ANESTHETIC MANAGEMENT FOR ORTHOTOPIC LIVER TRANSPLANTATION (OLT)

(Revised July 2012)

Jeffrey S. Plotkin, M.D.
Director of Transplant Anesthesiology and Critical Care Medicine

2012 Revision by Mike Rasmussen, M.D., Chief Resident

I. PREOPERATIVE PREPARATION

A. Pre-op evaluation by organ system:

1. Cardiovascular

a. The presence of a hyperdynamic circulation (high cardiac output, low SVR) should be documented. This is considered "normal" for the patient with end stage liver disease.

b. All patients should be evaluated with a 12-lead EKG and an echocardiogram. Additionally, some patients may require a dobutamine stress echo as discussed below.

c. Ejection fraction should be > 60% (probably closer to 75-80%), with the exception of fulminant hepatic failure (FHF) where cardiovascular changes have not had sufficient time to develop, thus, EF should be evaluated as the normal population.

d. Determine the extent of any underlying cardiac pathology and understand its implications. Traditional risk factors for ischemic heart disease/CAD include age > 50, male gender, smoking, hypertension, hypercholesterolemia, obesity, and family history. The Revised Cardiac Risk Index (RCRI) has been validated in several studies to predict risk for perioperative cardiac events in patients undergoing noncardiac surgery:

- Age > 50*
- High Risk Surgery (major vascular)‡
- Ischemic Heart Disease (prior MI, angina, Q waves, T or ST changes, etc)
- History of CHF
- History of CVA
- Diabetes
- Renal dysfunction (Cr > 2, CrCl < 60)

From Lee TH, Marcantonio ER, Mangione CM, et al: Derivation and prospective validation of a simple index for prediction of cardiac risk of major noncardiac surgery. Circulation 100:1043-1049, 1999.
** Not officially part of RCRI*
≠ Not a clinical predictor in the ACC/AHA 2007 guidelines

i) **Dobutamine Echocardiography** is the stress test of choice for CAD, and should be done in patients with long standing DM and/or > 50 years of age with 1 other risk factor.

ii) ESLD with cardiac involvement may include Alcoholic Cirrhosis, Wilson's Disease, Hemochromatosis, Amyloidosis and possibly Autoimmune Hepatitis.

2. Pulmonary

a. Hepatopulmonary syndrome is manifested by orthodeoxia (hypoxia worsened when erect)

Georgetown ANESTHESIA

platypnea (dyspnea worsened when errect). This is present in approximately 25% of patients with ESLD, however few patients actually develop hypoxemia requiring supplemental oxygen. If suspected, obtain ABGs on both room air and 100% oxygen. Transthoracic echocardiography will reveal intrapulmonary shunting upon the rapid injection of agitated saline (bubbles appear in the left atrium after 3-4 heart beats via the pulmonary veins, not a PFO).

b. Portopulmonary Hypertension (PPHTN) is present in 2-10% of patients presenting for liver transplantation. Mild PPHTN exists if MPAP > 25 mm Hg, moderate if > 35-40 mm Hg, and severe if > 50 mm Hg (these definitions assume PCWP < 15 mm Hg). If PPHTN exists, right heart function must be carefully evaluated by echocardiography and/or right heart catheterization. Right ventricular dysfunction in the face of PPHTN is a relative contraindication to OLTx. We have published multiple papers documenting the chronic use of epoprostenol (aka Prostacyclin or PGI_2) to manage PPHTN preoperatively and to be used intraoperatively to manage acute pulmonary vasoconstriction. In general, mild to moderate PPHTN can be managed during OLT with such techniques, however severe PPHTN is a contraindication.

c. V/Q mismatching may occur due to the above concerns in addition to porto-pulmonary shunting, intrapulmonary shunting, pleural effusions, decreased muscle mass, and decreased FRC from significant ascites.

d. Suspected pulmonary dysfunction should be evaluated with an ABG, CXR, and PFT's to evaluate for obstructive and/or restrictive disease.

3. Renal

a. Evaluate preoperative renal function tests. Be aware that a normal BUN and Cr may not rule out renal dysfunction as these patients may be on low protein diets and have decreased muscle mass. Attempt to delineate acute tubular necrosis vs chronic renal insufficiency vs Hepato-Renal Syndrome. It is absolutely imperative to know whether or not the patient makes urine preoperatively. Also be aware that some immunosuppressant medications used will decrease creatinine clearance by an average of 30%. In addition, patients with renal failure (especially those with FHF) may be on some form of RRT (renal replacement therapy) at the time of surgery. Continuous-RRT (e.g. CVVH) may be continued intraoperatively.

