The role of platelets: hemostasis and transfusion therapy

Moderators: Manuel Quintana Díaz and Juan Ramón Fernández Villanueva

Monday, June 16, 2025

1. INTRODUCTION

Manuel Quintana Díaz

The use of platelets in Spain is currently excessive, and the trend is to keep on growing. Moreover, although not as much as red blood cell transfusion, platelet transfusion is associated to certain problems, such as fever reactions, allergic reactions, and TRALI—Transfusion-Related Acute Lung Injury.

The article by Blumberg et al., entitled *Platelet Transfusions: The Good, the Bad, and the Ugly,* summarizes the issues related to platelet transfusion that must be tackled[1]:

THE GOOD

- Altruistic donation
- Sound evidence to prevent bleeding if < $10x10^9$/L
- Low doses are equally effective
- Deciding about the transfusion considering the clinical history and the absolute figure

THE BAD

- Unjustified use if originating from apheresis
- Liberal transfusions increase bleeding and mortality
- When stored, they become proinflammatory and dysfunctional
- It has an immunological role o review

THE UGLY

- Ignoring the ABO group can cause refractoriness and damages
- Refractoriness can be prevented with an ABO-identical and well-performed leukoreduction
- ABO incompatibility may lead to bleeding, sepsis, and death
- Potential solutions (washing or plasma reduction) are expensive and are not always carried out

Questions arising from platelet transfusion

Impact?	Clinical, emotional, and ethical consequences?	Is it a good practice if it does not improve outcomes or prevents damage?	Can do less be better?

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2. ROLE OF PLATELETS IN HEMOSTASIS AND MONITORING: NUMBER OR FUNCTION?

Rocío Amézaga Menéndez

Platelets have multiple roles in the body, beyond hemostasis regulation:

Hemostasis	Immunity	Inflammation	Endothelial repair

Platelet alterations are associated with bleeding, thrombosis, and organ failure. Thus, both the **number of platelets** and their **functionality** must be assessed.

THROMBOCYTOPENIA[2-4]

PREVALENCE	DEFINITIONS	EVOLUTION	PROGNOSIS
43-67% patients in ICU	Absolute if < 150,000 / µL	Decrease up to day 4-5	Good, if >30x 10^9/L
20% develop it during hospitalization	Relative if there is a 30-50% drop	Recovery after days 7-10	Bad, if < 6x 10^9/L
			Increase in mortality if it persists > 4 days

Often, decisions are made in a thrombocytopenia situation that may not be the right ones and that are related to an alert:

- Postpone prophylactic heparin
- Postpone lumbar punctures
- Transfuse the patient without bleeding
- Not placing emergency central venous catheters
- Preventing anticoagulation in patients with deep vein thrombosis

In these contexts, knowing the causes for platelet decrease and the clinical context is as relevant as knowing the figure. Sepsis is the most common cause for thrombocytopenia[4,5].

↓ Production	Myelosuppression, nutritional deficiency, pregnancy, hematologic diseases, etc.
↑ Consumption or destruction	Sepsis, disseminated intravascular coagulation, autoimmunity, microvascular thrombosis, hemorrhages, drugs, etc.
Distribution / sequestration	Splenomegaly, hypersplenism, hypothermia, etc.
Dilution	Massive transfusion, fluid resuscitation, ECMO, etc.

It is also crucial to determine their functionality, even if it is within normal, based on the presence of the following clinical situations[3,4]:

- Absence of bleeding, petechias, or thrombosis
- Clinical stability
- Known compensatory mechanisms, such as young reactive platelets, adapted chronic thrombocytopenia or transitory states without actual hemostasis activation

In some situations, thrombosis may appear in patients with a low platelet count[4]:

Anomalous activation	Heparin-induced thrombocytopenia, disseminated intravascular coagulation, sepsis
Immunothrombosis	Sepsis, thrombotic microangiopathy, COVID
Intravascular consumption	Disseminated intravascular coagulation
Extracorporeal factors	CRRT, ECMO

THROMBOCYTOSIS

CAUSES	DEFINITION	EVOLUTION
Acute inflammation	> 450 x10^9/L	It is usually benign and transitory
Trauma		Thrombotic risk if there are added factors
Sepsis		Considering risk if 1000x10^9/L
Surgeries		Considering risk in an oncological or myeloproliferative context, or with previous thrombosis

In conclusion, it is necessary to take into account the following:

- Identifying and treating the cause of the platelet disorder
- Individualizing thresholds and treating patients, not figures
- Assessing the presence of bleeding, the platelet function, and the context before transfusing a patient

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3. THROMBOELASTOGRAPHY IN THE TRANSFUSION DECISION

Ainhoa Serrano Lázaro

Platelet transfusion is still an uncertain decision that must be frequently taken in the ICU setting. Besides the number of platelets, it is crucial to assess their function and the patient's overall coagulation state, since a platelet count within normal limits does not guarantee proper function.

In this context, thromboelastography (viscoelastic tests) is useful to make safe guided decisions on platelet transfusion, because it provides an estimation of how platelets function in an actual clot, and whether they provide real-time strength to every specific patient.

Thromboelastography provides a context for the count and allows an individualized goal-directed approach. The most commonly used viscoelastic tests are TEG® and ROTEM®.

