 units of packed red blood cells (PRBC),
 - 4 units of fresh frozen plasma (FFP),
 - 20 units of cryoprecipitate,
 - 6 g of fibrinogen concentrate,
 - 4 F prothrombin complex concentrate (PCC) (1000 IU),
 - tranexamic acid (4 g).
- Intraoperatively, the patient experienced cardiac arrest; return of spontaneous circulation was achieved after two minutes of advanced resuscitation

Timepoint	Hemoglobin (g/L)	Platelets (×10 ⁹ /L)	INR	Fibrinogen (g/L)	Notes
Pre-PPH	119	212	1		Admission labs
Peak Hemorrhage	62	39	1,7	0,6	Severe coagulopathy and bleeding
Post-surgery (ICU admission)	82	61	1,1	4,15	After hysterectomy & massive transfusion
ICU Day 2	69	61	1,2	4,4	Stable, extubation planning

Parameter	Reference range	Peak hemorrhage value	Post-correction value	Interpretation
EXTEM clotting time (CT), s	38-79	282	49	Markedly prolonged clotting time – significant clotting factor deficiency
INTEM clotting time (CT), s	100-240	430	147	Severe deficiency of factors in the intrinsic pathway
EXTEM maximum clot firmness (MCF), mm	50-72	26	59	Very weak clot – indicates fibrinogen deficiency and thrombocytopenia
FIBTEM MCF, mm	9-25	0	24	Fibrinogen deficit, replacement effective
EXTEM A10, mm	43-65	14	49	Critically low early clot firmness, normalized after correction
INTEM A10, mm	44-66	15	49	Global coagulopathy improved with treatment
FIBTEM A10, mm	7-23	0	21	Stable fibrinogen response
Maximum lysis (%)	0-15	0	3	No evidence of hyperfibrinolysis





Case report 2.

- After surgery the patient was transferred to the intensive care unit. On admission, the coagulation parameters were fully corrected (fibrinogen 4.15 g/L, INR 1.1, platelets $61 \times 10^9/\text{L}$).
- On ICU day 2, pelvic packing was removed, sedation was discontinued, and the patient was successfully extubated. She remained hemodynamically stable without further bleeding.

Case report 2.

Conclusion.

- ROTEM demonstrated critical utility in this emergency scenario. It facilitated rapid assessment of clotting factor and fibrinogen deficiencies—pathophysiological disturbances commonly observed in the early stages of amniotic fluid embolism (AFE)-associated disseminated intravascular coagulation (DIC).
- Using ROTEM to guide a massive transfusion protocol (MTP) helped focus treatment with fibrinogen concentrate, prothrombin complex concentrate (PCC), platelets, and cryoprecipitate.
- *Important:* keeping fibrinogen levels above 2 g/L or FibTEM maximum clot firmness (MCF) over 12 mm improves outcomes in severe postpartum hemorrhage (4–6). In this case, those targets were reached during surgery, leading to quick stabilization.
- This case shows the value of bringing ROTEM-guided transfusion strategies into obstetric emergency care, as they support faster decisions, more accurate treatment, and better chances of survival.

„STOP the Bleeding Campaign“, an international initiative launched in 2013 to reduce morbidity and mortality associated with bleeding following traumatic injury.



Search for patients at risk of coagulopathic bleeding
Treat bleeding and coagulopathy as soon as they develop
Observe the response to interventions and
Prevent secondary bleeding and coagulopathy

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Critical Care

GUIDELINES

Open Access



The European guideline on management of major bleeding and coagulopathy following trauma: sixth edition

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- *European Society for Trauma and Emergency Surgery (ESTES)*
- *European Society of Anaesthesiology (ESA)*
- *European Shock Society (ESS)*
- *European Society for Emergency Medicine (EuSEM)*
- *Network for the Advancement of Patient Blood Management, Haemostasis and Thrombosis (NATA)*
- *European Society of Intensive Care Medicine (ESICM)*

Problem No. 1: Crystalloids



- Treatment of bleeding - volume replacement using physiological saline (NaCl 0.9%) - (low cost, algorithms) - the most *non-physiological* crystalloid
- Short-term maintenance of volume, but:
 - dilutional anemia and coagulopathy,
 - systemic inflammatory response, cell edema,
 - hyperchloremic acidosis, metabolic dysfunction, and apoptosis.

The main factors that cause secondary coagulopathy - consumption and dilution of clotting factors and platelets by infused crystalloid solutions and RBC.

Problem No. 2. Hypothermia.

- Temperature $\downarrow$ 1°C - clotting factor activity $\downarrow$ 10%, and at temperatures $< 33^{\circ}\text{C}$, this activity decreases $> 50\%$.
- Obvious platelet dysfunction is observed at $< 34^{\circ}\text{C}$.

When you use many “blood”, they are cold blood products...



