16.50 Valutazione del profilo coagulativo perioperatorio
A. De Gasperi
monitoring haemostasis in surgical patients

- **preoperative testing**
  - to identify pts at increased risk for perioperative bleeding

- **intraoperative monitoring**
  - to identify pathological hemostatic changes in surgical procedures at risk
  - cardiac and vascular surgery
  - liver surgery
    - major resection
    - transplantation
  - orthopedic surgery (?)
  - trauma / trauma surgery
  - obstetric emergencies

- **postop monitoring**
  - bleeding tendency
  - tendency towards hypercoagulation
* Routine refers to a policy of performing a test or tests without regard to clinical indications in an individual patient.
† Screening means efforts to detect disease in unselected populations of asymptomatic patients.


STATEMENT ON ROUTINE PREOPERATIVE LABORATORY AND DIAGNOSTIC SCREENING

Committee of Origin: Standards and Practice Parameters

(Approved by the ASA House of Delegates on October 15, 2003, and last amended on October 22, 2008)

Preoperative tests, as a component of the preanesthesia evaluation, may be indicated for various purposes, including but not limited to: 1) discovery or identification of a disease or disorder which may affect perioperative anesthetic care, 2) verification or assessment of an already known disease, disorder, medical or alternative therapy which may affect perioperative anesthetic care, and 3) formulation of specific plans and alternatives for perioperative anesthetic care. No routine* laboratory or diagnostic screening† test is necessary for the preanesthetic evaluation of patients. Appropriate indications for ordering tests include the identification of specific clinical indicators or risk factors (e.g., age, pre-existing disease, magnitude of the surgical procedure). This statement will be integrated into an update of the ASA Practice Advisory for Preanesthesia Evaluation¹ at a future date. It will not appear independently after that time.

Anesthesiologists, anesthesiology departments or health care facilities should develop appropriate guidelines for preanesthetic screening tests in selected populations after considering the probable contribution of each test to patient outcome. Individual anesthesiologists should order test(s) when, in their judgment, the results may influence decisions regarding risks and management of the anesthesia and surgery. Legal requirements for laboratory testing where they exist should be observed. The results of tests relevant to anesthetic management should be reviewed prior to initiation of the anesthetic. Relevant abnormalities should be noted and action taken, if appropriate.
Although some defend it as a means of avoiding litigation, it has been demonstrated that 30–95% of unexpected laboratory results from screening tests are either not documented or not pursued further (Muskett & McGreevy, 1986; Johnson & Mortimer, 2002). Therefore, random screening could potentially increase rather than reduce the risk of litigation.
Summary of key recommendations

1. Indiscriminate coagulation screening prior to surgery or other invasive procedures to predict postoperative bleeding in unselected patients is not recommended. (Grade B, Level III).

2. A bleeding history including detail of family history, previous excessive post-traumatic or postsurgical bleeding and use of anti-thrombotic drugs should be taken in all patients preoperatively and prior to invasive procedures. (Grade C, Level IV).

3. If the bleeding history is negative, no further coagulation testing is indicated. (Grade C, Level IV).

4. If the bleeding history is positive or there is a clear clinical indication (e.g. liver disease), a comprehensive assessment, guided by the clinical features is required. (Grade C, Level IV).
Guidelines on the assessment of bleeding risk prior to surgery or invasive procedures

British Committee for Standards in Haematology

Y. L. Chee, ¹ J. C. Crawford, ² H. G. Watson¹ and M. Greaves³

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British Journal of Haematology, 140, 496–504
Guidelines on the assessment of bleeding risk prior to surgery or invasive procedures

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By targeting a subgroup of patients with a positive bleeding history for further assessment and coagulation testing, it is plausible that the PV of the combination of an abnormal bleeding history and abnormal coagulation test may be higher for postintervention bleeding than either alone. Importantly, this strategy would enable testing to be focused on the minority of subjects in whom there is reasonable suspicion of the presence of a bleeding disorder.