Differences between TEG/ROTEM and specific platelet function tests:

TEG/ROTEM	SPECIFIC PLATELET FUNCTION TESTS
• They assess the whole blood and coagulation in an integrated manner and in real time. • They spot alterations between platelets, coagulation factors, and fibrinogen.	• They assess platelet function under controlled conditions and without integrating other components. • They assess adhesion, aggregation, and response to specific agonists. • Types: - Optical aggregometry, PFA-100 - VerifyNow and Multiplate, which are fast and can be helpful in the OR.
Useful to manage massive hemorrhage or surgery	**Useful to know the bleeding risk in antiaggregated patients**

There are intermediary modules supplementing TEG/ROTEM, which provide, in parallel to the viscoelastic information, the platelet function test for patients treated with antiaggregants:

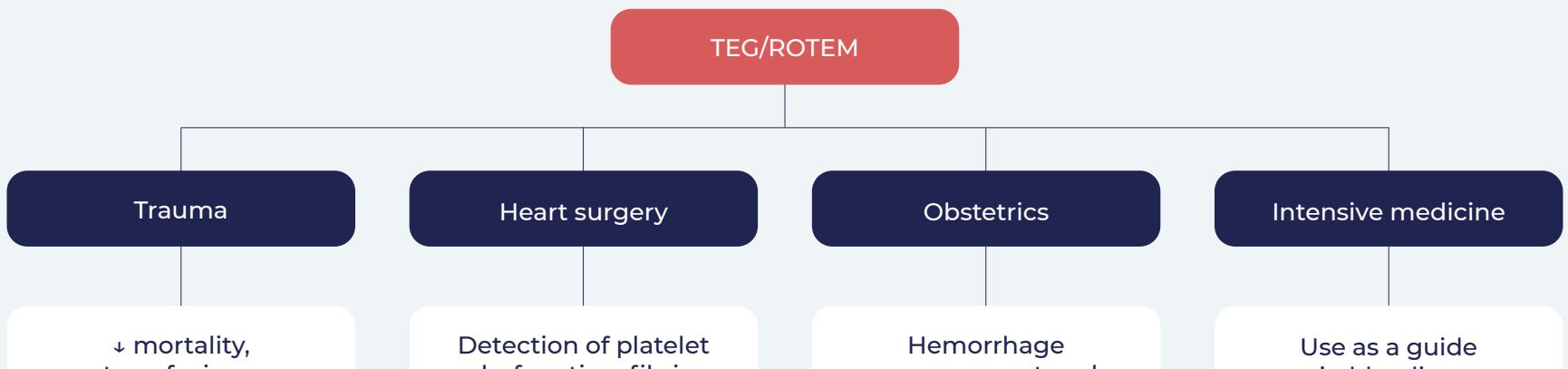
ROTEM platelet	TEG Platelet Mapping

Pros and cons of TEG/ROTEM versus traditional methods:

PROS	LIMITATIONS
Fast (results in 10 min) Functional dynamic information Holistic assessment of the whole hemostatic system Reduction of unnecessary transfusions Hemostatic treatment personalization	Context-based interpretation There is no standardization between sites Poor detection of adhesion/activation alterations and poor distinction between platelet dysfunction and dysfibrinogenemia False negatives if there are antiaggregant treatments Costs and availability

Thromboelastography should not replace clinical assessment, and a trained team is required to interpret and verify results. Clinical judgment and experience are required to make good clinical decisions.

Clinical practice guidelines recommend thromboelastography as a validated tool with sound evidence in areas such as trauma, heart surgery, obstetric hemorrhage[6], and cirrhosis[7]:



ESAIC, 2022	The use of ROTEM/TEG is recommended in surgery, trauma, and critical bleeding.
European Trauma Guidelines, 2023	ROTEM/TEG is a superior tool to INR or prothrombin time.
AHA, 2021	The use of ROTEM/TEG is recommended in cardiovascular surgery.

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4. THROMBOCYTOPENIA AND OUR FEARS: WHEN TO TRANSFUSE, HOW MUCH, AND WHAT CAN BE REVERTED?

María Gero Escapa

Thrombocytopenia is a common problem in critical patients, with diverse causes, and which may lead to serious consequences.

Platelet transfusion is the primary treatment, but it comes with certain drawbacks:

- Efficacy only in patients with low counts (< 10 x10^9/L) or platelet function disorders.
- Platelets are a valuable yet perishable resource.
- Their origin can change, but they are therapeutically equivalent products, with similar side effects:

WHOLE BLOOD DONATIONS | **APHERESIS**

- The process for their preservation and storage is complex: leukoreduction, continuous stirring, pollution detection or reduction systems, etc.
- Recommendations in current guidelines are based in the limited evidence, and their indications are not well defined.
- Transfusion thresholds[8,9] are just a figure, and they do not consider platelet functionality and patient circumstances.

There are four scenarios for platelet transfusion[9]:

Prophylactic transfusion		Therapeutic transfusion	
Hemorrhage prevention in patients with severe thrombopenia	Before an invasive procedure	Grade 2-4 hemorrhages (according to WHO)[10]	Massive hemorrhage /Hemorrhagic shock

According to the PLOT-ICU study[11]:

23% of ICU patients with thrombocytopenia receive platelets

64% of transfusions are prophylactic

It is essential to personalize the treatment for each patient, considering the platelet count, their function, and hemorrhagic and thrombotic risks.

PLATELET TRANSFUSION IS INDICATED IN MASSIVE HEMORRHAGE

Early transfusion is recommended as a part of massive transfusion protocols, particularly in patients with severe trauma, regardless of the platelet count [9].