4. CNS

a. The presence or absence of encephalopathy must be noted. If present, coma grade (I-IV) should be known.

West Haven Criteria for Grading of Mental State	
Grade I	Trivial lack of awareness
	Euphoria or anxiety
	Shortened attention span
	Impaired performance of addition
Grade II	Lethargy or apathy
	Minimal disorientation (time or place)
	Subtle personality changes
	Inappropriate behavior
	Impaired performance of subtraction
Grade III	Somnolence to semistupor, but responsive to verbal
	Confusion
	Gross Disorientation
Grade IV	Coma

b. For FHF patients, this is essential. In patients with coma grade III - IV, ICP may be elevated due to significantly increased cerebral blood flow (hyperemia). Full ICP monitoring guidelines and precautions, as set forth in the FHF protocol, must be followed.

Georgetown ANESTHESIA

5. Hematologic

   a. The degree of coagulopathy must be appreciated (platelets, PT/INR, and preop TEG if available. See appendix 3 for explanation of TEG).
   b. Make note of the preoperative HCT and WBC. The ideal HCT is 28%, as this represents a balance between O2 carrying capacity and viscosity. If the patient's WBC is elevated, the cause must be explained as active infection may preclude transplantation.

B. Anesthetic equipment and vascular access set-up: see Appendix 1

C. Medication set-up: see Appendix 2

D. Blood products: Communicate with the circulating nurse to ensure that the blood bank is contacted **early** and the first "batch" of blood products is being prepared and transported to the OR. Each batch consists of:

PRBC	10 units*
FFP	10 units*
Platelets	As requested**
Cryo	As requested

*May be substituted by 10 units of whole blood

**One unit platelets (formerly known as a "6-pack") will be sent up in single bags of either pooled multiple donor platelets or as single donor (apheresis) platelets.

Batches are transported to the OR in an iced, insulated cooler and kept in the room until they are used. Platelets, if requested, are transported along with the batches but are not iced. Once the first batch is delivered to the OR, the blood bank will begin making up a second batch (i.e. blood bank stays one batch ahead). The next batch must be summoned when the first batch is down to 4 or 5 units. Cryoprecipitate and additional platelets must be requested specifically.

II. POSITIONING / MONITORING / ACCESS

A. As the patient is moved from stretcher to the OR table, sit the patient up and place the five-lead ECG pads on the back. A medium Tegaderm dressing should be placed over each individual EKG pad with the wires directed cephalad. R2 pads should be placed appropriately as follows: One placed vertically btw the scapulae (wire facing cephalad), the other placed horizontally over the sternum high on the chest away from surgical field (the sternum pad is usually placed after central venous access is obtained).

B. The patient must be carefully positioned on a well-padded OR table containing a warming blanket. Pressure points should be padded.

C. The occiput should be placed on a foam pad, and the eyes lubricated and taped shut for protection.

D. Sequential compression devices (SCD's) should be placed, and heals should be padded.

E. Both arms are to be abducted and placed on padded armboards; be certain the arms are not abducted beyond 90 degrees to avoid brachial plexus injury.

F. NIBP cuff placed until arterial line established. Pulse oximeter on the opposite the arm.

Georgetown ANESTHESIA

***** ALL LINES MUST BE PLACED USING STRICT ASEPTIC TECHNIQUE *****

G. Peripheral IV line for induction. Size 20G and larger may be converted to a RIC (rapid infusion catheter)

H. Arterial Lines: 20G radial arterial line will be placed pre vs. post-induction depending on the medical condition of the patient (the right radial is preferred). An 18G right femoral arterial line will be placed post-induction, usually by your attending. A left femoral arterial line is the last resort as the surgeons may need the left groin for veno-venous bypass.

I. Large bore access (placed after induction of anesthesia): Appropriate IV access includes a "**MAC**" central line (preferably placed in the R or L internal jugular vein), and a 7.0 or 8.5 Fr **RIC** (rapid infusion catheter) in the right or left antecubital vein or large forearm vein. The perfusionist will use two large-bore tubing lines for rapid infusion; one of which will connect to the large port on the MAC central catheter, the other to the RIC. However, in the event a RIC cannot be placed peripherally, a Cordis may be placed centrally, creating two central venous catheters. Your blood-warmer will be connected to the smaller 2nd port on the MAC (to be used for blood products and bolus drugs…$CaCl_2$, $NaHCO_3$, Fentanyl, etc). The subclavian veins are to be used only if absolutely necessary. A **pulmonary artery catheter** will be inserted through the introducer port on the MAC.