The published data considered in this guideline indicate that an unstructured bleeding history is not a good predictor of postoperative bleeding (Grade B, level III) there are indications that a structured approach may be predictive. Therefore there is insufficient evidence to conclude that the bleeding history has no PV for postoperative bleeding. A bleeding history, including family history, evidence of excessive post-traumatic or postsurgical bleeding and use of antithrombotic drugs should be taken in all patients prior to surgery or invasive procedures. (Grade C, Level IV).
Coagulation disorders

Introduction

This section addresses the problem of patients with a potential coagulation disorder. This does not include the question of how to screen for coagulation disorders.
Preoperative evaluation of the adult patient undergoing non-cardiac surgery: guidelines from the European Society of Anaesthesiology

Stefan De Hert, Georgina Imberger, John Carlisle, Pierre Diemunsch, Gerhard Fritsch, Iain Moppett, Maurizio Solca, Sven Staender, Frank Wappler and Andrew Smith, the Task Force on Preoperative Evaluation of the Adult Noncardiac Surgery Patient of the European Society of Anaesthesiology

Recommendations

- 2+ Well conducted case-control or cohort studies with a low risk of confounding or bias and a moderate probability that the relationship is causal
- 2− Case-control or cohort studies with a high risk of confounding or bias and a significant risk that the relationship is not causal
- 3 Non-analytical studies (case reports, case series, etc.)
- 4 Expert opinion

(3) Routine use of coagulation tests is not recommended unless there are specific risk factors in the history (grade of recommendation: D).

Evidence level 3 or 4 or extrapolated evidence from studies rated as 2+
### Preoperative tests

The use of routine preoperative tests for elective surgery

#### Grade 2 surgery (intermediate)

**Grade 2 surgery continued**

**ASA Grade 2: adults with comorbidity from cardiovascular disease**

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#### Grade 2 surgery continued

**ASA Grade 2: adults with comorbidity from respiratory disease**

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**ASA Grades**

Grade 1: Normal healthy patient i.e. without any clinically important comorbidity and without a clinically significant past/present medical history.

Grade 2: Patient with mild systemic disease.

Grade 3: A patient with severe systemic disease but the disease is not a constant threat to life.

See pages 3-4 for more information.

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### Preoperative tests
The use of routine preoperative tests for elective surgery

#### Grade 3 surgery (major)

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#### Grade 3 surgery (major)

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## Preoperative Tests

The use of routine preoperative tests for elective surgery

### Grade 4 Surgery (Major+)

#### ASA Grade 2: Adults with comorbidity from cardiovascular disease

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### Grade 3: Adults with comorbidity from cardiovascular disease

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### Grade 3: Adults with comorbidity from respiratory disease

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See pages 3–4 for more information.
## Preoperative tests

The use of routine preoperative tests for elective surgery

### Grade 4 surgery (major+)

**ASA Grade 2: adults with comorbidity from renal disease**

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**ASA Grade 3: adults with comorbidity from renal disease**

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<td>Yes</td>
</tr>
<tr>
<td>Blood gases</td>
<td></td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Urine analysis</td>
<td></td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

**ASA Grades**

- Grade 1: Normal healthy patient (i.e., without any clinically important comorbidity and without a clinically significant past/current medical history).
- Grade 2: Patient with mild systemic disease.
- Grade 3: Patient with severe systemic disease but the disease is not a constant threat to life. See pages 3-4 for more information.

### Neurosurgery

**ASA Grade 1: children < 16 years**

<table>
<thead>
<tr>
<th>Test</th>
<th>Age (years)</th>
<th>&lt; 6 months</th>
<th>6 months to 12 months</th>
<th>&gt; 12 years</th>
<th>&lt; 6 months</th>
<th>6 months to 12 months</th>
<th>&gt; 12 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chest X-ray</td>
<td></td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>ECG</td>
<td></td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Full blood count</td>
<td></td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Haematology</td>
<td></td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Renal function</td>
<td></td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Blood gases</td>
<td></td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Urine analysis</td>
<td></td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

**ASA Grade 1: adults ≥ 16 years**

<table>
<thead>
<tr>
<th>Test</th>
<th>Age (years)</th>
<th>&lt; 16</th>
<th>≥ 16</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chest X-ray</td>
<td></td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>ECG</td>
<td></td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Full blood count</td>
<td></td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Haematology</td>
<td></td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Renal function</td>
<td></td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Blood gases</td>
<td></td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Urine analysis</td>
<td></td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

*Electroencephalography is recommended in asymptomatic individuals.*
Coagulation Studies

There is no evidence to support routine checking of coagulation studies unless clinical circumstances suggest a potential bleeding problem. This is because of the low sensitivity and lack of predictive value of these tests (Asaf, 2001 [C]).

- Coagulation studies
  - Patient has a known history of coagulation abnormalities or recent history suggesting coagulation problems or is on anticoagulants.
  - Patient needs anticoagulation post-operatively (where a baseline may be needed).

