

Dartmouth Hitchcock Medical Center CRNA CVOR Guide

Expectations and Keys to Success

No one is expecting you to become a cardiac nurse anesthetist. But, you will encounter many of these cardiac conditions in the main OR. There is no doubt you will have patients with aortic stenosis and you should know how to hemodynamically manage them. Or will likely read a transesophageal echocardiogram report and see phrases like 'severe global hypokinesis', and you should know what that looks like and how to manage these patients under anesthesia. This is meant to be a rough guide to get you started in cardiac OR here at Dartmouth. Everyone does things differently, but we hope this rough guide will give you the tools you need to succeed and start with the right foot forward.

A big key to success here is COMMUNICATION. If someone says 'lungs down', repeat the words 'lungs down' as you put the lungs down. Sometimes, the surgeon will just buzz the saw before cutting the sternum and not say anything. Communicate to them that you heard the saw by saying 'lungs down' even if they didn't verbally tell you what they were doing. Closed loop communication with the entire team is a biggie. The team in the heart rooms are very nice and they are really good at what they do, learn their names and they will be very appreciative.

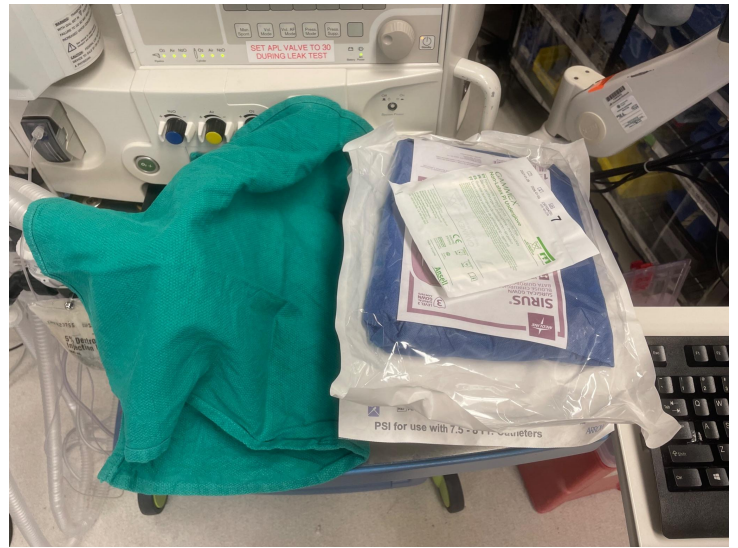
One last key to success is to save the charting for when you are on pump. Pay attention to what is going on in the case (why the drapes are clear!), how the heart looks on echo and to your eye, what step in the procedure they are at and anticipate the next move. Cardiac anesthesia seems scary, but the steps are almost always identical and you can easily predict what comes next.

Great resources to review before starting cardiac

- TEE standard views: [Virtual TEE: Standard Views, Cardiac, Transesophageal Echocardiography, 3D Heart Model, Education \(utoronto.ca\)](#)
- [Initiation of CPB](#): UpToDate
- [Weaning of CPB](#): UpToDate
- [Great review of Vasopressors](#): UpToDate

Morning Set Up

- Normal machine check, 8.0 tube for ICU
- On machine table top: central line (9 fr), CHG tegaderm, ultrasound probe cover, sterile gown and gloves
- Monitors
 - All should be disposable monitors for ICU- EKG leads, NIBP cuff, and pulse ox,
 - Extras/more sizes are in the bottom drawer of the anesthesia machine or in the supply room.
 - Defibrillator pads- found in sterile cabinet
 - Triple set (A line, PA, CVP) should be at the head of the bed and zeroed
 - Much easier to add an extra pressure tubing to the the arterial line to make ICU transport easier



Drugs- Standard Set Up

- Cardiac Tower (all drips programmed but on hold)
 - Normal saline @ 100 mL/hr
 - Norepinephrine @ 2 mcg/min
 - Epinephrine @ 2 mcg/min
 - If you are doing a valve, hang vancomycin bag: 1,000mg in 250mL
 - The ICU prefers the normal saline carrier long tubing taped to the drip tower (picture below), so lines don't drag on the floor/get tangled



- Syringes
 - Midazolam, 4mg
 - Fentanyl, 1mg in 20 cc
 - Propofol, 200mg in 20cc x2
 - Vecuronium or rocuronium
 - Ceftriaxone, 2mg in 20cc (all hearts)
 - Epinephrine, 8mcg/mL in 20cc
 - Norepinephrine, 8mcg/mL in 20cc
 - Vasopressin, 1unit/mL in 20cc
 - Nicardipine, 0.2mg/mL in 10cc