J. Infusion line: 1 L normal saline with a **microdripper** connected to a fluid warmer. Use micro-tubing as an extension to connect the warmer to a 4-port stopcock. The 4-port stopcock will connect directly to the white or gray PA catheter port, and set to run at a constant drip as a carrier for vasoactive medications and octreotide.

K. Other monitors: Indwelling urinary catheter placed by nurses or surgeons, OG tube, +/-TEE. All instrumentation of the esophagus should be done gently, with generous lubrication (esoph varicies). Place upper and lower body Bair Hugger. Avoid covering the left axilla and left groin with your Bair Huggers as these sites may be used for veno-venous bypass cannula sites.

III. INDUCTION AND MAINTENANCE

A. Pre-oxygenate in preparation for rapid sequence induction/intubation with Etomidate vs Propofol and succinylcholine. FiO_2 should be adjusted based on PaO2, with PEEP $\geq$ 5 as needed. Tidal volumes should be set at 6-8 ml/kg with respiratory rate adjusted to maintain $PaCO_2$ levels around 35-40 mm Hg (unless FHF protocol instituted).

B. Lorazepam, 4 mg IV should be used for amnesia initially, and can be redosed after reperfusion if necessary. Anesthesia is maintained primarily with Isoflurane and fentanyl. Isoflurane should be discontinued if hemodynamic instability exists. Re-dose neuromuscular blockade as needed to maintain full paralysis.

C. After induction and intubation, vascular access and placement of invasive monitors will be completed. The resident will usually focus on placing the central line, suture it into place, and then float the PA catheter with assistance from your attending. Do not wedge the PA catheter once floated, especially if PPHTN exists (unless directed by your attending). Connect fluid and infusions lines as discussed above (Section II: I-J).

D. Begin octreotide infusion at 50mcg/hr (discontinue during the anhepatic phase).

E. Antibiotics: Unasyn 3 gm and Cefotaxime 1 gm IV. Repeat q8h. (for PCN allergy, use Cipro/Flagyl).

Georgetown ANESTHESIA

F. Baseline labs: Draw a TEG (1-2 mL) and an ABG for the perfusionist to run. Remember to draw the TEG first, as heparin residue from the ABG syringe may contaminate the TEG. Repeat TEG and ABG q-1hr except during the anhepatic phase when ABGs should be done q 15-30 minutes. In addition, ABG's should be performed 10 minutes prior to, and 5 minutes after reperfusion, and a 3-channel TEG will be needed 15 min after reperfusion (4 mL). Refer to appendix 3 for explanation of the TEG.

G. Perform a baseline cardiac output and index measurement (using the thermodilution technique with room-temp saline injectate) to evaluate cardiovascular performance. Repeat Q 60 minutes. All cardiac outputs should be measured at end-expiration to ensure continuity with future measurements (CO varies throughout the respiratory cycle). Do not wedge the PA catheter once floated, especially if PPHTN exists. If C.I. is not > 3 L/min/m^2, TEE evaluation should be done and action must be taken as indicated (volume load, inotropes, calcium supplementation, etc.). TEE may be the best way to adequately assess cardiac function and volume status, and should be used when available and safe.

H. Maintain normothermia: After surgical skin prep and draping, ensure Bair Huggers are turned on. Temperature regulation is necessary for effective coagulation, though often times quite difficult. Note, in patients with fulminant hepatic failure, hypothermia may be needed for brain protection. Remember, significant platelet dysfunction occurs below 34^{o}C (in part due to hepatic sequestration), and arrhythmias < 32^{o}C.

IV. INTRAOPERATIVE MANAGEMENT

PHASE 1 - RECIPIENT HEPATECTOMY

A. Note continuation of the hyperdynamic state. As stated above, if C.I. is not > 3 L/min/m2, TEE assessment should occur and action taken as indicated (volume load, inotropes, calcium supplementation, etc).

B. Fluid Management: Coordinate with the perfusionist to replace intravascular volume losses secondary to initial drainage of ascites, third space losses, surgical bleeding and continuous formation of ascites. Massive blood loss is possible, especially in patients with significant portal hypertension and/or significant adhesions from prior surgeries, so pay close attention to surgical field and cardiac filling pressures. The rapid infusion system (perfusionist) should be used for the majority of volume replacement. The rapid infuser mixture (given below) may be altered depending on the patient's coagulopathy and HCT. Octreotide infusion (50 mcg/hr) is associated with decreased bowel congestion, blood loss, need for venovenous bypass and ICU stay. Therefore, this will be used in most cases, and is started immediately upon insertion of the PA catheter and should be discontinued during the anhepatic stage.