- Hemoglobin
  - Patient has a history of anemia or history suggesting recent blood loss or anemia.
### ASSETTO EMOCOAGULATIVO:

<table>
<thead>
<tr>
<th>ASA 1</th>
<th>Pazienti</th>
<th>Raccomandazione</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>grado di chirurgia 1, 2, 3</td>
<td>non raccomandato</td>
</tr>
<tr>
<td></td>
<td>grado di chirurgia 4</td>
<td>non raccomandato &lt; 16 anni da considerare &gt; 16 anni</td>
</tr>
<tr>
<td></td>
<td>neurochirurgia</td>
<td>da considerare sempre</td>
</tr>
<tr>
<td></td>
<td>cardiochirurgia</td>
<td>da considerare sempre</td>
</tr>
<tr>
<td></td>
<td>in caso di: chirurgia vascolare (per fornire un valore di base in cardiochirurgia o per pazienti chirurgici oncologici) o in pazienti che fanno uso di warfarin o altri anticoagulanti o in emodialisi</td>
<td>raccomandato A</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ASA 2</th>
<th>Malattia Cardiovascolare</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>grado di chirurgia 1, 2, 3</td>
<td>non raccomandato</td>
</tr>
<tr>
<td></td>
<td>grado di chirurgia 4</td>
<td>da considerare sempre</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ASA 3</th>
<th>Malattia Cardiovascolare</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>grado di chirurgia 1, 2</td>
<td>non raccomandato</td>
</tr>
<tr>
<td></td>
<td>grado di chirurgia 3, 4</td>
<td>da considerare sempre</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ASA 2</th>
<th>Patologia Polmonare</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>grado di chirurgia 1, 2, 3</td>
<td>non raccomandato</td>
</tr>
<tr>
<td></td>
<td>grado di chirurgia 4</td>
<td>da considerare sempre</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ASA 3</th>
<th>Patologia Polmonare</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>grado di chirurgia 1, 2, 3</td>
<td>non raccomandato</td>
</tr>
<tr>
<td></td>
<td>grado di chirurgia 4</td>
<td>da considerare sempre</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ASA 2</th>
<th>Patologia Renale</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>grado di chirurgia 1, 2</td>
<td>non raccomandato</td>
</tr>
<tr>
<td></td>
<td>grado di chirurgia 3, 4</td>
<td>da considerare sempre</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ASA 3</th>
<th>Patologia Renale</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>grado di chirurgia 1, 2, 3</td>
<td>da considerare sempre</td>
</tr>
</tbody>
</table>

- **Assetto emocoagulativo**
  - Anomalie rilevate: 0,4%-45,9% dei pazienti.
  - Modificazione del management clinico: 0%-7,3% dei pazienti.
  - Comparsa di complicanze post-operatorie: 0%-8,1% dei pazienti.
Preoperative evaluation of the adult patient undergoing non-cardiac surgery: guidelines from the European Society of Anaesthesiology

Stefan De Hert, Georgina Imberger, John Carlisle, Pierre Diemunsch, Gerhard Fritsch, Iain Moppett, Maurizio Solca, Sven Staender, Frank Wappler and Andrew Smith, the Task Force on Preoperative Evaluation of the Adult Noncardiac Surgery Patient of the European Society of Anaesthesiology

Recommendations

(1) If coagulation disorders are suspected, the patient should be referred to a haematologist (grade of recommendation: D).

(2) Preoperative correction of haemostasis decreases perioperative bleeding (grade of recommendation: D).

(3) Routine use of coagulation tests is not recommended unless there are specific risk factors in the history (grade of recommendation: D).

Evidence level 3 or 4 or extrapolated evidence from studies rated as 2+
Routine preoperative coagulation tests: an outdated practice?

J. J. van Veen¹, D. R. Spahn² and M. Makris¹*

that a structured bleeding history is taken and coagulation testing is undertaken only if there is concern about a bleeding tendency arising from the history. This may then also include referral to haematology to investigate disorders that are not detected by routine testing.

