8 Cardiac Operating Room Setup and Preparation of the Patient for Surgery

Ahmed S. Awad, Levi Mulladzhanov, Patrick O'Dunne, and Muhammed Muntazar

Prior proper planning and preparation prevent piss poor performance.

—James Baker

Preoperative Planning

The current practice at most institutions for elective cardiac surgical patients is to evaluate the patient before the day of surgery in the preoperative anesthesia clinic. The anesthesia provider who will be involved in the case interacts with the patient a day before surgery if the patient is in the hospital or just prior to the surgery for a same-day admission patient. Most patients will have had a general medical examination, left and right cardiac catheterization, echocardiogram, and carotid duplex evaluation before the day of surgery. The results of these tests should be readily available.

Other diagnostic tests (electrocardiogram [ECG], chest radiograph, and recent routine laboratory test results) also should be available and reviewed. If required, pulmonary functions tests and other studies should be ordered. Preparation for the scheduled procedure starts the day before surgery. The anesthesia provider must know the type of surgical procedure to be performed so that the anesthetic management and room setup can be arranged; for example, if the procedure is a minimally invasive one, additional equipment and setup will be needed.

A. S. Awad (✉) · L. Mulladzhanov · P. O'Dunne
Department of Anesthesiology and Perioperative Medicine, Cooper University Hospital, Camden, NJ, USA
e-mail: levi@temple.edu

M. Muntazar
Department of Anesthesiology and Perioperative Medicine, Deborah Heart and Lung, Browns Mills, NJ, USA
e-mail: muntazarm@deborah.org

A. S. Awad (ed.), *Cardiac Anesthesia*,
https://doi.org/10.1007/978-3-030-51755-7_8

To build a sound anesthetic plan tailored to the patient's needs, the anesthesia team must know and discuss all the patient's available preoperative information, including the severity of valve dysfunction, coronary artery anatomy, myocardial function, airway anatomy, relevant anesthetic history, and the critical implications of these factors.

Emergency cardiac surgery presents special challenges. Because of the operative urgency, relevant medical and anesthetic history, cardiac catheterization results, echocardiogram reports, and laboratory test results may not be available, and the patient may be unable to provide the necessary information.

The main types of cardiac surgery can be separated into two categories: epicardial operations, that is, operations on the surface of the myocardium, such as coronary artery bypass grafting, and intracardiac operations, such as valvular operations. Some cardiac operations can be performed off bypass ("off-pump"), while most are performed with cardiopulmonary bypass (CPB; "on-pump"). The anesthesia team should be prepared for the need to institute emergent, or "crash," bypass at any moment.

Cardiac Operating Room Setup

Anesthesia technicians usually stock supplies and help set up intravenous lines and transducers for invasive monitoring in cardiac rooms. The anesthesia provider assigned to the case is responsible for making sure that all necessary supplies are available in the operating room.

Operating Room Setup

Following the same setup routine each day in the operating room increases efficiency and creates a streamlined work environment. This routine helps reduce errors and reaction time during the perioperative phase. Many institutions use electronic medical records; thus, after arrival to the operating room, the anesthesia provider should ensure that the electronic medical recording system is in working order. Many anesthesia providers use acronyms as memory tools to help them safely and efficiently set up the operating room. Two of the most common acronyms are SOAP-TIM (suction, oxygen, airway, pharmacy, table, IVs, medications) and MS-MAIDS-T (machine, suction, monitor, airway, IVs, drugs, special equipment, and transesophageal echocardiography [TEE]). These mnemonics help ensure that all essential items for delivery and life support services are prepared and ready at a moment's notice.