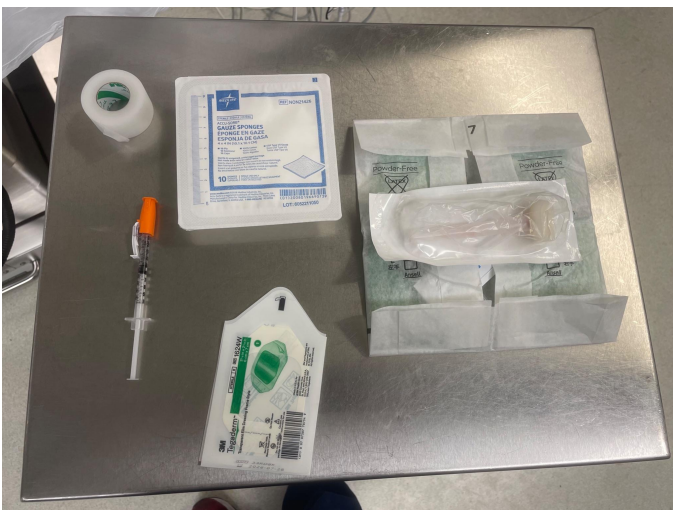


- On IV pole to the right of the bed
 - Blood tubing- primed through the warmer, with the double stopcock distal to the warmer
 - Tranexamic acid- 2,000mg in 20cc
 - To program on syringe pump: under miscellaneous drugs (#7), page over once and TXA will be the third option
 - 1mg/kg/hr infusion rate
 - Skip when it asks for a BOLUS dose. Program the **LOADING dose** to 10mg/kg
 - Make sure pacer turns on and has batteries
 - Check Zoll



Other DH Specific Notes

- Prime thermodilution bag with syringe, most of us place it on hook under APL valve (below)
- Arterial line set up on rolling mayo table (there is an extra for anesthesia)- lido in insulin/TB syringe for pre-induction line



Pre-Induction/Induction/Lines

Most of us are typically set up and ready to go by 7:15am, so I will ask the nurses in the room what time they want the patient in the room. You will get the patient from same day like normal, but if they are an inpatient they are typically in the new tower, so give yourself the extra time you need for the long travels.

We always do a pre-induction arterial line and we start on the right side. The right side because this is the same side as the swan, the same side of the monitoring equipment in the OR and the ICU, and there is less pulling on the lines when you transfer. As you are putting on monitors, perfusion will put on their cerebral oximeter stickers. Wait until they tell you they have obtained baselines before pre-oxygenating. You will typically be halfway through the arterial line when they do this, so your attending will be the one waiting for them to say this, but it is good to know in case the flow is different for the day.

After induction, the Nascar pit crew begins and you'll need to insert your central line with everyone else doing their thing. Wait to prep the neck until the attending has placed the TEE probe in case they need to sublux the jaw and potentially contaminate your prep. Typically while you are taping the tube, the cardiac PA is shaving and soaping down the chest. Wait for their soap wash to be done before prepping the neck. This may seem like you have a lot of time, but you can be opening your sterile gloves/gown on the back table, opening your central line kit and dropping in your supplies, and then usually that is a good time to prep the neck and go scrub your hands.

If you are new at central lines, talk through what you are doing and this will instill confidence in others you do know what you are doing. 'I see IJ lateral to the carotid, the IJ is collapsible when I press down with the probe, I am going down with my needle at a steep angle towards the ipsilateral nipple as I aspirate' etc etc. Once the attendings get to know you, they won't hover as much, they just want to be confident you know what you are doing... and you do! At the beginning, silence and performing incorrect actions is more scary than narrating exactly what you are doing. Make sure you can see your needle tip as you are entering the IJ. They confirm placement by seeing the wire on TEE, so you can throw the tubing manometer to the side.

A major key to success in any central line placement is to **never, ever lose sight of your wire**. You don't need to bury or hub your wire, and you'll likely see ectopy if you do. Once you thread the introducer over the central line, make sure you see the wire popping out the back before you begin to push in the dilator.

It would be highly suggested to practice suturing at home before you come into the CVOR. No one is expecting you to be perfect, but others may be tempted to take over the line procedure if you are fumbling with suturing. Use an orange, watch youtube videos, and practice with a needle driver on how to suture. This skill should not be overlooked.