Therefore, approach to

In conclusion, we feel that indiscriminate use of routine coagulation testing in the preoperative setting is not helpful and may cause unnecessary further testing and delay of surgery. Coagulation testing should be restricted to well-defined circumstances:

Testing, however, should be considered in patients with acute conditions potentially associated with a haemorrhagic tendency such as liver disease, sepsis, diffuse intravascular coagulation, pre-eclampsia, cholestasis, and poor nutritional states leading to vitamin K deficiency.
Preoperative evaluation of the adult patient undergoing non-cardiac surgery: guidelines from the European Society of Anaesthesiology
Stefan De Hert, Georgina Imberger, John Carlisle, Pierre Diemunsch, Gerhard Fritsch, Iain Moppett, Maurizio Solca, Sven Staender, Frank Wappler and Andrew Smith, the Task Force on Preoperative Evaluation of the Adult Noncardiac Surgery Patient of the European Society of Anaesthesiology

Assessment of the bleeding history, including a physical examination, is still considered the best tool for identification of patients with impaired haemostasis and/or an increased risk of bleeding complications during and after surgery. Platelet dysfunctions are the most common defects of haemostasis, occurring in up to 5% of patients undergoing surgery. When a coagulation disorder is suspected based on the patient’s history and/or clinical examination, further haematological assessment of the condition is warranted.

Published online 14 September 2011
Finally, there is increasing interest in the possibility of peri-operative monitoring of the effect of antiplatelet agents such as aspirin and clopidogrel. Although various point-of-care tests have been developed, there remain significant questions about their sensitivity, specificity, and ability to predict bleeding, and none of these tests are therefore currently routinely recommended in the preoperative setting but are the subject of ongoing studies.
Laboratory assessment and perioperative management of patients on antiplatelet therapy: From the bench to the bedside

Giuseppe Lippi a,*, Emmanuel J. Favaloro b, Gian Luca Salvagno a, Massimo Franchini c

3.3. Platelet function analyzer-100

Due to the rapidity, ease of use and favorable diagnostic performances, the platelet function analyzer-100 (PFA-100) is the most widely used compact analyzer for identifying disorders of primary hemostasis worldwide, being recently licensed by the US Food and Drug Administration (FDA) for this application [50,51]. The PFA-100 simulates the process of platelet adhesion and aggregation triggered by either collagen/epinephrine (CEPI) or collagen/ADP (CADP) in vitro, reporting results as a “closure time” (CT). Although the test would be seem ideally suited for monitoring platelet inhibition by several antiplatelet agents and for identifying aspirin-resistance [28], there are several factors that compromise the effectiveness of the PFA-100 in this setting. For the PFA-100, a prolongation

<table>
<thead>
<tr>
<th>Table 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laboratory tests used to assess primary hemostasis</td>
</tr>
<tr>
<td><strong>Bleeding time test</strong></td>
</tr>
<tr>
<td><strong>Platelet (light transmission) and whole blood (in vitro)</strong></td>
</tr>
<tr>
<td><strong>Platelet function screening tests</strong></td>
</tr>
<tr>
<td>- Platelet Function Analyzer-100® [PFA-100®, Siemens, Marburg, Germany]</td>
</tr>
<tr>
<td>- VerifyNow® [Accumetrics, Inc., San Diego, CA]</td>
</tr>
<tr>
<td>- Plateletworks® [Helena Biosciences, Beaumont, Texas]</td>
</tr>
<tr>
<td>- Hemostatus® [Medtronic, Parker, Colorado]</td>
</tr>
<tr>
<td><strong>Flow cytometry</strong></td>
</tr>
<tr>
<td><strong>Thromboelastography</strong></td>
</tr>
<tr>
<td>- Platelet Mapping® (Haemoscope, Niles, IL, USA)</td>
</tr>
<tr>
<td>- Sonoclot® (Sienco, Inc., Morrison, CO, USA)</td>
</tr>
</tbody>
</table>
monitoring haemostasis in surgical patients

- **preoperative testing**
  - to identify pts at increased risk for perioperative bleeding

- **intraoperative monitoring**
  - to identify pathological hemostatic changes in surgical procedures at risk
  - cardiac and vascular surgery
  - liver surgery
    - major resection
    - transplantation
  - orthopedic surgery (?)
  - trauma / trauma surgery
  - obstetric emergencies

- **postop monitoring**
  - bleeding tendency
  - tendency towards hypercoagulation
perdite ematiche nella chirurgia maggiore: come influenzarle

• riduzione di perdite ematiche e di entità trasfusionale
  – miglioramento delle tecniche chirurgiche
    • approccio chirurgico
    • innovazioni tecnologiche
  – migliore comprensione modificazioni del profilo fisiologico perioperatorio
    • monitoraggio
    • terapia sostitutiva
    • manipolazione farmacologica
monitoraggio: le finalità

- identificazione del problema
- diagnosi differenziale
- guida al trattamento
- conferma dell’effetto della terapia
the ideal test for the perioperative coagulation profile

- simple to perform
- accurate
- reproducible
- reliable
- diagnostically specific
- cost-effective
emostasi: monitoraggio clinico

- laboratorio
  - conta piastrinica
  - PT  aPTT  TT  TR
  - Fibrinogeno
  - FDP / d-Dimero
  - ATIII (?)
But ..... 