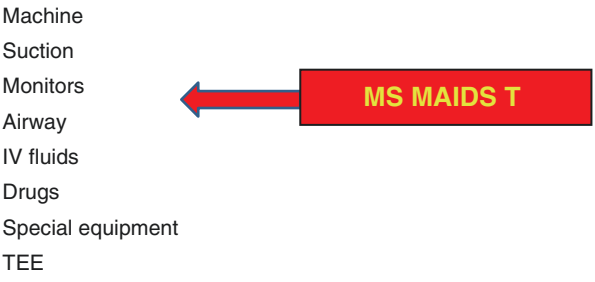

Fig. 8.1 Anesthesia machine check is a vital part of the OR setup. (**a**) *Proper monitor configuration,* (**b**) *Check of volatile agent dispensers*, *and* (**c**) *CO2 absorbent*

Machine Check

Each anesthesia machine or workstation must be checked thoroughly *daily* to ensure foolproof machine function. First, the anesthesia machine is turned off and on, and the machine check proceeds (most are automated with on-screen instructions). The anesthesia provider must make sure that the machine passes its intrinsic self-check; verify adequate pipeline and backup tank pressures; check that the vaporizers are adequately filled; confirm that the circuit is pressurized, as a check for any leaks; and make sure the CO_2 absorbent is not exhausted (Fig. 8.1).

Suction

A fully functioning suction setup is crucial for all cases. Suctioning can clear secretions to help visualization of the airway. Sutioning also functions as a rescue to evacuate the airway of debris, including vomitus and help deflate the lung in minimally invasive or robotic procedures that require single-lung ventilation. The anesthesia provider should make sure that the vacuum tubing is connected to the vacuum port on the suction canister and the Yankauer suction tip is connected through disposable connection tubing to the patient port on the canister. Next, the anesthesia provider should make sure that the on/off valve is turned on, that all unused ports of the suction canister are capped, and that the Yankauer suction tip is functional (Fig. 8.2).

Monitors

The anesthesia provider should make sure that the monitor display is appropriately configured with the elements needed for monitoring cardiac surgical patients. The screen usually is preprogrammed with options appropriate for the type of anesthesia used, for example, general, pediatric, perfusion (for the CPB portion of the case), or cardiac. The preprogrammed cardiac option should have the necessary hemodynamic parameters for cardiac surgery cases (Fig. 8.3). Also, the anesthesia provider

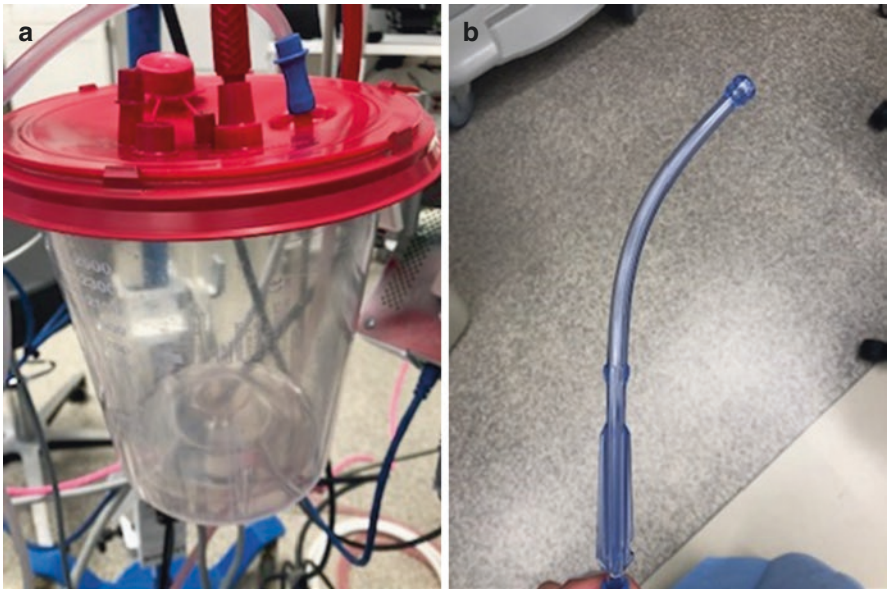

Fig. 8.2 Suction should be ready and functional; *suction canister should be sealed and have ample volume for adequate suction, b. Yankauer—used for clearing debris from patients' oropharynx*