Here at DH we use the VIP thermodilution PA catheters. You will take the swan from your attending still sterile, and place the swan cover ~80cm and lock the distal end in place. When inserting the swan, there is no reason to look down at the swan after you hit 20cm (and say 'balloon up'), this is the time where you look at the monitor and watch the waveform change. Remember when putting on your swan cover proximal to the patient there are two locks, one to lock the cover to the introducer and one lock to lock the swan in place so it doesn't move inside the cover.

Pre-CPB Time

After the lines, follow the ABCs. **A**ntibiotics, **B**lood gas/**B**aseline ACT, and **C**ardiac Output. All cardiac cases get 2g of ceftriaxone, and every valve gets 1g of vancomycin (over an hour) on top of that. All ACTs go to perfusion, and we need to call PSTs to send our gasses. Before shooting the cardiac output, make sure the patient's correct height and weight are in the monitor under the 'Patient Demographics' button at the bottom of the screen.

Be mindful of your IV fluids and limit these as much as possible. Perfusion does not often do retrograde autologous priming, so we need to preserve the Hct as much as possible. Before pump it would be ideal to have less than a liter in, so be mindful when you are pushing drugs and leaving drip lines open.

Some of the surgeons will ask anesthesia 'OK to start?', so before this time you should be prepared for the high blood pressure that will come with incision. Some of the surgeons don't say anything at all and just make an incision. The 3 most stimulating portions of the procedure: incision, sternotomy, and cutting through the pericardium. You want to get ahead of this response before they make incision- many of us give fentanyl prior to incision as we are finishing draping and turn up the gas. You also have propofol and nicardipine at your disposal. But do not let the pressure hit 190 as the case starts, be vigilant and prepared for the next steps of the case.

With a CABG, you will have some 'down time' between sternotomy and going on pump as they harvest. When taking down the LIMA/RIMA watch your tidal volumes and they'll typically ask

for no PEEP. I like to get my pressures dialed in to where you want them going on pump so you are ready to go when they are (SBP 85-100).

Prior to cannulation the surgeon will ask for Heparin, which comes from perfusion, and you'll draw an ACT 3 minutes after. The surgeon will specifically ask for this and verbally respond '30,000 of heparin going in'. Goal ACT 400-500. Watch your pressure after a huge slug of heparin due to its effect on viscosity.

In order of cannulation: they will first cannulate the aorta, then insert their venous cannula(s), next is the antegrade cardioplegia cannula, retrograde cardioplegia cannula if they are using it, and then finally the LV vent.

On CPB

DO NOT STOP VENTILATION UNTIL PERFUSION HAS ANNOUNCED FULL FLOW.

If there is pulsatility on the arterial line you are responsible for ventilation/oxygenation.

Turn the ventilator off/standby, turn off vaporizer, turn FGF down to 0.1LPM

Ensure perfusion has turned on their isoflurane vaporizer. Communicate with the patient's anesthetic requirements.

Paralytics: Redosing is preference but it is accepted practice to redose at the beginning of bypass and upon rewarming/or when the aortic clamp comes off

Electrolytes/Labs: Keep the glucose under 200. Insulin drips and boluses are your friend. Keep an eye on acid base status and potassium/calcium. Perfusion will be adjusting their setup for titration but we can offer assistance as needed. While on pump, order a stat CBC and a DIC panel (no D-dimer) to draw with your post-protamine ACT and ABG. The labels will print in the room and the circulator will give you the labels.

Monitor temperature or ensure perfusion can see it so they can monitor it as well.

Monitor urine output. It is good practice to know the prebypass, bypass, and post bypass urine amounts. Perfusion will ask you how much urine that patient had while on bypass as you come off pump. If output is low while on bypass, let perfusion know (goal ~1mL/kg/hr on pump).

Pressers: Perfusion generally manages vasopressor requirements but we can turn on drips if needed such as norepinephrine etc. When transitioning to bypass ensure that perfusion is aware of current vasoactive drips. There will be a discussion about which ones to continue and how much. Titration may be required so keep the lines of communication open.

Plan for separation of bypass: Use this time to plan the separation process in terms of drips. Consider LV and RV function preop and how the surgery is going. Any added procedures, prolonged cross clamp time etc. Have a plan for which drips, doses, and when to start them with your attending since they may not be in the room.

Rewarming: Anesthetic requirements increase with temperature. This is the second most likely time for awareness after sternotomy. Ensure patients have adequate depth!

