9.0 LABORATORY TESTS

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The laboratory tests section will address the following recommendation statements: 5, 17, 20 -23.

9.1 Minimum recommended laboratory testing

CBC, INR, activated partial thromboplastin time (aPTT, at baseline only), fibrinogen, electrolytes, calcium (ionized), arterial or venous blood gas (pH and base excess) and lactate, are the minimum recommended tests to be performed **(Statement 22)**.

- Attention needs to be given to specific characteristics of each facility, such as size (tertiary care vs. small vs. community hospitals) and test availability and its turnaround time.
- Smaller hospitals should establish in their site specific MHPs the changes to the above minimum tests, depending on their test availability. For example, fibrinogen may not be available on-site at all Ontario hospitals.
- Clinicians may choose to alter the testing panel depending on the clinical scenario, giving greater importance to specific tests in place of others for different patient populations. For example, in a massive variceal bleed in a patient with end-stage liver failure the clinical team may also order liver function testing.

9.2 Minimum laboratory protocol resuscitation targets

The panel recommends minimum resuscitation targets for transfusion **(Statement 23)**, as follows: (a) hemoglobin>80 g/L (RBC); (b) INR<1.8 (plasma or prothrombin complex concentrates); (c) Fibrinogen>1.5g/L (replaced preferably with fibrinogen concentrate); (d) platelets > 50 $x10^9$/L; (e) ionized calcium >1.15 mmol/L.

- In facilities that use viscoelastic testing, relevant transfusion targets currently published in clinical practice guidelines should be used.
- In neonates on extracorporeal life support or in severe respiratory distress higher thresholds for RBC transfusion may be required if severely bleeding.
- Patients with post-partum hemorrhage or post cardiac surgery may benefit from higher fibrinogen targets (>2.0 g/L).

9.3 Processes for blood sample collection

Facilities should have their sample tubes in situ, pre-organized in bundles, ready for baseline blood testing. It is also recommended that for the subsequent time points (hourly testing), tubes are, again, pre-organized in bundles, properly identified, and easily dispensed, to increase awareness for the next blood withdrawals.

- Each facility should have a process for replacement of sample tubes and management of their inventory. A logical process is to attach sample tube kits to each MHP pack/cooler.

9.4 Minimum frequency of testing

Laboratory testing should be done at baseline and then at minimum hourly until the termination of the protocol, as recommended by the panel **(Statement 21)**.

- Smaller community hospitals where the patient is promptly transferred to a facility for definitive bleeding control may only have baseline blood work performed.
- In addition, different clinical scenarios may require different approaches, such as in Jehovah`s witnesses or anticoagulated patients, for example.

- Clinicians may also decide to do specific testing more frequently than others depending on previous results, rapidity of transfusion, and patient response to the resuscitation process.

9.5 Expected turnaround times

Laboratories are expected to have processes in place to prioritize performing and releasing tests in an MHP scenario. However, other factors in the pre-laboratory period may add to the turnaround time of the MHP panel, such as the time for the blood samples to reach the laboratory. Hospitals should minimize this pre-laboratory time with having dedicated staff to transport blood samples from bedside to the laboratory. A turnaround time of 20 minutes would be ideal for the completion of all tests once the samples arrive in the laboratory. However, each facility will determine their local turnaround time, according to local characteristics such as test menu and staffing levels. Turnaround times should be a focus of quality assurance.

9.6 Communication of results to the treating clinician

Critical laboratory values and all transfusion-related targets (hemoglobin, platelet count, INR, and fibrinogen) should be communicated verbally to the treating clinician as soon as they are available **(Statement 17)**. The release of abnormal results to the clinical team should not be delayed while completing confirmatory testing (e.g., repeats and dilutions for the Clauss fibrinogen). This may impact clinical decisions, which may cause further complications in a patient already experiencing a life-threatening condition. Furthermore, this may mitigate the risks of under- or over-transfusion, and improve time to correction of other coagulation, electrolytic, or metabolic abnormalities.

- Laboratories should release results with a verbal disclaimer that the test result is pending confirmation.
- For patients transferred from smaller facilities for definitive care in larger facilities, baseline test results should be sent with the patient, to the receiving clinical team.

9.7 Prioritization of tests

Group and screen sample testing should be prioritized as recommended by the panel **(Statement 20)** to minimize impact on group O red blood cell and AB plasma stocks. Characteristics of each facility or laboratory, such as staffing or availability of kits, may also influence prioritization of blood sample collection. Furthermore, different clinical scenarios may require specific tests more importantly than others. In these situations, prioritization will be the decision of the treating clinician. The recommendations for MHP state that patients should be switched to ABO group specific red cells as soon as is feasible in order to conserve group O red cells. A second sample must be obtained to confirm the patient's ABO group before non-group O ABO compatible red cells can be issued (CSA Z902 Standard 10.6.1.3).