The recommendations and suggestions in the HEMOMAS-II document are the following[12]:

Active hemorrhage	Massive bleeding and y traumatic brain injury/ocular trauma	Neurosurgical or ocular posterior pole intervention	Active bleeding not stopping with 50 x 10^9	Major invasive procedure	Multiple trauma, even with no bleeding
Transfusion to keep the 50 x 10^9/L threshold	Transfusion to keep the 100 x 10^9/L threshold	Transfusion to keep the 100 x 10^9/L threshold	Transfusion to keep the 100 x 10^9/L threshold	Transfusion to reach the 50 x 10^9/L threshold	Transfusion to reach the 50 x 10^9/L threshold

PLATELET TRANSFUSION IS INDICATED TO CHANNEL A CENTRAL VENOUS CATHETER (CVC).

- In a multi-site randomized controlled clinical trial, it was observed that discontinuing prophylactic transfusion before placing a CVC with a 10-50 x 10^9/L count leads to more hemorrhages related to CVC than prophylactic transfusion[13].

Hemorrhage relative risk 2-4: 2.45 (90% CI 1.27 -4.70)

PLATELET TRANSFUSION IS NOT INDICATED FOR REVERSION OF PLATELET ANTIAGGREGANTS[14–17]

No improvement has been observed in patient outcomes with[18]:

- Traumatic brain injury
- Spontaneous intracranial hemorrhages, which in some cases include deterioration of neurological recovery.

PLATELET TRANSFUSION IS NOT INDICATED FOR REVERSION IN PATIENTS WITH MASSIVE HEMORRHAGE.

In antiaggregated patients with massive hemorrhage, administering desmopressin is suggested, and in patients with intracranial hemorrhage, platelet transfusion should be avoided, unless they require neurosurgery[12].

- An early transfusion is suggested in patients with a hemorrhage clearly related to antiaggregants, preferably having monitored the platelet function[12].

PLATELET TRANSFUSION IS NOT INDICATED FOR REVERSION IN PATIENTS WITH BRAIN HEMORRHAGE.

The *European Stroke Association* calls into question the efficacy and safety of desmopressin in patients with intracranial hemorrhage related with the antiaggregant treatment, and it also rejects the use of platelets[14].

Dosing of platelet transfusion:

1 apheresis or 1 mix of 4-6 recovered units → 30-50 x 10^9/L increase in the count after 10-60 min → Consider refractoriness if:
- CCI* is <7.5 repeatedly or
- CCI* is <4.5 after 18-24 h

*Platelet Corrected Count Increment (CCI) = [(post-transfusion platelet count - pre-transfusion platelet count) x body surface area] / number of transfused platelets.

In general, platelet transfusion indications should be better defined to prevent unnecessary transfusions and to obtain improved clinical outcomes. However, further studies are required to determine the best strategies and to minimize the associated risks.

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Heart surgery: the intensivist after cardiovascular surgery

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1. MECHANICAL CIRCULATORY SUPPORT IN HEART-LUNG TRANSPLANT

Clara Hernández Caballero

HEART TRANSPLANT

In 2016, the SUHAS protocol was approved in the United Kingdom, which indicates the performance of high-emergency transplant in patients with extracorporeal membrane oxygenation (ECMO) or short-term mechanical circulatory support, with any configuration.

In actuality, access to transplants in the United Kingdom is very different to Spain:

	Population	Transplant sites	N annual heart transplants	N annual transplants in asystole
United Kingdom	~ 68 million	6	202	60
Spain	~ 48 million	19	347	101

The distribution of transplants based on the level of emergency is also different: in the United Kingdom, the rate of very urgent patients is higher, whereas the rate of elective surgeries is lower than in Spain. Most transplant patients in the United Kingdom are hospitalized and have circulatory support.

In Royal Brompton and Harefield hospitals, the average waiting time with mechanical circulatory support until transplant in the high-emergency list is 50 days, compared to 7-10 days in Spain.

Survival of transplant patients after 90 days is 100%, whereas after 1 year, it is 81-100%.

Progress in the field of mechanical circulatory support is fast, which means that the available evidence soon turns obsolete.

Several studies published between 2017 and 2020 concluded that support with venoarterial ECMO does not decrease mortality after the transplant[1,2].

- In patients with mechanical ventilation and renal replacement therapy, survival was significantly lower, but such conditions are a contraindication for transplant in the United Kingdom.

Nevertheless, the bridge with temporary left ventricular assist devices was associated with better outcomes than the bridge with venoarterial ECMO or with temporary biventricular assist devices in a national study[3].

In Harefield, the experience in patients with short-term mechanical circulatory support over the last few years was the following:

	2022-2023 15 patients		2023-2024 35 patients	
	Bridge to decision 7 patients	**Bridge to transplant** 8 patients	**Bridge to decision** 24 patients	**Bridge to transplant** 11 patients
Survival after 30 days	57%	100%	63%	100%
Survival after 90 days	57%	75%	63%	100%
Time in waiting list	23 days		40 days	
Survival with ECMO	*63% after 30 days* *59% after 90 days*			
Survival with other systems	*91% after 30 days* *87% after 90 days*			

Temporary mechanical circulatory support as a bridge to transplant is a feasible therapeutical strategy in the context of an efficient fast donor allocation system with organ availability, such as in Spain.

In clinical settings like in the United Kingdom, ECMO therapy is a good option as a bridge to a decision, once stability is attained and the organ failure improves. While waiting for a transplant, it is advised to use other more appropriate devices for long waiting lists.