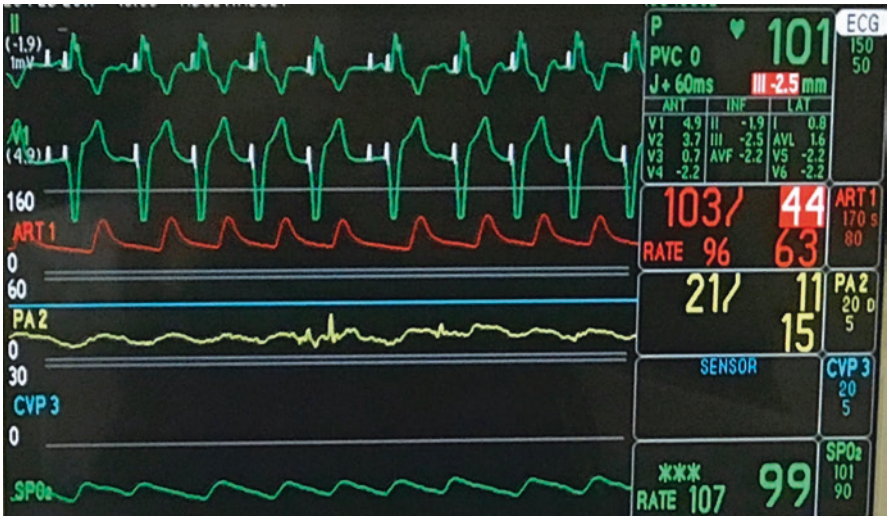

Fig. 8.3 Monitor display should be appropriately configured; *ensure waveforms for EKG, SpO2, temperature, end tidal CO2, NIBP, A-line, CVP +/− PA catheter are all present*

should make sure that the mirroring function is operational, so that other operating room screens can display the patient's vital signs. Please refer to Chaps. 4 and 9 for more information about monitoring and recognizing arrhythmias.

Cardiac cases require all standard American Society of Anesthesiologists monitors (pulse oximetry, capnography, temperature, ECG and noninvasive blood pressure monitoring) plus several additional monitors.

Additional Monitors for Cardiac Cases

- Additional ECG leads

A five-lead ECG is mandatory to increase the detection of myocardial ischemia. Additional ECG leads may be connected to the patient for a defibrillator and the TEE machine. The ECG signal may be "slaved off" from the primary ECG monitor.

- Pressure transducers

It is advisable to have a transducer manifold capable of holding three to six transducers. The transducer manifold should be attached to the operating room table so that it is maintained in a fixed position relative to the heart as the table is moved up and down (Fig. 8.4). At a minimum, an arterial line pressure transducer is required.

Fig. 8.4 Transducers on the manifold are primed and zeroed

If central venous pressure (CVP) and/or pulmonary artery (PA) pressure are monitored, two more pressure transducers are required; these can be attached to a 500 mL or 1000 mL saline bag via single or split tubing. The transducers are then attached to their respective pressure cables. It is advisable that the pressure cables be labeled for ease of identification throughout the case. The manometer tubing should be primed, and the transducers zeroed. The dial on the pressure bags can be turned off to avoid dripping of fluid until the patient is in the room and attached to the monitors.

- Invasive blood pressure (A-line)

An arterial line is used in every case. It is essential that blood pressure be monitored beat-to-beat during cardiac cases; further, with non-pulsatile flow during CPB, the arterial line is the only means of monitoring mean arterial pressure.