9.8 Use of viscoelastic testing

Goal-directed therapy based on viscoelastic testing such as thromboelastography (TEG®) and rotational thrombelastometry (ROTEM®) has been used to guide resuscitation of severely bleeding patients, especially in trauma[1,2], cardiac surgery[1-3], post-partum hemorrhage[1-4], and liver transplant[1-5]. In Canada, few large centres use viscoelastic testing to guide transfusion due to logistics and costs. Additionally, transfusion parameters are hard to define and have not been validated in large randomized controlled trials. If capable, facilities should establish their own protocols for using these methods, including their thresholds for transfusion based on current published clinical practice guidelines in viscoelastic testing.

9.9 Special patient populations

As recommended by the panel, a single protocol for all patient populations is preferred to optimize compliance **(Statement 5)**. However, the protocol may be tailored for specific settings for transfusion thresholds and weight-based dosing. For laboratory testing, the following particularities should be considered:

a. **Cardiac surgery patients:** Currently in post-cardiac surgery hemorrhage, there is evidence to support the use of viscoelastic testing as compared to standard laboratory tests in reducing the risk of major bleeding. In this clinical setting, viscoelastic tests should be used if available. Samples should be collected as per each facility guideline on these methods.

b. **Massive obstetrical hemorrhage associated to trauma:** A sample for fibrinogen level testing should be prioritized and collected early in the resuscitation process and repeated at least hourly.

Pediatric

(1) Prioritization of collection of CBC and group/screen testing if there is limitation, with a reminder that they can be performed with capillary samples (microcontainer samples); (2) Each facility should be aware of what types of testing can be bundled up to decrease the volume of blood collected, depending on their devices; (3) A blood glucose test should be added as blood glucose levels are important predictors of outcome in the pediatric population with brain injury. In addition, a magnesium level measure should also be performed, as abnormal results are more common in this population and may exacerbate hypocalcemia; (4) Physicians should be aware of pre-analytical issues with microcontainers and avoid using them for platelet counts. However, for hemoglobin level these samples are usually concordant with vacutainer results; (5) The minimum volume of testing will depend on the type of analyzers and systems at each facility. For neonates a 500µL sample of whole blood, using the gel methodology is the minimum volume required for group and screen. However, other methodologies may require more volume; (6) Avoid intra osseous samples for the pediatric population. If access is an issue, consider capillary samples instead. Of note, intra osseous samples can be used for group and screen.

BLOOD DRAW TOOL

MHP Blood Draw and Testing Protocol									
Lab tests[1]		**Adult**	**Pediatric**	**Baseline**	**#1**	**#2**	**#3**	**#4**	**#5**
INR, aPTT (baseline only), Fibrinogen	Sodium Citrate (Blue)	2.7mL	1.8 mL	x	x	x	x	x	x
ROTEM/TEG	Sodium Citrate (Blue)	2.7 mL	1.8 mL	x	x	x	x	x	x
Na, K, Cl, Mg, Urea	Serum (Red/Gold)	4.5 mL	2.0 mL	x	x	x	x	x	x
Glucose (baseline only)	Serum (Red/Gold)	NA		x	NA	NA	NA	NA	NA
Ionized Calcium[2]	Serum (Gold)	4.5 mL	2.0 mL	x	x	x	x	x	x
Venous Lactate[2]	Lithium Heparin (Green)	4.5 mL	2.0 mL	x	x	x	x	x	x
G&S (baseline only)[3]	EDTA (Pink)	6.0 mL	1.0 mL[4]	x	NA	NA	NA	NA	NA
CBC	EDTA (Lavender)	4.0 mL	1.0 mL	x	x	x	x	x	x
Venous Lactate	Lithium Heparin (Syringe)	-	-	x	x	x	x	x	x
Arterial Lactate	Lithium Heparin (Syringe)	-	-	x	x	x	x	x	x
Blood gas (pH and base excess)	Lithium Heparin (Syringe)	-	-	x	x	x	x	x	x
Ionized Calcium	Lithium Heparin (Syringe)	-	-	x	x	x	x	x	x
Na, K, Cl	Lithium Heparin (Syringe)	-	-	x	x	x	x	x	x

[1]Lab draws appear in appropriate draw order - Sodium Citrate should always be draw n first.

[2]Can be bundled up (i.e., done together with a blood gas sample, if device/analyzer is available).

[3]Follow facility specific policies regarding ABO confirmation and requirement for second specimen.

[4]500uL for neonates

Prioritize samples as per MHP lead and as available at your facility - vacutainer/microtainers may differ depending on facility and patient population.

References

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2. Nicola S. Curry,[1,2] Ross Davenport,[3] Sue Pavord,[1,2] Susan V. Mallett,[4] Dianne Kitchen,[5] Andrew A. Klein, Helena Maybury,[7] Peter W. Collins[8] and Mike Laffan[9]. The use of viscoelastic haemostatic assays in the management of major bleeding. A British Society for Haematology Guideline. Br J Haematol. 2018 Sep;182(6):789-806. doi: 10.1111/bjh.15524.
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4. Ariunzaya Amgalan[1], Terrence Allen[2], Maha Othman[3,4], Homa K Ahmadzia[5] Systematic Review of Viscoelastic Testing (TEG/ROTEM) in Obstetrics and Recommendations From the Women's SSC of the ISTH. J Thromb Haemost. 2020 Aug;18(8):1813-1838. doi: 10.1111/jth.14882. PMID: 32356929.
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