• conventional laboratory assessment of coagulation takes time.
• 30 to 60 minutes lag time required for results of PT / aPTT
Near-patient testing of haemostasis in the operating theatre: an approach to appropriate use of blood in surgery

C. M. Samama¹ & Y. Ozier²
¹Department of Anaesthesiology and Intensive Care, Hôpital Avicenne, Bobigny, France ²Department of Anaesthesiology and Intensive Care, Groupe Hôpitalier Cochin 27, Paris, France

Activated partial thromboplastin time (aPTT) and prothrombin time (PT) are basic coagulation tests that are commonly used intraoperatively. In various clinical situations, especially when replacement of massive blood loss is needed, monitoring of the PT and aPTT is very helpful. A lengthening of the tests may be understood to be a consequence of haemodilution, but it also can be attributed to a consumption coagulopathy. Most current guidelines for blood-component therapy recommend measurement of the PT and aPTT to diagnose an intraoperatively acquired coagulopathy and to consider the need for transfusion with fresh-frozen plasma (FFP). Therefore, an immediately available result is critical for patient care.
Near-patient testing of haemostasis in the operating theatre: an approach to appropriate use of blood in surgery

C. M. Samama\textsuperscript{1} & Y. Ozier\textsuperscript{2}

\textsuperscript{1}Department of Anaesthesiology and Intensive Care, Hôpital Avicenne, Bobigny, France \textsuperscript{2}Department of Anaesthesiology and Intensive Care, Groupe Hospitalier Cochin 27, Paris, France

• rapid detection and timely correction of haemostatic defects are the driving forces leading to the implementation of point-of-care (POC) testing of haemostasis in the operating theatre
Near-patient testing of haemostasis in the operating theatre: an approach to appropriate use of blood in surgery

C. M. Samama1 & Y. Ozier2
1Department of Anaesthesia and Intensive Care, Hôpital Avicenne, Bobigny, France 2Department of Anaesthesia and Intensive Care, Groupe Hospitalier Cochin 27, Paris, France

Real-time aPTT and PT undoubtedly would provide useful information for anaesthetists. A compact portable coagulation monitor (CoaguChekProDM® monitor, ex CoaguChek-plus®, and formerly Ciba Corning Biotrack 512 monitor; Roche Diagnostics, Mannheim, Germany) is available to perform instantaneous aPTT and PT, and several studies have been published [1–7,15,16]. Of note, this whole-blood technology cannot be strictly compared to conventional aPTT and PT performed on platelet-poor plasma. What you see is probably not exactly what you get. CoaguChek aPTT and PT results are not exactly laboratory aPTT and PT results.
the ideal test
for the perioperative coagulation profile

• no single monitoring device / test available with these characteristics
• many provide useful information to guide patient management
  □ combinations of these devices relevant to provide critical diagnostic insights
• the importance of integrated monitoring to define perioperative coagulation profile
Monitoring Intraoperative Coagulation


A. De Gasperi, O. Amici, E. Mazza, F. Garrone, A. Sciascia, and A. Corti

Instead of measuring the single “static” thrombin time to “dynamical formation to clot formation”, a laboratory evaluation of hemostatic function is needed. The ideal laboratory test to evaluate hemostasis in the bleeding surgical or medical patient should reflect the dynamic status of bleeding and be accurate and available in real time to enable the physician to make treatment decisions rapidly. Testing should be specific for different physiologic mechanisms to target.

Vol. 110, No. 2, February 2010
Thromboelastography (TEG)

- The method is of more clinical relevance during surgery than a limited series of tests who looks only at the first stages of clot formation.

- As with any form of monitoring, decision regarding therapeutic intervention should always be based on clinical ground in addition to the results of the tests.

The patterns of changes in shear-elasticity enable

- the determination of the kinetics of clot formation and growth
- the strength and stability of the formed clot
- the strength and stability of the clot provides information about the ability of the clot to perform the work of hemostasis
- the kinetics determine the adequacy of quantitative factors available to clot formation

• Data obtained from thromboelastography in the study of blood hypercoagulability in surgical patients.