1. Because of difficulty in obtaining reliable blood loss measurements, your guide for fluid/transfusion management should include hemodynamic variables, urine output, laboratory values and inspection of the surgical field.

2. Rapid infuser mixture: Consists of 2 units RBC's, 2 units FFP and 500 mL normal saline (should yield a HCT of 28-30%) This ratio may be altered during the case as clinically indicated. All blood products are checked prior to being loaded into the rapid infuser by the perfusionist. Maintain Hct 28-30% to maximize the balance between O2 carrying capacity and viscosity.

3. Urine output should be kept > 0.5 ml/kg/hr. Ensuring adequate intravascular volume should be the first therapeutic maneuver for treatment of oliguria. The data remain inconclusive for the use of Fenoldapam (0.01-0.03 ug/kg/min), Dopamine (2-3 ug/kg/min), lasix and/or mannitol, and

Georgetown ANESTHESIA

therefore should be discussed with your attending on a case-by-case basis.

C. As stated above, repeat labs q 1hr except during the anhepatic phase when ABGs should be done q 15-30 minutes. In addition, ABG's should be performed 10 minutes prior to, and 5 minutes after reperfusion, and a 3-channel TEG will be needed 15 min after reperfusion (4 mL).

1. Ionized calcium levels must be kept above 1.0 at all times. A good rule of thumb is to give 500 mg CaCl for every 1000 ml transfused via the rapid infuser (remember FFP contains more citrate than PRBC's). Note: hypERcalcemia can lead to increased mitochondrial calcium uptake during ischemia, the final event in cell death.
2. Potassium should be kept $\leq$ 4.0 mEq/L prior to reperfusion. Hyperkalemia (K > 4.0) should be aggressively treated with acid/base manipulation and/or insulin/glucose (20u IV regular insulin with 25-50ml D50…note, rapid bolusing of D50 will cause temporary impaired cardiac contractility…ask Dr DeMarchi; he will show you with TEE in place).
3. Serum glucose should be > 90 mg/dL at all times. Use D5W or D50 if necessary.
4. pH should be kept above 7.30, and bicarbonate level above 17. Sodium bicarbonate or THAM may be used depending on the patient's serum Na+ and ability to hyperventilate the pt (see appendix 2 for bicarb and THAM dosing equations). Avoid serum Na+ changes > 12 mEq/L during the case for fear of central pontine myelinolysis.
5. Coagulopathy should be corrected based on assessment of the TEG (appendix 3), the surgical field and discussions with the surgeon regarding hemostatic difficulties. The TEG can be a helpful guide to replacement of FFP, platelets, amicar, protamine, DDAVP, etc. as needed. If fibrinolysis is occurring, 250-1000 mg of Amicar is all that is required. Should significant "heparin effect" occur, 25-50 mg Protamine is all that is required.
6. Magnesium: Keep in mind that as ionized calcium levels fall, so too do ionized magnesium levels, both due to citrate chelation; therefore, magnesium supplementation with 4 grams (over 5 minutes) may be required at some point prior to reperfusion (discuss with attending).

D. IVC cross-clamp: The retrohepatic portion of the inferior vena cava is usually removed along with the liver; the donor liver is harvested in the same fashion so that the donor retrohepatic IVC can be connected end-to-end to the recipient's IVC above and below the liver. In most cases, the surgeon chooses to fully cross-clamp the IVC without bypass (after a test clamp) which significantly decreases preload. It is wise to begin volume loading prior to test clamping, with the potential for more volume needed to tolerate the test clamp. In some instances, depending on the surgeon's judgment, a "piggyback" procedure may be used where the liver is dissected off the IVC, preserving the portion of the IVC posterior to the liver. The hepatic vein of the new liver is then anastmosed onto the side of the IVC. This is performed without complete cross-clamping of the IVC, but rather with a partial side clamp.

E. Veno-venous bypass (VVB) is rarely used, but if needed, the cannulas may be placed by the surgeon into the left femoral vein and the left axillary or subclavian vein for partial bypass. If full bypass is to be used, a third cannula will be placed in the portal vein.

1. To assist the surgeons, it is imperative to watch all connections to ensure the removal of all air prior to initiating bypass.
2. VVB will be initiated prior to cross-clamping of the IVC. Volume expansion, however, may be necessary since cardiac output is not matched by VVB pump flows (3-5 L/min) thereby decreasing venous return.
3. Hemodynamic stability may depend on adequate bypass flow. In cooperation with the perfusionist, attempt to maintain flow at 2 -5 L/min, or at least 40% of cardiac output, with allowable minimum flow of 1 L/min. Be alert for perturbations of flow secondary to kinked tubing, air emboli, hypovolemia, etc.