LUNG TRANSPLANT

The number of yearly transplants and specialized sites is also remarkably lower in the United Kingdom than Spain.

The bridge to lung transplant with ECMO is safe, with no controversy whatsoever, and survival is comparable to that of patients without ECMO[4].

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2. POSTOPERATIVE SETTING IN HEART SURGERY, BEYOND ERAS PROTOCOLS

Emilia Rosas Carvajal

The first guidelines on enhanced recovery after surgery (ERAS) in heart surgery provide recommendations before, during, and after surgery[5]. In Spain, since 2021, there is a consensus document endorsed by different scientific societies, but with a low participation from intensivists[6]. Almost in parallel, a document was published to update perioperative management in cardiovascular surgery by the Spanish Society of Intensive & Critical Medicine, and Coronary Care Units[7].

The peculiarity of heart surgery when compared to other surgeries is extracorporeal circulation (ECC), which may trigger coagulation and inflammatory response cascades, besides producing oxidative stress[8].

Hypovolemia | **Low output** | **Vasodilation** | **Ventricular dysfunction**

Postoperative low cardiac output syndrome

Incidence: 7,5%

Post-cardiotomy shock

In this regard, the guideline *Management of post-cardiotomy shock from the perspective of the intensivist* is also published, suggesting a step-by-step action[9]:

1. ARRHYTHMIA ASSESSMENT AND CONTROL

TACHYARRHYTHMIAS

Auricular fibrillation (AF) is more common (20-40% patients).

- There are no differences in terms of the hospital stay, AF recurrence, or mortality with rhythm control and frequency[10].
- Rhythm should be prioritized in the following cases:
  - Left ventricular dysfunction
  - Right ventricular dysfunction
  - Pulmonary hypertension
  - Refractory hypotension or persistent low output

BRADYARRHYTHMIAS

Control by temporary epicardial pacemaker in high-risk patients, that is, virtually all of them (11). It should not be used in revascularization surgery.

2. MANAGEMENT OF MECHANICAL COMPLICATIONS

Although it involves a diagnostic challenge, the presence of tamponade should be suspected if we are in any of these cases[12]:

- Hypotension and persistent low output
- Sudden cessation of chest drainage
- Maintained sinus tachycardia

3. PRELOAD ASSESSMENT

According to a meta-analysis published in 2016, advanced hemodynamic monitoring to guide fluid therapy is effective to reduce complications and hospital stays[13].

4. ASSESSMENT OF SHOCK HEMODYNAMIC PROFILE AND VASOACTIVE SUPPORT MANAGEMENT

It is hard to recommend a single vasoactive drug, and there is a significant international heterogeneity. The most widespread uses in Spain are the following:

SHOCK VASOPLEGIC	LOW OUTPUT WITH PRESERVED MAP	RIGHT VENTRICULAR DYSFUNCTION	LEFT VENTRICULAR DYSFUNCTION
Noradrenaline + vasopressin	**Inotropics** Dobutamine or Levosimendan	**Inotropics** Milrinone > Dobutamine +/- noradrenaline	**Inotropics** Dobutamine + noradrenaline or adrenaline

5. MECHANICAL CIRCULATORY SUPPORT

An accurate selection of candidate patients to mechanical circulatory support is required.

Step-by-step management of patients in post-cardiotomy shock provides a systematic treatment option that can be extrapolated to all complex patients. Immediate postoperative management of patients undergoing heart surgery requires a multidisciplinary approach, including anesthesiologists, surgeons, and intensivists.

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3. POSTOPERATIVE MONITORING OF HIGH-RISK PATIENTS—ULTRASOUND, SWAN GANZ, PICCO?

Ana Ochagavía Calvo

Heart surgery entails a number of associated conditions (local surgical damage, ischemia, reperfusion, ECC, cardioplegia, and hypothermia) that impact a patient who is already complex to start with, because it presents ventricular dysfunction or even heart valve diseases.

Complications associated to heart surgery and variables to assess and monitor:

	Vasoplegia	Low cardiac output syndrome	Other complications
CHARACTERISTICS	• It has a 9 - 44% incidence, and it is associated with a 30 - 50% mortality • Definition CI > 2.2 L/min/m^2 • Independently associated with: age, female gender, preoperative creatinine, ECC time, and other variables[14]	• Insufficient cardiac output to meet tissue O_2 demand • Its maximum expression is post-cardiotomy shock: Definition CI > 2 L/min/m^2 and POAP > 16 - 18 mm Hg	• Acute myocardial infarction • Cardiac tamponade • Hemorrhages • Arrhythmias
MONITORING	• Volemia • Vascular resistances	• Systolic / diastolic biventricular function • Pulmonary edema: PAOP / ELWI • Pulmonary hypertension • Heart valve diseases	• Arterial O_2 saturation • Electrocardiogram • Heart rate • Arterial pressure

ELWI, Extravascular Lung Water Index; CI, Cardiac Index; PAOP, Pulmonary Arterial Occlusion Pressure

In hemodynamic resuscitation from cardiogenic shock, besides monitoring the shock, special attention must be paid to the presence of arrhythmias, ventricular and valvular function, and cardiogenic pulmonary edema.

BASIC MONITORING[15]:

- Blood pressure, perfusion (lactate and venous saturation)
- Central Venous Pressure (CVP) / Pulse pressure variation (PPV)
- Advanced ultrasound (transthoracic or transesophageal), although the 2014 consensus document recommended basic ultrasound[15], because it is about complex patients who already got a transesophageal ultrasound in the OR.
- Hydric balance, gasometry[16].