Separation from CPB

1. Airway
 1. ETT in a good position? Can be moved if using bronchial blockers or with surgical jostling
2. Breathing
 1. Ventilator on with FGF
 2. Consider recruitment breaths if surgeon allows it (work together, do not recruit while they are working since the lungs get in the way)
3. Cardiac
 1. Rhythm
 2. Rate
 3. If the above two are not acceptable PACE
 1. DOO or VOO to avoid bovie triggering
 2. Rate of 80 usually acceptable
 4. Function
 1. Check TEE
 2. Consider inotropes
 3. Consider anti-HTN drugs if needed
4. Depth of Anesthesia
 1. Vaporizer on
 2. IV sedation on or wait until the chest is closed
5. Exposure
 1. Temperature > 36 C

6. FIND YOUR ATTENDING

It is also good to check your labs specifically acid/base and potassium. It is unsafe to come off if these are way out of normal limits.

Another common separation mnemonic is WARM

Warm 36

Anesthesia

Adjunct meds

Air

Rate

Rhythm

Respiratory

Metabolic/**M**onitors

K

Ca

Glucose

It is common that there is VF/VT requiring defibrillation prior to separation. The Zoll should be hooked up and ready. If using the internal paddles charge to 10j. If using the normal chest pads 200j is standard. Ensure everyone is clear of the patient before shocking.

Optimizing the patient before separation is good practice. Usually the first separation is the best separation.

Once separated, shoot an output. Use CI, CVP and MAP to help guide you through the immediate separation phase. Low MAP and Low CVP give volume. Low MAP with high CVP give inotropes. High MAP and low CI start nicardipine. Volume is usually the toughest call to make. Look at the heart. Is it bulging and has no wrinkles? Volume is probably not needed. Does it look normal and snappy? Might need some inotropes. It is not appropriate to just give bolus after bolus of neo/norepi until you drop off in the unit. Use drips, volume, and a plan to guide your thinking.

Protamine: Large dose in a relatively short time frame. Consider using calcium and/or vaso to help with protamine hemodynamic shifts/protamine reaction. Once the protamine is in, wait five minutes and draw labs.

Post protamine labs: ABG, ACT, purple top, blue top. Also send the icu sheet with the lab runner.

Chest Closure and Transport

After the chest closes CVP should rise so be mindful of additional volume if CVP is already 15.

Lungs down so the sternum does not trap the lungs between it. Usually no PEEP during chest closure.

Once the sternum is closed the level of stimulation drops off and so does the blood pressure. Call the ICU for the heads up while the chest is being closed. Shoot one last output after the chest is closed.

If the patient is stable, begin preparing for transport. Cleaning up your lines, disconnecting cables etc. Wait for vital signs cables until the final second before moving over. TEE probe can come out. When moving to the bed the patient can become unstable due to hemodynamic shifts and air bubble movement. Watch the monitor and know where your push line is. Have pressers ready.

Make sure you have enough oxygen to get the unit. Be judicious in ventilation. Be mindful of all wires and cables. This will be the time the pacer wires are pulled out or you lose an arterial line. Get to the ICU safely and assist with hook up as needed. Have a sign out report ready for the team. Do not leave until everyone is satisfied and the patient is stable.

Structural Heart (Cath Lab 6)

General Set up: Standard GETA set up with arterial line set up. Fluid warmer with blood tubing and stopcocks for bolusing drugs ready to go. Phenylephrine, norepinephrine, epinephrine infusion programmed with flush/drip line at 150cc/hr. Have some kind of central line access kit in the room. Have access to the CMAC.

Cables for vitals are the white disposable ekg leads, sticker pulse oximeter, and single channel white disposable BP cuffs.

Emergency drugs: Push dose epi, norepi, nicardipine/nitro, vaso if needed. Have heparin and protamine syringes. Consider having some 5% albumin available or blood in the room

Pacer box and zoll available and turned on. TAVRs require two pacer boxes.

Discuss plan for access and procedure with all providers involved. In some cases we can use their radial or femoral access for BP monitoring.

Induction: Gentle and then get lines in quickly. TEE probe follows if necessary.

Maintenance: Maintain the BP and monitor EBL and any ectopy. Be ready to give immediate emergency drugs and or zoll therapy. Sometimes the proceduralist needs to be reminded that there is significant ectopy and they can back off on what they are doing and things stabilize without additional treatment. Best practice is to keep communicating and give very small amounts of drugs due to the potential for proceduralist induced hypotension with rapid resolution.

These are not overly stimulating procedures. It is generally accepted to keep the patient paralyzed and keep the anesthetics to a minimum. Any movement can prove deadly due to the intracardiac devices present in the heart.

Emergence: Smooth with minimal coughing. Be mindful of the access points. Patients should not move their legs etc.

Procedure Specific Tips

TAVR

TAVR morning meeting at 0700 in the cath lab lounge. All cases are presented. This is nice to gain an overview of the day and hear about any potential complications and concerns that each member of the team may have.