- Central line

The CVP/Central line is vital during open-heart surgery, as it allows for rapid resuscitation and additional monitoring. The decision of whether to place this line pre-induction or post-induction depends on each patient and the anesthesiologist. Placing the line before induction assures reliable venous access. The type of central line used may be institutionally dependent; however, commonly, a two-lumen 9 French introducer is used (Fig. 8.5). This introducer has one lumen for use as an infusion and/or CVP line and another for use as a bolus/blood-product line. Usually, it has also a central introducer hub to allow for insertion of a PA catheter if needed.

Monitoring CVP values and trends is a useful, albeit nonspecific, means of gauging preload.

For setup, the anesthesia provider needs to prepare:

(a) Central venous catheter kit
(b) Flushes

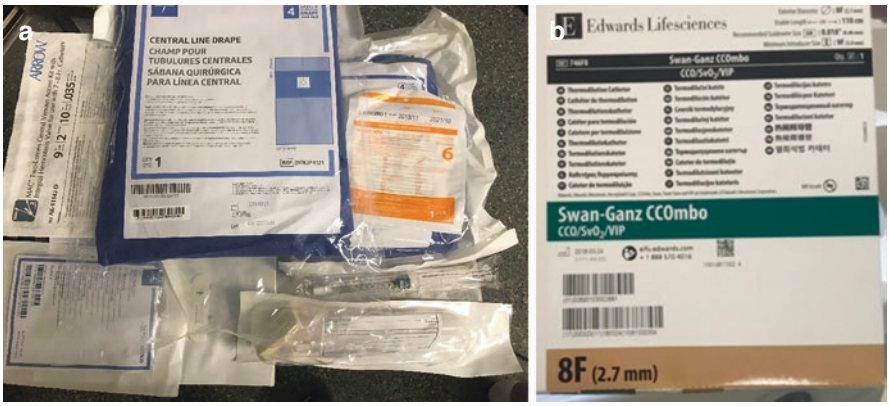

Fig. 8.5 (**a**) An example of a 9 French two-lumen central venous catheter kit. (**b**). CCO/MvO_2 Swan–Ganz/pulmonary artery catheter kit. (*CCO* continuous cardiac output, MvO_2 mixed venous oxygen saturation)

(c) Sterile gloves, gowns, towels, and whole-body drape
(d) Line dressing. An antibiotic-impregnated dressing is suggested
(e) Mayo stand or an operating room table
(f) Ultrasound machine with sterile ultrasound probe cover
(g) Swan Ganz catheter if required for the operation

Not all cardiac cases require a PA catheter; however, a PA catheter is the only way to directly and continually monitor PA pressure, and it can be a helpful tool in determining left ventricular filling. There are many types of Swan Ganz catheters: regular PA catheters, pacing PA catheters (useful in patients undergoing minimally invasive valve surgery with conduction problems), continuous cardiac output PA catheters, and mixed venous oxygen saturation catheters. Often, a combination of these catheters is incorporated into a single catheter.

- Central Nervous System monitoring
  Cardiac surgery patients are at increased risk of stroke, postoperative delirium, and postoperative cognitive dysfunction. Processed electroencephalographic monitoring, such as the bispectral index and cerebral oximetry, are monitoring modalities that help regulate the depth of anesthesia and the adequacy of blood flow to the brain, respectively. Both monitors are placed on the patient's forehead.
  – The bispectral index
    The bispectral index is used to assess the depth of anesthesia. It converts EEG data into a numerical scale (0 = electrical silence to 100 = full wakefulness), which allows for easier interpretation by anesthesia providers, especially during CPB, when the perfusionist may be the principal provider of anesthetics via the CPB circuit.
  – Cerebral oximetry
    Cerebral oximetry is a noninvasive monitor that uses infrared light and the optical properties of hemoglobin, which permit early recognition of hemoglobin desaturation in superficial cortical layers; hemoglobin desaturation may be a surrogate measure of cerebral perfusion (Fig. 8.6).
- Point-of-care glucose monitoring

For reasons described elsewhere, it is essential to track a cardiac patient's blood glucose levels (Fig. 8.7). However, with regards to preparedness, it is recommended

Fig. 8.6 An example of a cerebral oximetry monitor

Fig. 8.7 Point of care (POC) glucose monitoring

that a point-of-care glucose monitor be available in the room. These monitors have quality-control routines, which usually are run daily. Blood samples can be obtained from the central line or A-line, thus obviating the need for lancets, alcohol swabs, or 2 × 2 gauze sponges.