ASSESSMENT OF VOLUME RESPONSIVENESS[17]:

- Systolic volume variation (SVV) has a good predictive value after surgery ➡ It requires a cardiac output device.
- PPV may be useful when the cardiac output device is not available ➡ The right ventricular dysfunction can be caused by a false positive.

ECHOCARDIOGRAPHY[18–21]

- Fundamental for the assessment of prosthetic dysfunction and ECMO.
- It is the only way to assess dynamic obstruction in the outflow tract.
- Variability between and within observers is one of the limitations of ultrasounds. Thus, proper training is needed, as well as assuming an advanced skill level.
- Advanced monitoring after heart surgery is a priority in the following cases:

Poor response to treatment	Worsening in the pathophysiology of the process	Shock-ARDS	Right ventricular failure-PH	Heart valve diseases-Ventricular dysfunction

Monitoring systems:

- **PICCO**
  - There are two different techniques: transpulmonary thermodilution and pulse wave contour analysis.
  - No difference between right and left ventricular dysfunction, and must be supplemented with echocardiography.
  - It is not valid with ECMO or counterpulsation balloon..
- **Pulmonary arterial catheter**
  - This should be the device of choice, given the comprehensive information it provides: pulmonary arterial pressure (PAP), PAOP, metabolic data, but it is more invasive.

The goal of hemodynamic resuscitation is to revert the signs of tissue hypoperfusion[16].

Tool parameters and target parameters:

TOOL PARAMETERS	TARGET PARAMETERS
• Heart rate • Cardiac output • PPV, SVV, Global telediastolic volume (GTDV), PLR (Passive Leg Raising)	• Arterial pressure • Lactate • Central & mixed venous saturation • Cardiac output, systolic volume • CVP, PAOP • Diuresis

Last, hemodynamic monitoring is still necessary in the ultrasounds era for the following reasons:

- The need for training in advanced ultrasound.
- Experts in echocardiography are not available 24/7.
- Transesophageal ultrasound is not always available.
- Ultrasounds take time.
- All the team should be aware of the information provided by continuous monitoring, not just the person performing the ultrasounds.

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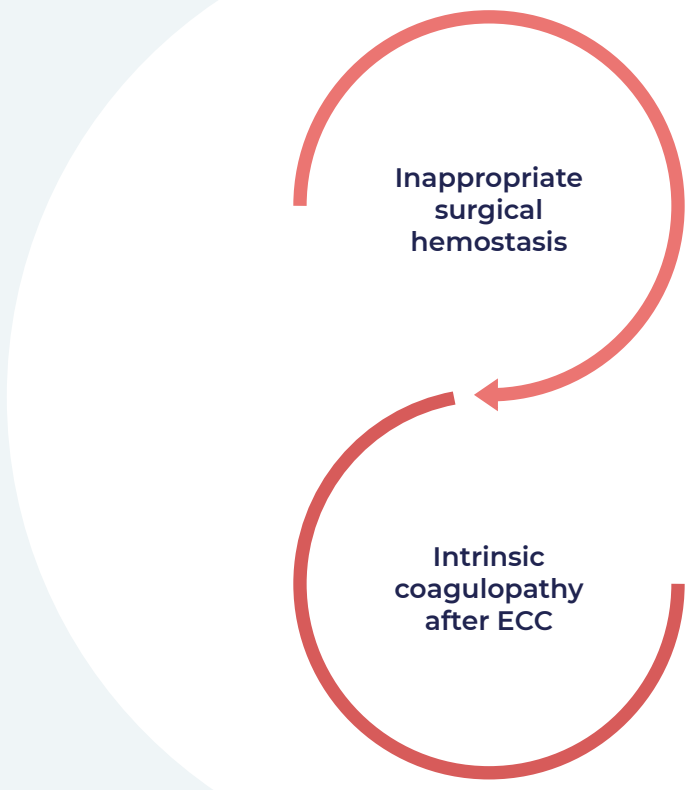
4. BLEEDING CONTROL STRATEGIES, IT'S NOT JUST ABOUT REOPERATING

Cristina León Moya

Bleeding after heart surgery is a severe multifactorial complication, with a 2-15% incidence[22].

66% of bleeding cases after heart surgery have a surgical cause, while the rest are due to coagulopathies.



Bleeding after a heart surgery can have certain consequences. If the volume is significant, it may involve a risk similar to that of thrombotic events[23].

↑ Reoperations	↑ Blood transfusions	↑ Hospital stay	↑ Costs	↑ Morbidity & mortality

VISCOELASTIC TESTS ARE IMPORTANT TO APPLY A DIRECTED TREATMENT IN THE MANAGEMENT OF COAGULOPATHY AFTER ECC.

The implementation of bleeding management algorithms guided by viscoelastic tests (TEG/ROTEM) is associated to a significant reduction in the requirements for perioperative transfusion of all blood products. Thus, the use of viscoelastometry-based algorithms is recommended in the care of bleeding patients[24,25].

On the contrary, the value of platelet function tests, together with viscoelastic tests, is not well defined, although it could be used before surgery in patients at high risk of bleeding[24,25].

HEMOSTATIC TREATMENT SHOULD BE APPLIED IF THERE IS BLEEDING, BUT NEVER AS A PROPHYLACTIC[23,25].