During time out the circulator will ask about expected heparin dosing: normally $80\% \text{ of kg} \times 100$ or if it's easier to think about it: $\text{kg} \times 80$. This usually ends up being somewhere around 5-10,000.

Antibiotics are always 2g Ceftriaxone and 1g of vancomycin. If the decision is made to forgo an a-line insertion proceduralist will give you groin access and you need to hook up to our a-line setup.

Usually MAC (75%) Many different cocktails including propofol drip, midazolam/fentanyl, precedex bolus and drip, remifentanyl drip, precedex/midazolam/fentanyl bolus etc etc. Be ready for potential conversion to open cardiac surgery. Be prepared and have heparin available for CPB.

During the valve deployment there needs to be rapid ventricular pacing. Heart rates are typically 150-220bpm. If you are doing a mac the patient may and will feel dizzy, woozy, lightheaded, and have crushing chest pain. Try to warn them and console them if they feel this. Also be prepared for brief but extreme hypotension: MAP < 50. Do not treat as this will cause a large overshoot after the valve is deployed and the HR returns to normal. Once the valve is in, keep the BP <160. You may need to turn off or titrate up/down some vasoactives. Rapid pacing and valve deployment can cause rhythm disturbances after the valve is in. This is partly due to the proximity of the aortic valve annulus and the conduction system. Have two pacer boxes ready so that you can quickly pace at a rate of 60-80bpm if the patient is in heart block or asystole.

Watchmans

We are moving away from arterial access. Communicate with the structural heart team so that they can provide ACT measurements from their femoral vein access. They will need reminding in some cases about drawing an ACT.

Due to the septal puncture the structural heart team requests in line filters be placed on all IV lines to avoid or minimize air bubbles in the venous system. The hope is that there is never right to left shunting but if there is, the filter should remove the bubbles before they cause a major problem. Ask the cath lab staff for some filters before each case. If you are setting up ahead of their arrival the cath lab supply room code is 143. Do not place the filters before induction as the filters do a great job filtering out propofol. They will then be clogged and the patient is half asleep. Get the patient to sleep, organize the lines, and then place the filters before the arms are tucked.

Mitral Clips/Triscupid Clips

These cases are for patients with severe regurgitation but are not surgical candidates. They will get groin access and have a transseptal puncture (Mitral). A clip is then guided with TEE in order to help the leaflets close better to hopefully reduce the regurgitant flow. These cases take time or they can be over very quickly. Anesthesia is general with an ETT, TEE, arterial line, sometimes extra lines for pacing as needed. Use the standard cath lab anesthesia set up adding drips as needed (some of these patients are very sick and already lined up, intubated etc in the unit). The best way to do these cases is keep them paralyzed and as close to their normals as possible. Usually very judicious fluid management, again think their normal. They usually ask for filtered iv lines for the mitralclips.

Lead Extractions

These cases are general with an ETT and arterial line. Sometimes temporary venous pacing wires are needed which necessitate an IJ introducer. Have all of these ready. These patients can be very sick from their infection so ensure you have all of the drips as stated above ready. These patients can lose lots of volume quickly from SVC damage, subclavian damage, and direct cardiac damage. There is always a CT surgeon and operative team on standby. You should have blood available and/or 5% albumin in the room. In terms of volume, often these patients have a very poor EF so that will hamper significant resuscitative efforts. Communicate with the surgical and procedural team if you are struggling. The proceduralist will place a balloon in the superior vena cava in the event the subclavian vein is severely damaged or ripped off. This will be the first step of the procedure. The next step will be to excise the pacemaker device and then isolate the leads. Extraction will then commence. This happens with two devices: a tightrail and a laser. Your attending should be in the room when the laser comes on, or the tightrail is being used. Both devices need to have the leads be pulled tight to work, both devices can result in catastrophic damage. When the leads are pulled tightly there can be invagination of the heart tissues. This can cause a drastic decrease in RV output and therefore decrease in cardiac output and blood pressure. Watch the monitors during this time and alert the proceduralist to rapid loss in blood pressure. Be careful to treat this as the blood pressure can be quickly corrected by letting off the lead. Communicate with the proceduralist!!! If the blood pressure is starting to trend down be communicative as this can mean bleeding from the subclavian, vena cava, and/or the heart. A worst case scenario is cardiac tamponade and this is very common with this procedure. Be vigilant and communicate! The final piece of this case is what will the patient have for a pacemaker after the device is removed? Ensure that there is a plan in place before the device is removed!!!