Airway

As with every operation, one of the primary responsibilities of the anesthesia provider in cardiac operations is managing the airway. Endotracheal tubes (ETTs) and laryngeal mask airways should be readily available. If a problematic airway is suspected, proper intubation equipment, that is, a video laryngoscope or a fiberoptic bronchoscope, should be in the room. The significance of this precaution cannot be overstated, as induction of anesthesia can lead to loss of airway patency (Fig. 8.8).

Cardiac patients have limited reserves and may be sensitive to apnea. They require adequate oxygenation (to help avoid ischemia) and may have associated respiratory disease. Therefore, backup plans for airway management, such as laryngeal mask airways and video-assisted laryngoscopy, must be available and ready to use at a moment's notice. Various airway assist devices can be deployed—for example, nasal or oral airways—to help overcome airway obstruction. It is important that these airway adjuncts be immediately available in order to minimize nonventilated time. In some instances, such as minimally invasive valve operations, coronary artery bypass graft, or robotic cardiac operations, lung isolation is required; this is best accomplished by the use of double-lumen tubes or a bronchial blocker.

In *any* case, it is essential that the room be stocked with these vital airway supplies:

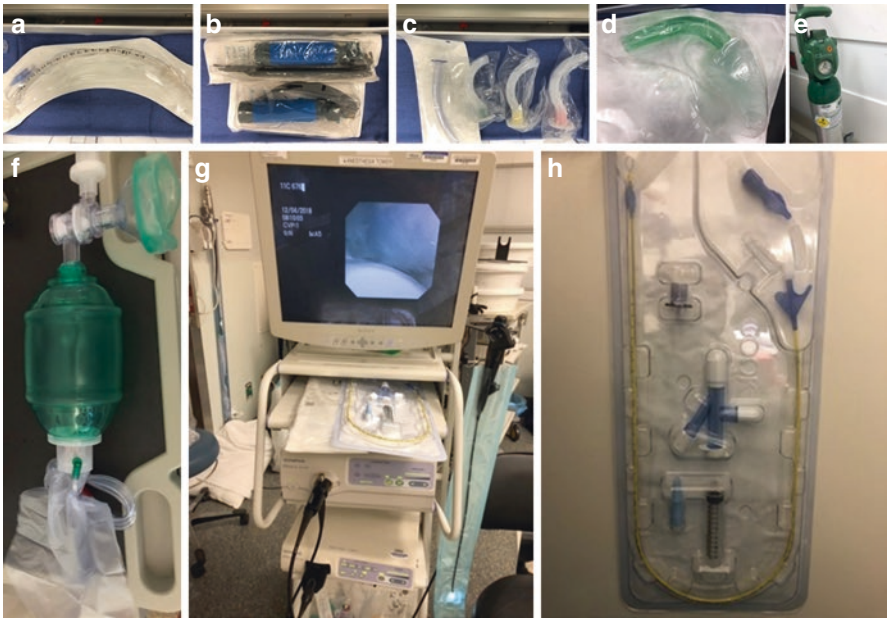

Fig. 8.8 (**a**–**h**) Airway equipment. (**a**) Endotracheal tube (ETT) with balloon cuff attached. (**b**) Laryngoscope blades. (**c**) Adjunct airway equipment—pictured is a nasopharyngeal airway on the far left, accompanied by various sizes of oral airways. (**d**) Laryngeal mask airway (LMA). (**e**) oxygen tank. (**f**) Bag mask valve (BMV). (**g**) Fiberoptic bronchoscope (FOB). (**h**) Bronchial blocker