Antifibrinolytics

- They are used to minimize the bleeding, the need for transfusion, and the incidence of interventions for bleeding[25].
- They are the only treatment backed by an I-A evidence level.
- Tranexamic acid has been proven to reduce the risk of reoperation for any cause and for major hemorrhage[26].
- As a side effect, tranexamic acid increases the risk of convulsions[26].

Fresh plasma

- Its prophylactic use to reduce the hemorrhage risk is not recommended. It could be used to revert the effects of anticoagulants or in cases of persistent perioperative bleeding[25].

Prothrombin complex

- In Europe, only the 4-factor concentrate is available.
- In order to administer it, it is crucial for fibrinogen levels to be appropriate, because otherwise, the clot formation time can be longer ➡ first correct fibrinogen levels[26].
- The 25 UI/kg dose significantly improves the hemostatic response with respect to fresh plasma[27].

Fibrinogen

- Its prophylactic use is not recommended to reduce postoperative hemorrhage risk, or transfusion risk, but it can be considered in patients with low fibrinogen levels and signs of persistent microvascular hemorrhage[25].

Desmopressin

- It can mainly be used in patients with hemorrhage after heart surgery and an altered platelet function, but its prophylactic use should be avoided[25].

Factor XIII and factor VII

- The use of FXIII is not recommended in patients with normal FXIII concentrations, due to the lack of evidence[25].
- The use of FVII, in very low doses, is reserved to patients with refractory bleeding[25].

THORACIC DRAINAGE IS ESSENTIAL IN THE MANAGEMENT OF PATIENTS UNDERGOING HEART SURGERY

Thoracic drainage is essential to prevent complications such as hemothorax, pneumothorax, infections, and cardiac tamponade, and it must be removed at the right time[25,28].

A UNIVERSAL DEFINITION IS NEEDED FOR EXCESSIVE BLEEDING AFTER HEART SURGERY, AS WELL AS FOR COAGULOPATHY[23].

There are several definitions of significant bleeding in heart surgery

- > 1000 ml in the first 12 hours[29]
- 2000 ml in thoracic tube in the first 24 h[30]
- 1.5 ml/kg/h for 6 consecutive hours in the first 24 h[31]
- > 900 ml in the first 12 h[32]

Coagulopathy should also be defined in patients with ECC, because some patients bleed despite having normal TEG and lab tests, and some patients present a coagulopathy according to the tests but do not bleed[23].

THE REVISION SURGERY SHOULD BE PERFORMED AS SOON AS POSSIBLE[25].

- The bleeding has to be reexamined in case of hemodynamic instability or evidence of cardiac tamponade..
- It is recommended to correct hypothermia, acid-base unbalance, coagulopathy, or ionized calcium

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The coagulopathy battle in polytraumatized patients

Moderators: Juan Antonio Llompart and María Gero Escapa

Tuesday, June 17, 2025

1. ACUTE COAGULOPATHY IN TRAUMA: ON THE RADAR

Jesús Barea Mendoza

Coagulopathy is an **extremely complex situation, closely related to morbidity and mortality**; this is why it should always be on the radar.

MORTALITY

The incidence of coagulopathy in polytraumatized patients has not changed over the last few years, remaining around 20%[1,2].

Over 3,000 trauma patients from different areas have been randomized in clinical trials to receive different interventions, but none of them have been seen to have an impact on the incidence of coagulopathy[3-8].

Coagulopathy not only has an impact on the most severe patients:

When compared to mortality in patients without coagulopathy, its impact on mortality is significant in all patients, but it is higher in less severe patients—with a lower ISS, *Injury Severity Score*[2].

COMPLEXITY

Coagulopathy is a complex condition for different reasons:

It is a systemic disease (blood dysfunction)	**Multiple interventions to manage it affect multiple physiological systems**	**The effect of time is hard to measure**

Although all intensivists are aware of the complexity of coagulopathy, unidimensional approaches are still common.

Going forward, the approach should follow precision medicine: breaking down the heterogeneity of patients and setting the therapeutic goals based on individual features[9]:

- Key lab values[10]
- Patient phenotypes[11]

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Tuesday, June 17, 2025

2. HEMORRHAGE MECHANICAL CONTROL TECHNIQUES: UPDATE

Marc Morales Codina

The ultimate treatment for hemorrhage is surgical or interventionist in nature, but several local control measures can be implemented in the outpatient setting to buy time before a hospital intervention. When the patient is admitted to the emergency room, some of these tools for hemorrhage mechanical control may already have been applied. The evidence backing the use of these devices stems mostly from military medicine.

In regard to coagulopathy, they are relevant to minimize the patients' bleeding, and thus the loss of blood products, so that their live can be preserved.

DEVICES	INDICATION	CHARACTERISTICS
Pelvic strap and belt	Pelvis fracture	It allows to homogeneously apply pressure and to regulate the force applied and compression.
Tourniquet and the like	Venous and arterial bleeding	It is proximally applied to the bleeding wound. Sometimes supplemented with endotracheal tube cuff.
Emergency bandage	Venous bleeding	Elastic bandage with a device that allows a higher pressure than direct compression.
Gauzes with or without topical hemostatic agents	Penetrating wounds	Hemostatics are fungi derivatives used in surgical settings that produce an inflammation and trigger the coagulation cascade. Drawbacks: They can cause microthrombi.
Resuscitative Endovascular Balloon Occlusion of the Aorta (REBOA)	Bleeding in the pelvis, abdomen, or lower limbs with permeable access.	It causes an intermittent occlusion of the aorta. Drawbacks: It can cause ischemia in the area.