DE HAYNIN G, WITZ JP, BOURGON, WEISS AG.

PMID: 13587597
• [PubMed - OLDMEDLINE for Pre1966]
Table 2. Nomenclature and Reference Values of Thrombelastography (TEG®) and Thrombelastometry (ROTEM®)

<table>
<thead>
<tr>
<th>Measure</th>
<th>TEG®</th>
<th>ROTEM®</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clotting time (period to 2 mm amplitude)</td>
<td>R (reaction time)</td>
<td>CT (clotting time)</td>
</tr>
<tr>
<td></td>
<td>N (WB) 4–8 min</td>
<td>N (Cit, in-TEM) 137–246 s</td>
</tr>
<tr>
<td></td>
<td>N (Cit, kaolin) 3–8 min</td>
<td>N (Cit, ex-TEM) 42–74 s</td>
</tr>
<tr>
<td>Clot kinetics (period from 2 to 20 mm amplitude)</td>
<td>K (kinetics)</td>
<td>CFT (clot formation time)</td>
</tr>
<tr>
<td></td>
<td>N (WB) 1–4 min</td>
<td>N (Cit, in-TEM) 40–100 s</td>
</tr>
<tr>
<td></td>
<td>N (Cit, kaolin) 1–3 min</td>
<td>N (Cit, ex-TEM) 46–148 s</td>
</tr>
<tr>
<td>Clot strengthening (alpha angle)</td>
<td>α (slope between r and k)</td>
<td>α (slope of tangent at 2 mm amplitude)</td>
</tr>
<tr>
<td></td>
<td>N (WB) 47°–74°</td>
<td>N (Cit, in-TEM) 71°–82°</td>
</tr>
<tr>
<td></td>
<td>N (Cit, kaolin) 55°–78°</td>
<td>N (Cit, ex-TEM) 63°–81°</td>
</tr>
<tr>
<td>Amplitude (at set time)</td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td>Maximum strength</td>
<td>MA (maximum amplitude)</td>
<td>MCF (maximum clot firmness)</td>
</tr>
<tr>
<td></td>
<td>N (WB) 55–73 mm</td>
<td>N (Cit, in-TEM) 52–72 mm</td>
</tr>
<tr>
<td></td>
<td>N (Cit, kaolin) 51–69 mm</td>
<td>N (Cit, ex-TEM) 49–71 mm</td>
</tr>
<tr>
<td>Lysis (at fixed time)</td>
<td>CL, CL.30, CL.60</td>
<td>LY, LY30, LY60</td>
</tr>
</tbody>
</table>

Coagulation Monitoring: Current Techniques and Clinical Use of Viscoelastic Point-of-Care Coagulation Devices

Perioperative monitoring of blood coagulation is critical to better understand causes of hemorrhage, to guide hemostatic therapies, and to predict the risk of bleeding during the consecutive anesthetic or surgical procedures. Point-of-care (POC) monitoring monitoring devices provide the clinician access to critical hemostatic parameters.
• **R time** 6 – 8 min  
  – initiation of the test to the initial fibrin formation  
    • intrinsec pathw  

• correlated with  
  – coagulation factors  
  – aPTT  

• changes  
  – Long R  
    • anticoagulants  
    • Coagulation factors **deficit**  
  – Short R  
    • Hypercoagulation
• **K time** (reaction time)
  – 2 – 4 min
  • from beginning of clot formation until TEG amplitude reaches 20 mm, (dynamics of clot formation)

• correlated with
  – fibrinogen
  – PLT

• long K
  • anticoagulants
  • Fibrinogen deficit

• short K
  • Increased fibrinogen level improve dPLT function
**α angle**

- **α angle** (Clot formation rate)
- >50°
- angle between the line in the middle of thromboelastogram and the line tangential to the developing "body" of the thrombelastogram.
- acceleration (kinetics) of fibrin build up and cross-linking.
  - **Fibrinogen**
  - **PLT**
- Reduced
  - Fibrinogen deficit
  - anticoagulants
- Increased
  - Increased fibrinogen
  - better PLT function (£)
MA amplitude

- 50 – 70 mm
- **Maximum Amplitude**
- strength of a clot
  - dependent on number and function of platelets and its interaction with fibrin (via GP. IIb/IIIa)
- **MA/ 60:**
- rate of amplitude reduction 60 min. after MA and represents the stability of the clot.