(i) Styletted ETT (usually size 8.0 for female patients, 8.5 for male patients) with a syringe
(ii) Laryngoscope handle with functioning Macintosh No. 3 or 4 blades or Miller blades
(iii) Airway adjuncts (multiple sizes of oral airways), tongue blades, and mask strap
(iv) Silk tape to secure ETT
(v) Tape or protectors for the eyes
(vi) Orogastric tube with lubricant
(vii) Circuit mask
(viii) Ambu bag
(ix) Oxygen tank
(x) If bronchial blocker/double-lumen tube will be used, spray the endobronchial blocker and fiberoptic scope with lubricant or silicone spray. The lubricant can be applied by using gauze. It is often helpful to lubricate the tip of the double-lumen tube for easier insertion through the larynx

IV Fluids

Intravenous (IV) fluids are drugs. The anesthesia provider must be judicious in the amount of IV fluid delivered to the patient to avoid the development of a markedly positive fluid balance, which may affect ventricular preload and myocardial contractility. Two fluid lines should be prepared for central-line infusions. For volume resuscitation, a balanced crystalloid solution usually is primed in a fluid line, with a large-caliber tubing running through a warming device. Another fluid line is primed to be a fluid carrier line, with multiple stopcocks or other attachments for the delivery of medication drips. There are two main types of fluids: colloids and crystalloids. In addition to these, other volume expanders—such as packed red blood cells, which have the added benefit of built-in oxygen-carrying capacity—should be available. It is essential to recognize that the CPB circuit is a generator of extracellular volume expansion; the expansion can affect patient's fluid balance, hematocrit and the rheology of the blood, as well as the intraoperative anesthetic management—namely dilution of plasma concentrations of drugs, which may result in the need to re-dose medications. Recall that most total body water, about 65%, is intracellular, while the remainder is extracellular fluid that is distributed to the interstitial space and plasma. Of the IV fluids available, balanced crystalloid solutions that contain magnesium and potassium, such as Plasma-Lyte solution, have several benefits, including maintenance of renal function, avoidance of hyperchloremic metabolic acidosis, and perhaps reduced incidence of postoperative atrial fibrillation. Crystalloid IV fluids can generate volume expansion of 20% of the administered fluid, and colloids generate even more expansion. In the post-CPB state, both crystalloids and colloids lose their oncotic volume-expanding effects and are siphoned off into the interstitial space. As a result, CPB patients are prone to developing interstitial edema postoperatively.

The main colloid used in the anesthesia management of cardiac surgical patients is albumin (human-derived), which is available in 5% and 25% concentrations. The main crystalloids are normal saline and lactated Ringer's solution. When considering crystalloid solutions, it is essential to try to maintain physiologic tonicity. This requirement has significant implications, as normal saline is *hyper*tonic with relation to plasma; hypertonicity has been associated with renal vasoconstriction (in animal studies), as well as hyperchloremic acidosis when administered in large quantities. Lactated Ringer's solution is mildly hypotonic relative to plasma.

At present, the literature does not allow one to make a final determination as to whether crystalloid or colloid substitution should be preferred for cardiac surgery; both colloids and crystalloids are reasonable to use, with isotonic solutions being favored.

In preparing the operating room for IV fluid administration, a fluid warmer should be ready for use in most situations. This is *especially* true for redo and off-pump cases.

The goals and parameters of IVF management include maintenance of the following:

- Mixed venous oxygen saturation (SvO_2) >65%
- Mean arterial pressure (MAP) >65 mmHg
- Central venous pressure (CVP) 8–12 mmHg
- Cardiac index (CI) >2 L/min/m^2
- Pulmonary artery occlusion pressure (PAOP) 12–15 mmHg
- Diuresis >0.5 mL/kg/h

Drugs

Perhaps the most time-intensive portion of the cardiac operating room setup is the preparation of the drugs that are needed for these complicated cases. The medications include those for induction, pressors, muscle relaxants, antihypertensives, heparin, protamine, antifibrinolytics, and, potentially, inotropes. For a more detailed discussion of drug pharmacology, please refer to Chap. 3.