Local control measures of the hemorrhage are part of multidisciplinary management, together with other interventions, including drugs, blood products, and fluids for resuscitation.

The technique for the application of these measures should be practiced before facing vital emergency situations.

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3. HEMORRHAGE PHARMACOLOGICAL CONTROL TECHNIQUES: UPDATE

Carolina Mudarra Reche

Resuscitation therapies have evolved over time:

There are new recommendations for the management of whole blood, suggesting that its benefit lies in saving blood products, rather than differences in morbidity and mortality[12].

This trend change puts healthcare organizations in a somewhat difficult logistical position, but it can entail certain benefits:

- Although it may seem otherwise, there are publications revealing that whole blood is associated with lower costs, due to savings in blood products
- Better ability to transport O_2 with less volume
- Improvement of coagulopathy
- It can be administered using a rapid infuser
- The transfused volume is lower

The use of complexes in resuscitation may allow to buy some time in regard to coagulopathy. However, the evidence available may be biased by INR figures and the thresholds used in studies, as well as by the use of factors with plasma.

4-FACTOR PROTHROMBIN COMPLEX CONCENTRATE (CCP-4)

In the trial carried out by Bouzat et al., no decrease was observed in the total use of blood products within 24 hours in the arm treated with CCP-4, compared to placebo, whereas there was an increase in thrombotic risk in the group treated with CCP-4[5]. It must be reminded that this clinical trial comes with limitations, including that coagulopathy was not assessed by a viscoelastic test.

TRANEXAMIC ACID

The PATCH study assessed the use of tranexamic acid in the pre-hospital setting. No statistically significant differences were observed in this study in terms of survival, with favorable functional results after 6 months with the usual doses of tranexamic acid versus placebo[13].

Currently, they are not well known, and it is crucial to define the following aspects:

Trauma phenotypes

Dosing

Time intervals for its use

FIBRINOGEN

Fibrinogen is usually the first factor reaching critically low levels in cases of massive hemorrhage. Its deficiency is associated with a higher risk of massive transfusion and mortality. Although it has been suggested that early replacement therapy may improve clinical outcomes, the evidence available does not show a clear benefit in the studies conducted to date[14].

Again, there is a great variability in the studies carried out, and the optimal time and dose of administration are yet unknown[15]. Some of these studies compare it to cryoprecipitate, and others to placebo.

CRYOPRECIPITATE

In the case of cryoprecipitate, a lower mortality has been reported due to thrombotic events when used early and at a high dose (equivalent to 6 g of fibrinogen), rather than with standard treatment[16].

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4. THE SITUATION INSIDE HOSPITALS IN SPAIN

María Ángeles Ballesteros Sanz

The Neurointensivism and Trauma Working Group at the SEMICyUC, launched in March 2019 a survey to assess available resources, logistics, and the management of hemorrhagic shock in severe trauma conditions in Intensive Medicine Units in Spain.

Participation in the survey was low (35 units out of the 128 invited):

First level (< 300 beds)	**Second level** (300 - 800 beds)	**Third level** (300 -1500 beds)
14%	**34%**	**51%**

- Only 31% reported having blood products available within 15 minutes. 42% reported having them available in 15-30 minutes, and 27%, immediately.
- The existence and use of transfusion protocols in massive transfusion is not as widespread as may be expected—27% of the responders declared having a massive transfusion protocol.
- Most responders said that, at their sites, initial resuscitation is led by intensivists, but there were differences according to the healthcare level of each site.

Intensive medicine	Emergency	General surgery	Anesthesia
53%	**26%**	**6%**	**6%**

- Most responders (94%) reported performing initial resuscitation in the emergency room.
- Some variability was observed in the availability of tranexamic acid, coagulation factor concentrate, desmopressin, cryoprecipitates, and FVII.
- The administration of blood products was carried out following lab data in most sites:

Lab data	Blood product fixed ratio	Viscoelastic tests	Lab data and viscoelastic tests
60%	**17%**	**14%**	**6%**

- Some variability was observed in terms of patient assessment, monitoring, and follow-up:
  - 87% used conventional coagulation tests, and 26% used viscoelastic tests.
  - Coagulation control frequency was also variable

At medical discretion	15-30 min	30 min	60 min	4 hours
14%	**14%**	**26%**	**31%**	**14%**

In the survey, differences were observed in all these variables when comparing third-level sites with first- and second-level sites.

In conclusion, there is heterogeneity in terms of available infrastructures, logistics, and hemorrhagic shock management in severe trauma conditions in ICUs in Spain. It would be interesting to launch the survey again to determine whether the current snapshot has changed, and to develop indicators to achieve a lower variability.

The coagulopathy battle in polytraumatized patients

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Tuesday, June 17, 2025

5. THE SITUATION OUTSIDE HOSPITALS IN SPAIN

Alberto Hernández Tejedor

IS IT FEASIBLE TO CARRY OUT OUTSIDE OF THE HOSPITAL CERTAIN PRACTICES ABSOLUTELY LINKED TO THE HOSPITAL SETTING, BOTH THERAPEUTICAL AND DIAGNOSTIC OR FOR MONITORING PURPOSES?

There are many practices, endorsed by current guidelines[17], that are currently applied outside of the hospital, although they were limited to the hospital setting years ago.