Georgetown ANESTHESIA

4. If using venovenous bypass, avoid platelet administration prior to reperfusion if possible as this may destroy platelet function. However, if massive blood loss is occurring, platelets may be needed anyway.

PHASE 2 - ANHEPATIC PHASE

A. Discontinue the **Octreotide** infusion

B. **ABG's** every 15-30 min. Understand that the liver is now totally out of the system; therefore, lactic acidemia, citrate intoxication, hypoglycemia and coagulopathy can progress rapidly.

C. **Urine output** will decrease secondary to increased venous congestion from clamping of the IVC. **Cardiac output** may decrease somewhat and SVR may increase primarily due to decreased preload; however, the removal of the liver will decrease the needed cardiac output by about 25%. This is a normal occurrence.

D. Sequence of anastamoses: suprahepatic cava, then infrahepatic cava, then portal vein, followed by reperfusion by unclamping of the IVC. The hepatic artery and bile duct anastamoses are completed after reperfusion. If the piggyback technique is used, there will only be 1 caval anastamosis followed by the portal vein prior to reperfusion (refer to IV-D for explanation of piggyback).

C. Preparation for Reperfusion: Administer **Solumedrol** (methyprednisolone) 500 mg IV during completion of the portal vein anastomosis. In the case of HBV, Hepatitis B immune globulin (*HBIG*) 10,000 units should be given while the liver is physically out of the body.

1. Prior to reperfusion, perform the following checklist:
   a. Check ABG 10 min prior to reperfusion (K+ less than 4.0 is desirable).
   b. 100% FiO2
   c. Epinephrine is the pressor/inotropic agent of choice: 8mcg/ml in 10ml syringes. You will also have the epinephrine bag mixed up in case an infusion becomes necessary.
   d. Have platelets ready for infusion if needed (to be given after reperfusion).
   e. Blood sample syringes ready: ABG, 3-channel TEG.
   f. Ionized calcium should be corrected prior to reperfusion based on lab work.
   g. Avoid overly-aggressive correction of base deficit (see Phase 3, section A-1). A bicarb level of $\geq$ 17 is adequate.

2. Preload is rapidly restored upon unclamping the infrahepatic and suprahepatic vena cava, and as part of the post-reperfusion syndrome (mentioned below), the right heart may become quite distended with cold, acidemic, hyperkalemic blood. For this reason, limit the volume administration towards the end of stage 2. In practice, aim for low-normal filling pressures.

H. **Reperfusion**: Abrupt hemodynamic changes may occur on reperfusion due to an acute influx of blood that is hyperkalemic, acidemic and cold from preservation solution, and also contains vasoactive substances released from the grafted liver and ischemic splanchnic bed. Initially, blood pressure may rise as a result of increased venous return. However, within 5 minutes, the "post-reperfusion syndrome" (PRS) can occur, consisting of progressive bradyarrhythmias, decreased SVR, impaired myocardial contractility that all present as hypotension and high cardiac filling pressures. Epinephrine is the agent of choice for resuscitation. Be prepared for full-scale CPR if necessary. If epinephrine is required, discontinue the use of Isoflurane and proceed with a narcotic technique.

Georgetown ANESTHESIA

1. Additionally, fibrinolysis can occur due to TPA release from the newly perfused, grafted liver. This should be treated with Amicar based on the TEG (250-1000mg).
2. A heparin load may occur as heparin is a component of the University of Wisconsin solution (aka Viaspan) used as the preservation solution for the donor liver. This may lead to a significant "heparin effect" seen on the TEG, and may require treatment with Protamine (25-50mg).

PHASE 3 - NEOHEPATIC PHASE

A. Once reperfusion is complete, the hepatic artery and bile duct anastamoses will commence. If the new liver is functioning well, the patient should stabilize dramatically. Hepatic lactic acid metabolism will begin. The surgeons will inquire about the lactate trend going forward as a measure of liver function. Wean infusions as tolerated.

1. Metabolic alkalosis may become evident as metabolism of lactate and citrate results in generation of an equivalent amount of bicarbonate.
2. If the new liver is not functioning, be ready for continued instability and the need to take over all functions of the liver. Furthermore, if this continues, the patient may need an emergency re-transplant.

B. 5 minutes after reperfusion: Draw ABG.

C. 15 min after reperfusion: Draw 3-channel TEG. Also, assess hemodynamics with cardiac output/index and TEE (measuring cardiac output using the thermodilution method immediately after reperfusion is unreliable secondary to the influx of cold preservation solution into the blood stream)

1. The circulatory system may become even more hyperdynamic than baseline. This is normal.
2. TEE may be useful to evaluate cardiac function. In addition, as cases of pulmonary emboli on reperfusion have been reported, TEE is invaluable in confirming this diagnosis.