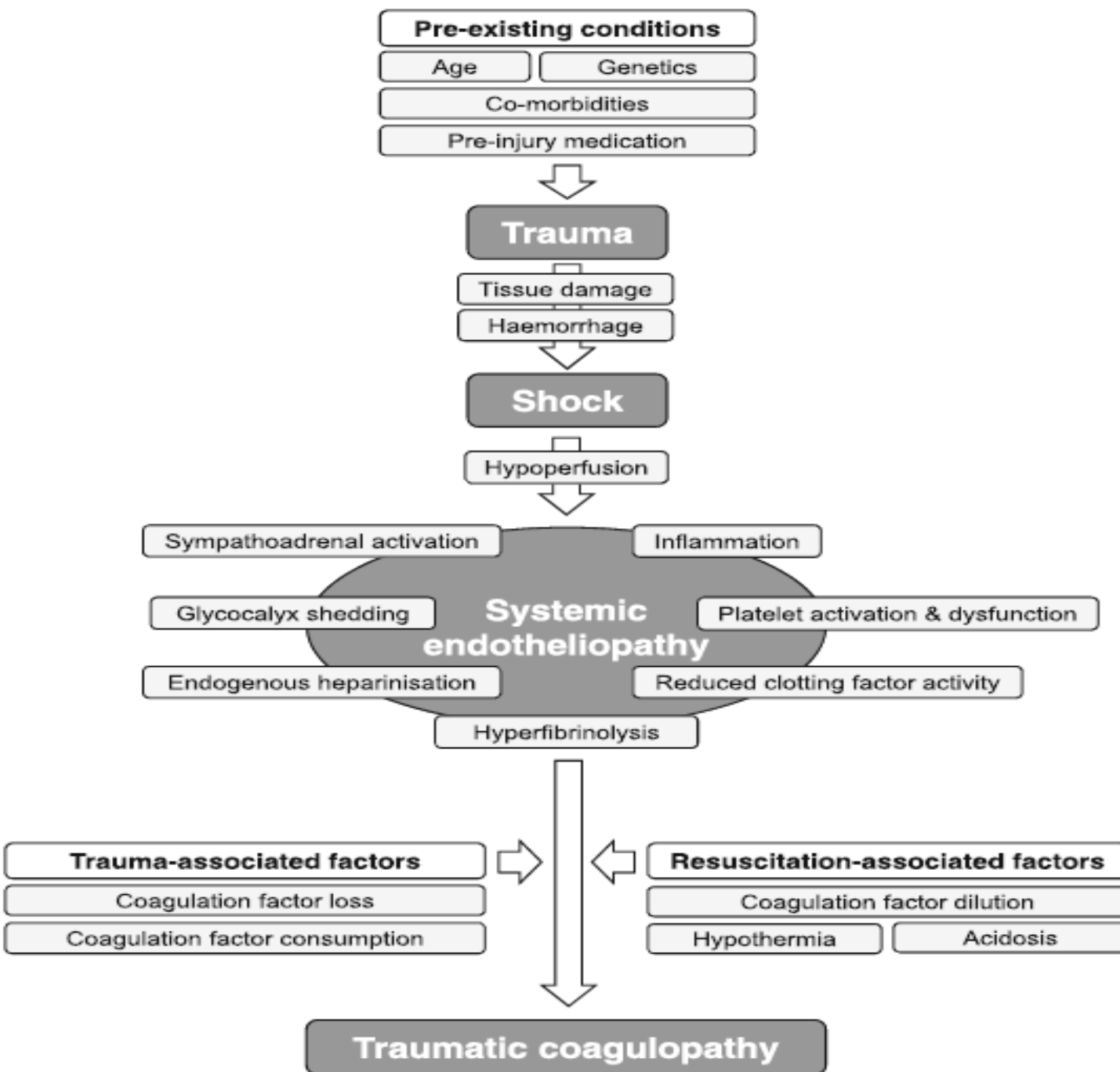
Problem No. 3. Acidosis

- Systemic hypoperfusion and lactatemia → acidosis.
- Blood products used for transfusion increase acidosis (RBC pH ↓ from 7.4 to 6.9 after preparation, and ↓ to 6.7 after 3 weeks).
- Clotting factor activity is 50-90% lower at pH 7.0.
- PT and APTT do not reflect the true severity of coagulopathy - standard laboratory conditions (pH 7.4, normothermia).
- Viscoelastic tests - fibrinogen levels, platelet function, thrombus formation, and fibrinolysis. But there is no endothelium...

Problem No. 4. Hypocalcemia

- 3 g of citrate is added to RBC and FFP, which binds Ca^{2+} . A healthy liver removes it in 5 minutes.
- But ... hypothermia, hypotension – hepatic clearance?
- Ca^{2+} - coagulation factor activity, myocardial contraction, and vasomotor tone.
- Hypocalcemia $< 0.8 \text{ mmol/L}$ causes coagulopathy and cardiovascular dysfunction.





About 30% of all bleeding trauma patients present with a coagulopathy upon hospital admission

Maegerle M, Lefering R, Yucel N, Tjardes T, Rixen D, Paffrath T, et al. Early coagulopathy in multiple injury: an analysis from the German Trauma Registry on 8724 patients. Injury. 2007;38(3):298–304.

Fig. 1 Schematic drawing of the factors, including those that are preexisting as well as those related to both trauma and resuscitation measures, that contribute to traumatic coagulopathy. Adapted from [20, 24, 30–32, 38]

V. Initial management of bleeding and coagulopathy

Initial coagulation resuscitation

Recommendation 24

In the initial management of patients with expected massive haemorrhage, we recommend one of the two following strategies:

- **FFP in a FFP:RBC ratio of at least 1:2 as needed. (Grade 1C)**
- **Fibrinogen concentrate and RBC. (Grade 1C)**
- *Whole blood?*



VI. Further goal-directed coagulation management.

Goal-directed therapy

Recommendation 25

We recommend that resuscitation measures be continued using a goal-directed strategy, guided by standard laboratory coagulation values and/or **viscoelastic tests**. (Grade 1B)



Massive bleeding management –
team is crucial

Thank you

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