- Correlated with
  - **PLT number and function**
  - fibrin
clot lysis parameters

- Clot lysis index \( \frac{A_{60}}{MA} \times 100 \)
  - Lysis index
    - > 85%
- Clot lysis time
  - (LY 30; LY 60)
  - Lysis index at 30 and 60 mins
    - TEG AUC
fibrinolysis,  Kaolin

Sample time: 08/12/00 10.03.45 PM - 10.50.49 PM
### III. Treatment Guide

<table>
<thead>
<tr>
<th>TEG® value</th>
<th>Hemostasis state</th>
<th>Common treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>R between 11-14 min</td>
<td>↓ clotting factors</td>
<td>x 2 FFP or 8 ml/kg⁷,⁸,²⁶</td>
</tr>
<tr>
<td>R greater than 14 min</td>
<td>↓↓ clotting factors</td>
<td>x 4 FFP or 16 ml/kg¹,⁵,²⁶</td>
</tr>
<tr>
<td>MA between 46 -54 mm</td>
<td>↓ platelet function</td>
<td>.3μg/kg DDAVP²⁷,¹¹</td>
</tr>
<tr>
<td>MA between 41 -45 mm</td>
<td>↓↓ platelet function</td>
<td>x5 platelet units⁸,²⁶</td>
</tr>
<tr>
<td>MA at 40 mm or less</td>
<td>↓↓↓ platelet function</td>
<td>x10 platelet units⁵,²⁶,⁸,¹</td>
</tr>
<tr>
<td>α less than 45°</td>
<td>↓ fibrinogen level</td>
<td>.06 u/kg cryo⁵</td>
</tr>
<tr>
<td>LY30 at 7.5% or greater, C.I. less than 1.0</td>
<td>Primary fibrinolysis</td>
<td>antifibrinolytic of choice⁵,¹</td>
</tr>
<tr>
<td>LY30 at 7.5% or greater, C.I. greater than 3.0</td>
<td>Secondary fibrinolysis</td>
<td>anticoagulant of choice⁵,¹,₁⁵</td>
</tr>
<tr>
<td>LY30 less than 7.5%, C.I. greater than 3.0</td>
<td>Prothrombotic state</td>
<td>anticoagulant of choice¹¹,¹⁵</td>
</tr>
<tr>
<td>R less than 4 min or MA greater than 73</td>
<td>Prothrombotic state</td>
<td>anticoagulant of choice¹¹,¹⁵</td>
</tr>
</tbody>
</table>

Table 3. Example of a TEG based transfusion protocol

<table>
<thead>
<tr>
<th>TEG Parameter</th>
<th>Level</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>r time</td>
<td>Increased</td>
<td>FFP</td>
</tr>
<tr>
<td>K time</td>
<td>Increased</td>
<td>Cryoprecipitate</td>
</tr>
<tr>
<td>Alpha Angle</td>
<td>Decreased</td>
<td>Cryoprecipitate</td>
</tr>
<tr>
<td>MA</td>
<td>Decreased</td>
<td>Platelets</td>
</tr>
<tr>
<td>Lysis index</td>
<td>Increased</td>
<td>Antifibrinolics</td>
</tr>
</tbody>
</table>

Modified from Stahel et al,²⁰ Enriquez et al,²² and Avidan et al.²³
Native after reperfusion

- A

TEG con eparinasi

- B

TEG with Heparinase

Protamina 100 mg

- C

TEG after Protamine sulphate 100 mg
### Cuvetta Eparinase

- \( R \): 4,5
- \( K \): 2,0
- \( \text{Angle} \): 63,5
- \( \text{MA} \): 59,3

### Cuvetta Semplice

- \( R \): 4,5
- \( K \): 2,0
- \( \text{Angle} \): 63,5
- \( \text{MA} \): 59,3
Figure 5. ROTEG output from an investigation of the effects of increasing doses of rFVIIa on the clotting of whole blood from patients with severe hemophilia. Reprinted from Ingerslev et al. with permission of Lippincott Williams & Wilkins.
But.....