D. Maximize hepatic oxygen delivery by maintaining a perfusion pressure $\geq$ 60 mm Hg, HCT 28-30%, SaO2 $\geq$ 97% and avoidance of vasoactive agents, if possible.

F. In cooperation with the perfusionist, discontinue use of the cell-saver after reperfusion to avoid contamination with bile, thus reducing the risk of infection (note: cell saver will not be used at any time in patients with cancer, such as hepatocellular carcinoma). The rapid infuser can also be discontinued around the time of closure with appropriate flushing of the lines.

G. Abdominal Closure and Preparation for transport to ICU:

1. Note how the abdominal closure may affect cardiac filling pressures, BP, airway pressures.
2. Call the receiving ICU nurse to give report. Your attending will give report to ICU attending.
3. Prepare patient for transport: Disconnect warmer from your blood tubing. If vasopressors are still required, prepare pumps for transport. Secure OG/NG. Tape PA cath to forehead. Prepare emergency pack (airway devices, meds, etc).
4. Administer additional narcotics, benzodiazepines, paralytics if necessary prior/during transport to ICU. However, be careful not to over-medicate at this point as hemodynamic stability may be negatively impacted, and also impair the ICU's ability to start immediate weaning of mechanical ventilation. Make sure the ICU resident is present for report upon arrival to the ICU.

Georgetown ANESTHESIA

APPENDIX 1:

EQUIPMENT AND FLUID SET-UP

- Blood warmer and blood tubing x 1 with normal saline. Setup on patient's right.
- Micro-dripper with normal saline connected to a fluid warmer. Set up on patient's left.
    - Use micro-tubing as an extension to connect the warmer to a 4-port stopcock.
    - The 4-port stopcock will connect directly (no extension) to the gray or white port on the PA catheter.
- Medication infusions described in appendix 2, set up on patient's left.
- Triple pressure transducer set; use for femoral A-line, PAP, CVP. You'll need to set up your own pressure bag with 500 mL NS (attach transducers to the small pole that connects to the OR bed; see photos in appendix 4).
- Single pressure transducer set; use for radial A-line.
- Standard ASA monitors (note: Temperature will be measured through the PA catheter).
- R2 defibrilation pads (set out on OR bed).
- 5 medium-sized Tegaderms (set out on OR bed to cover EKG leads placed on the patient's back).
- 8.0 ETT or larger
- Oral airway with tongue depressor
- Laryngoscope of choice
- ABG syringe and 3 mL syringe set out for baseline labs.
- 18 Fr OG tube with lubricating jelly
- Standard IV kit with standard tubing set-up for induction IV
- Femoral arterial line kit
- Radial arterial line set-up
- 1 Rapid infusion catheter (RIC) kit, along with chloroprep, sterile towels, sterile gloves, medium Tegaderm.
- "MAC" Two-lumen central venous access kit.
- Pulmonary Artery Catheter kit.
- Central Venous access catheter kit bag (contains gloves, gowns, biopatch, sterile dressing, CL insertion form etc.)
- Upper and lower body Bair Huggers
- Warming blanket on OR table (usually set out by circulating nurse)
- 10 ABG syringes, 10 3mL syringes for TEGs, and one 5mL syringe for 3-channel TEG after reperfusion.

Set up monitor for Cardiac Output measurements:

- Enter patient weight and height as follows:

More Menus
↓
Patient Data
↓
Cardiac Calcs
↓
Change Value
↓
Scroll down and enter WT and HT

- Enter Computation Constant as follows:

CO
↓
Computation Constant
↓
Enter **0.595**
(used for 10mL Room temp injectate)

Note: The Cardiac Output section will not appear on the monitor unless the CO cable is plugged in to the monitor.

Georgetown ANESTHESIA

APPENDIX 2:

MEDICATIONS

INFUSIONS

DRUG	AMOUNT	MIXED IN	CONCENTRATION	NOTES
Norepinephrine	4 mg	250 ml D5W	16 mcg/ml	Spike, set on pump at 2 mcg/min
Octreotide	250 mcg	250 ml D5W	1 mcg/ml	Spike, set on pump at 50 mcg/hr
Epinepherine	2 mg	In 250 ml D5W	8 mcg/ml	Set aside, do NOT spike. Use for syringes and possible infusion if needed.