Standard Anesthesia Medications

Induction and rescue medications should be pre-drawn and appropriately labeled.

- Induction medications:
  - Propofol, etomidate, or midazolam can be used to induce anesthesia in cardiac surgery patients. Care should be taken to choose the agent and dose that will provide the greatest hemodynamic stability. When it is essential to maintain sympathetic drive and tachycardia is not deleterious, such as in patients with cardiac tamponade, ketamine can be used as well.
  - Opioids, typically fentanyl or sufentanil, are titrated to provide a balanced and hemodynamically stable induction.
- Analgesia:
  - Usually accomplished with fentanyl or sufentanil.
    Adequate analgesia blunts the patient's sympathetic response to pain. If left unchecked, the response may put undue stress on the cardiovascular system and precipitate myocardial ischemia.
- Muscle relaxation:
  - Non-depolarizing neuromuscular blockers, such as rocuronium, vecuronium, and cisatracurium may be used. Pancuronium had been used often in the past, when cardiac operations were longer, and because of its mild sympathomimetic properties, which counterbalance the bradycardia produced by opioids and induction agents. However, for fast track and rapid extubation after surgery, residual neuromuscular weakness after operation is undesirable, so pancuronium is used less often.
  - Succinylcholine has advantages when rapid securing of the airway is needed. In the era of sugammadex, rapid relaxation can also be achieved with rocuronium, especially if it is administered in a moderately higher dose than

its ED95 intubation dose. The choice of paralytic agent may be an institutional or individual preference if the patient does not have significant comorbidities; otherwise, the choice may be tailored based on the presence of renal or hepatobiliary disease.

Syringes for Bolus Doses

Cardiac surgical patients may decompensate at any time. Heparin and other emergency drugs should be drawn up and ready for use in the event of a "crash" on CPB (Fig. 8.9).

Table 8.1 lists common cardiac medications that should be prepared, with suggested syringe sizes and concentrations.

Drips

Most institutions have a dedicated "Heart Bag" or a cardiac tray that is prepared by the pharmacy. It includes pre-made drips, which may include regular insulin,

Fig. 8.9 Syringes with medications drawn for bolus doses; ostensibly separated by drug class, induction, maintenance, vasopressors, and vasodilators should be easily identifiable and separated to help prevent mistaken administration

Table 8.1 Common medications used in the cardiac surgery operating room

Drug	Syringe	Concentration
Propofol	20 mL	10 mg/mL
Etomidate	10 mL	2 mg/mL
Aminocaproic acid (on-pump-only cases)	60 mL × 2	10 g/mL
Heparin	30 mL	1000 units/mL
Rocuronium	10 mL	10 mg/mL
Fentanyl	20 mL	50 μg/mL
Midazolam	10 mL	1 mg/mL
Succinylcholine	5 mL	20 mg/mL
Nitroglycerin	20 mL × 2	40–50 μg/mL
Phenylephrine	20 mL × 2	100 μg/mL
Epinephrine	20 mL	4 μg/mL
Norepinephrine	20 mL × 2	4–16 μg/mL
Atropine	5 mL	0.1 mg/mL
Calcium chloride	10 mL	100 mg/mL
Glycopyrrolate	3 mL	0.2 mg/mL
Lidocaine	5 mL	20 mg/mL