In the case of blood products, these recommendations are not clear. However, it makes more sense to perform each intervention at the right time rather than in the ideal space, provided the decisions are backed by the best evidence available.

Probably no interventions belong to the hospital or off-hospital setting—they should just all be applied at the right time.

This premise could be applied to the following interventions:

INTERVENTION	RECOMMENDATION OR REASONING
Tranexamic acid	The guidelines state it should be administered as soon as possible, preferably on the way to the hospital and within 3 hours of the injury, without having to wait for the results of viscoelastic tests[17-19].
Fibrinogen	In the initial management of patients with expected massive hemorrhage[17,20,21].
Shock index	Moderate efficacy in the identification of trauma patients with hypofibrinogenemia[22].
Prothrombin complex	Patients with INR < 1.5 or edoxaban, or lacking other more specific antidotes?
Vitamin K	Patients anticoagulated with antivitamin K?
Idarucizumab	Patients anticoagulated with dabigatran?
Andexanet alfa	Patients anticoagulated with apixaban or rivaroxaban?

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Tuesday, June 17, 2025

6. THE FUTURE IS IN OUR HANDS

Manuel Quintana Díaz

What is our **present**?

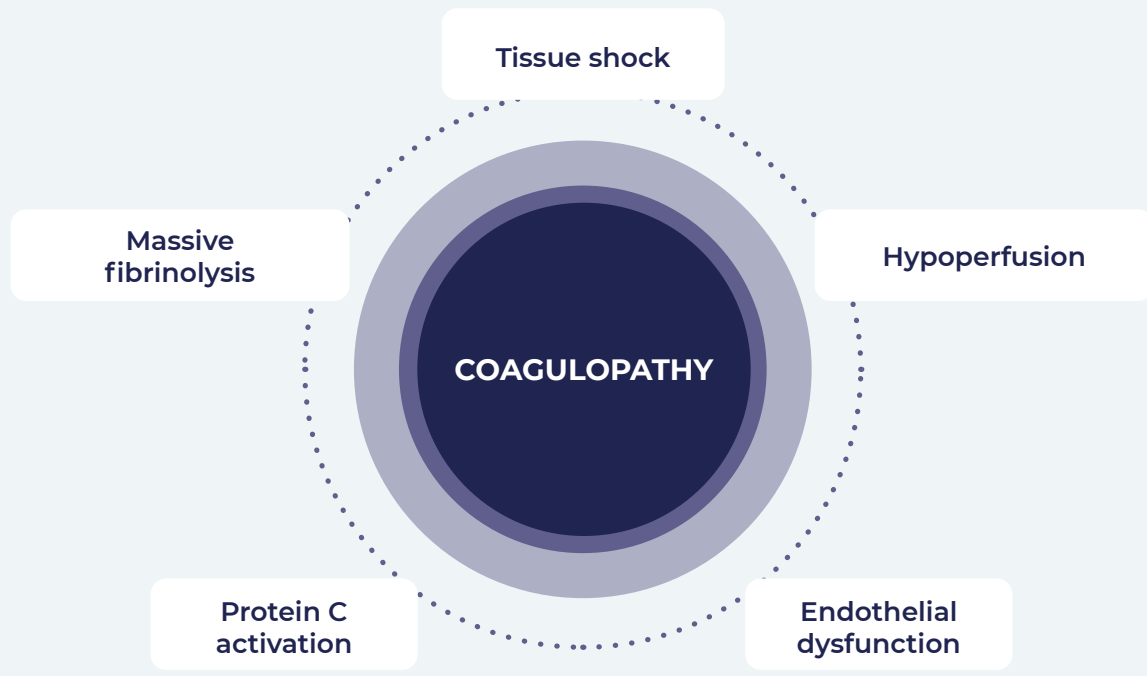
- The amount of bleeding does not determine the coagulopathy
- Coagulopathy is multifactorial
- Systematic empirical treatment is not justified
- Placing the focus on monitoring allows for an early identification and a more individualized treatment.
- Viscoelastic test-guided treatment decreases the need for blood products, and possibly the bleeding.
- Further randomized studies are necessary to learn the outcomes on morbidity and mortality.

Currently, there are massive transfusion protocols, and treatments are applied according to clinical practice guidelines.

What is our **future** and what **changes lie ahead**?

DEFINITION OF COAGULOPATHY

Since the coagulopathy is not just the result of bleeding, dilution or consumption, but it arises as a consequence of endothelial damage, inflammation and hypoperfusion, it must be taken into account that it is an autonomous biological entity.



DETECTION OF COAGULOPATHY

The problem with coagulopathies is endotheliopathy. There are some coagulopathy severity markers already available: syndecan and heparan sulfate. There are other markers under development:

MicroARNs | **Calprotectin** | **Extracellular vesicles**

COAGULOPATHY MANAGEMENT

Diagnosis will be faster and anticipative: hemostatic kinetics will be integrated with physiological details.

Portable coagulation sensors | **AI integrated in the pre=hospital setting** | **Individualized coagulation models**

Risk classification and guide for immediate transfusion

Drugs will target the endothelium, not the clot, and adaptive resuscitation:

Antioxidants, hydrogen, HES130 | **Specific fibrinolysis inhibitors** | **Molecular therapies + factor concentrates and extracellular vesicles** | **Personalized blood products (precision reconstituted plasma)**

In conclusion, the future will be personal, predictive, and prehabilitave:

- **The diagnosis will be anticipative and not reactive.**
- **The treatment will be modular and not replacement-based.**

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