RESUCITATION

DRUG	CONCENTRATION	SYRINGE SIZE	QUANTITY
Epinephrine (draw from bag)	8 mcg/ml	10 ml	1
Epinephrine	100 mcg/ml	10 ml	1 Bristojet available but NOT opened
Norepinephrine (from bag)	16 mcg/ml	10 ml	1
Phenyephrine	100 mcg/ml	10 ml	1
Ephedrine	10 mg/ml	5 ml	1
Lidocaine 2%	20 mg/ml	5 ml	1
Calcium Chloride	100 mg/ml	10 ml	3 Bristojets opened and ready (or drawn up in syringes if Bristojet unavailable)
Sodium Bicarbonate 8.4%	1 mEq/ml	50 ml	3 Bristojets opened and ready (or drawn up in syringes if Bristojet unavailable)
	Bicarb dose = (kg lean body mass)(base deficit)(0.2)		0.2 is the proportion of body WT that is extracellular fluid. (0.4 for Peds).

INDUCTION/MAINTENANCE

DRUG	CONCENTRATION	SYRINGE SIZE	QUANTITY
Lorazepam	2 mg/ml	3 ml	4-6 mg
Fentanyl	50 mcg/ml	20 ml	1
Lidocaine 2%	20 mg/ml	5 ml	1
Propofol	10 mg/ml	20 ml	1
Etomidate (case-by-case basis)	2 mg/ml	10 ml	0-1
Succinylcholine	20 mg/ml	10 ml	1
Vecuronium	1 mg/ml	20 ml	1
Ampicillin/Sulbactam (Unasyn) 3gm	300 mg/ml	10 ml	1
Cefotaxime 1gm	100 mg/ml	10 ml	1
Cipro / Flagyl for PCN Allergy	400mg / 500mg		

Georgetown ANESTHESIA

IMMUNOSUPRESSANT DRUGS

IMMUNOSUPRESSANT DRUGS	
DRUG	NOTES
Methylprednisolone (Solu-Medrol)	500 mg
Hepatitis B immune globulin (HBIG)	10,000 Units. (For HBV ONLY; see section IV-phase 2-C)

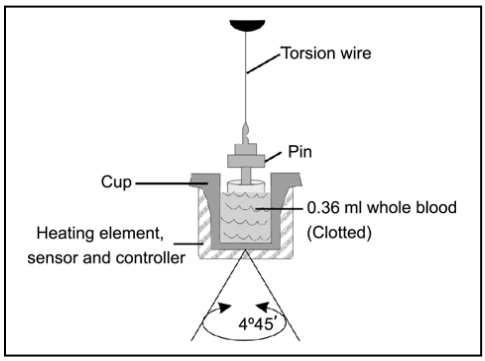
OTHER DRUGS THAT SHOULD BE READILY AVAILABLE
Atropine
Additional Sodium Bicarbonate
Additional Calcium Chloride
Dextrose 50%
Regular Insulin 100 u/ml vial
Aminocaproic Acid (Amicar)
DDAVP
Protamine
Heparin
THAM 0.3M (THAM dose = kg lean body mass X base deficit)
Magnesium Sulfate
Mannitol
Albumin 25%
Dopamine
Amiodarone
Esmolol, labetolol, metoprolol

Georgetown ANESTHESIA

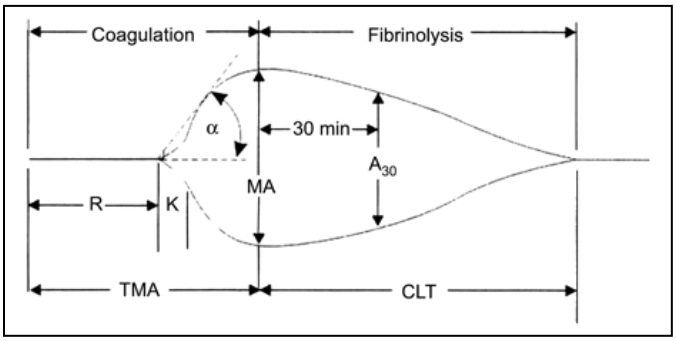
APPENDIX 3

Basics of the Thromboelastogram (TEG)

CODE FOR TEG CABINET: 1-5-2-3 (shake)