• TEG has not gained universal acceptance, especially among hematologists.
• The sensibility and sensitivity of TEG in the identification of the coagulation abnormalities are not well defined.
• An abnormal trace is not always associated with abnormal bleeding and may resolve spontaneously without treatment.
Many transfusion medicine specialists feel that near-site hemostasis monitoring could significantly improve clinical decision-making in patients undergoing surgery. Until recently, the vast majority of studies using the TEG® have been descriptive in design and, therefore, have had a limited impact on clinical decision-making. The next major advance will require a multicenter, interdisciplinary approach to design the studies needed to establish evidence-based transfusion algorithms. If multidisciplinary teams do not address these remaining issues, use of the TEG® in the perioperative period will remain limited.
Conclusion

The TEG®/ROTEM® has been used for many years as a guide to blood product and drug administration during cardiac and hepatic surgery. It is capable of providing a robust, inexpensive, snapshot of haemostasis at the bedside. For laboratory use, the need for an anticoagulated sample has led to stricter controls over sample handling. The search for a ‘global’ assay of haemostasis continues and the TEG®/ROTEM® or a derivative of this technology may provide the answer, or part of the answer, to that quest. There is more work to be carried out particularly with regard to standardization and reagent optimization before this potential can be fully evaluated.
Standardization of Thromboelastography: Values and Challenges

Meera Chitlur, M.D.,¹ and Jeanne Lusher, M.D.¹


The number of publications in the field of thromboelastography is growing daily, and many areas of clinical medicine are targeting the ability of this assay to evaluate in real time the process of coagulation and fibrin polymerization. It is clear that the methods employed by different investigators differ significantly, and therefore the results are not comparable. It is therefore critical to standardize the assay to achieve clinical relevance. This article summarizes the TEG-ROTEM Working Group’s efforts to try and standardize thromboelastography and the challenges faced in this process. Although this has been the first effort to standardize this test, it is extremely important to continue this work, so that we may investigate the usefulness and possible applications of thromboelastography in evaluating the process of hemostasis.
Nevertheless, one has to accept that even thromboelastometry is an artificial system that may not be able to analyse shear stress or endothelial influence. Additionally, ROTEM was not designed to detect disturbances in primary haemostasis; therefore alternative point-of-care tests such as the multiplate® or PFA-100® system need to be performed to answer these questions.
Point of care diagnostic: thromboelastometry (ROTEM®)

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In sum, the ROTEM device offers a fast diagnosis of haemostasis disorders by providing graphical and numeric information that enables the user to gain a more detailed insight into the complex interaction of the coagulation system. Future investigations are warranted to proof the assumption that a more targeted approach of coagulation therapy might lead to less use of blood products, shortening of time in critical care unit and finally a decrease in morbidity and mortality.
Perioperative bleeding: surgical or not surgical...

• surgical bleeding
  – failure to control bleeding vessels at the operative side
    • surgical technical problem
    • surgical technical solution

• non surgical or “haemostatic bleeding”
  – failure of the haemostatic pathways
    • generalized oozing
Strategies to reduce perioperative blood loss related to non-surgical bleeding

diffuse bleeding from numerous tiny capillaries. In the following, this type of blood loss will be referred to as ‘non-surgical blood loss’. Since it cannot be treated mechanically by clipping or ligation, it is mostly the anaesthetist who is challenged by this type of bleeding. An imbalance between coagulation and fibrinolysis, and a lack or malfunction of platelets are possible reasons for such non-surgical bleeding.
Managing critical bleeding in the periop period: a team – based procedure

- better surgical techniques
  - aggressive surgical / invasive approach
  - innovative technologies
    - CUSA, Cavitron
  - fibrin glues
- better understanding of the physiologic profile performed by anesthesia / CCM physicians
  - appropriate resuscitative measures
  - ad hoc monitoring to understand the haemostatic derangements
  - appropriate correction of the hemostatic defects
    - blood components
    - drugs
  - treatment of the underlying cause(s)
    - if possible
...to correct the bleeding tendency....or disorders

- Diagnosis of the underlying defect (hopefully)
- in vitro testing of efficacy of correction of coagulation abnormalities with
  - blood components
  - pharmacological agents
    - DDAVP
    - Antifibrinolytic agents
      - tranexamic acid
      - Aprotinin
      - Protamine sulphate
      - rFVIIa
  - combination therapy
...to correct the bleeding tendency....or disorders

- Diagnosis of the underlying defect (hopefully)
- in vitro testing of efficacy of correction of coagulation abnormalities with
  - blood components
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      » tranexamic acid
      » Aprotinin
      » Protamine sulphate
      » rFVIIa
  - combination therapy

![Diagram of step-by-step approach to the treatment of non-surgical blood loss](image)