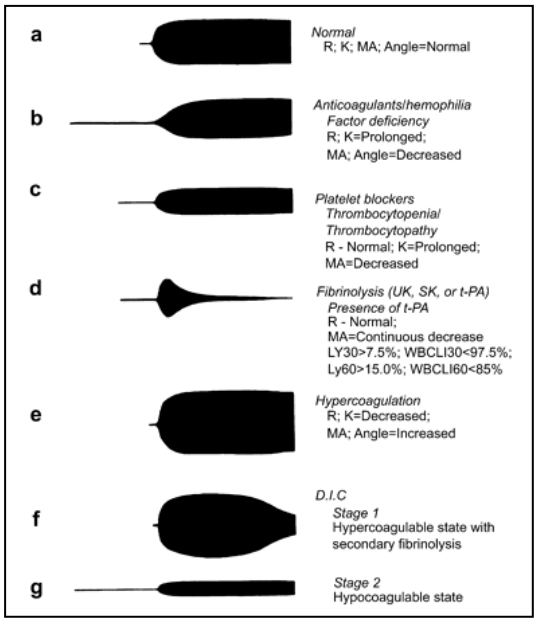


Basic overview: A sample of the patient's blood is placed in a small cup and set to oscillate back and forth. A torsion wire dangles into the cup; as the blood begins to clot, the wire is distorted. A tracing is created based on the movement of this wire caused by the coagulating blood. This tracing can be used to analyze various properties of the forming clot such as time to initial clot formation, speed of clot formation, strength of final clot, and presence of clot breakdown (fibrinolysis). Note: in some machines, the wire oscillates back and forth while the cup remains stationary.



R-Time (reaction time):
- The time from placement of blood in the TEG analyzer until the initial clot formation causes wire movement.
- Generally thought to be a function of **clotting factors** (anticoagulants, factor deficiencies).
- However, thrombocytopenia and/or platelet dysfunction can also significantly prolong the R-time.
- Normal is around 7-15 min. However this may vary slightly from machine to machine.

K-Time (Kinetic time):
- A measure of speed to reach a certain level of clot strength
- Specifically: time from beginning of clot formation until the amplitude of the TEG reaches 20mm
- Generally thought to be a measure of **fibrinogen** and platelets.
- Normal is around 3-6 min.



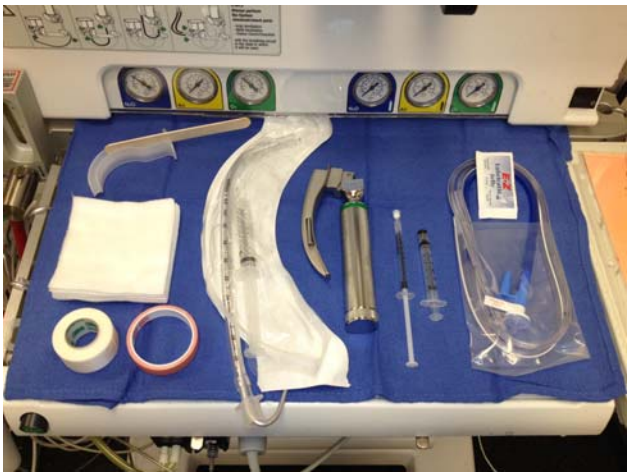
Alpha angle:
- Similar to K-time, the α-angle represents the speed of fibrin build-up and cross-linking (clot strengthening).
- A function of **fibrin** and platelet function.

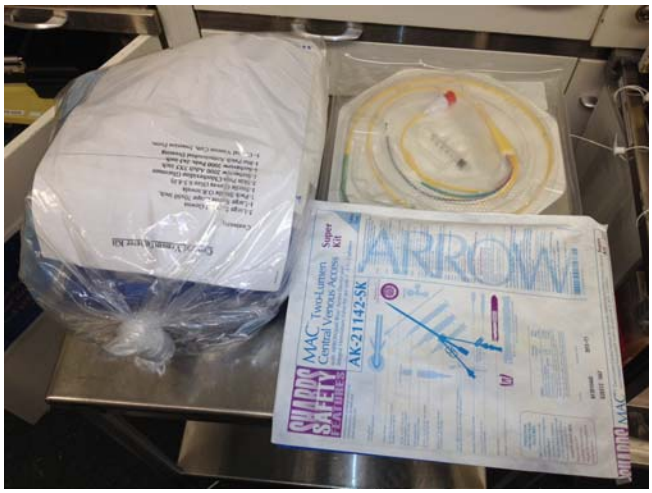
MA (maximum amplitude):
- A reflection of the final clot strength, or maximum clot strength.
- A measure of **platelet function**, both quality and quantity. Represents platelet aggregation to fibrin via GPIIb/IIIa receptors.
- Normal is 50-60 mm.

LY-30 (Lysis 30 min after MA):
- Representation of clot breakdown (**fibrinolysis**) 30 min after clot formation.

Georgetown ANESTHESIA

APPENDIX 4: PHOTOS





Georgetown ANESTHESIA