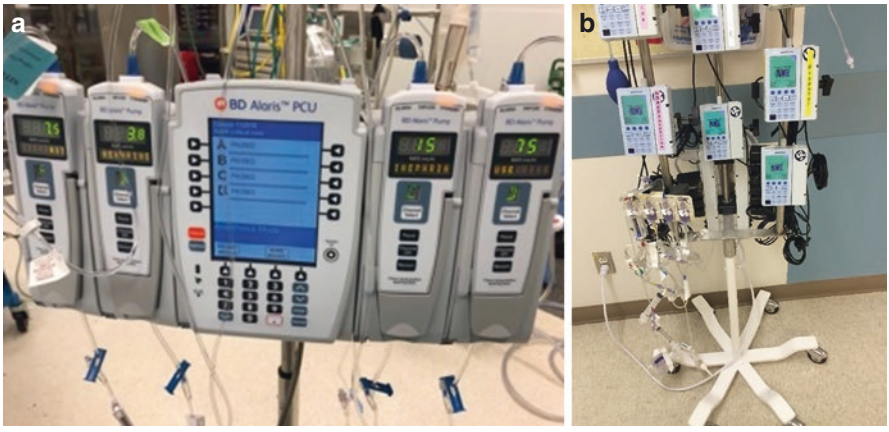

Fig. 8.10 (**a**) Alaris programmable pumps with drips primed. (**b**) Baxter programmable pumps on IV pole each labeled for cardiac drug infusion

milrinone, epinephrine, norepinephrine, phenylephrine, dopamine, and nitroglycerin. It is advisable to prime nitroglycerin and a pressor, such as norepinephrine, and have them ready for use on an infusion pump (Fig. 8.10). Concentrations of drugs used may vary among institutions. Table 8.2 list common cardiac drips.

A good practice for safe medication delivery is to label the ends of all continuous infusion lines with large readable print and color-coded stickers that correctly identify the medication.

Common Cardiac Drips

Table 8.2 Common cardiac drips*

Drug (Starting infusion rate)	Concentration	Dilution
Aminocaproic Acid Load: 5–10 g then (1.5 g/h)	20 g/250 mL	80 mg/mL
AMIODARONE Load: 150 mg over 10 min, then (1 mg/min for first 6 h)	450 mg/250 mL	1.8 mg/mL
Dexmedetomidine Load: 1 mcg/kg over 20 minutes then (0.2–0.7 mcg/kg/h)		
Diltiazem (2.5–15 mg/h)	125 mg/125 mL	1 mg/mL
Dobutamine (2.5–20 mcg/kg/min)	500 mg/250 mL	2 mg/mL
Dopamine (0.5–20 mcg/kg/min)	400 mg/250 mL	1.6 mg/mL
Epinephrine (0.01–0.05 mcg/kg/min)	2 mg/250 mL	8 mcg/mL
Esmolol Load: 150 mcg/kg over 30 seconds then (10–300 mcg/kg/min)	2000 mg/100 mL	20 mg/mL
Fenoldopam (0.1–0.16 mcg/kg/min)	10 mg/250 mL	40 mcg/mL
Milrinone Load: 50 mcg/kg then (0.5 mcg/kg/min)	20 mg/100 mL	200 mcg/mL
Isoproterenol Load: 1–4 mcg then (0.01 mcg/kg/min)	4 mg/250 mL	16 mcg/mL
Lidocaine Load: 100 mg then (1 mg/min)	2 g/250 mL	8 mg/mL
Nicardipine (2.5–15 mg/h)	40 mg/200 mL	200 mcg/mL
Nitroglycerin (1 mcg/kg/min)	100 mg/250 mL	400 mcg/mL
Nitroprusside (0.1–2 mcg/kg/min)	50 mg/250 mL	200 mcg/mL
Norepinephrine (0.1 mcg/kg/min)	4 mg/250 mL	16 mcg/mL
Phenylephrine (50–150 mcg/min)	100 mg/250 mL	400 mcg/mL
Regular insulin (4–10 U/h)	100 units/100 mL	1 unit/mL
Rocuronium Load 0.6–1.2 mg/kg then (8–12 mcg/kg/min)	1250 mg/250 mL	5 mg/mL
Vasopressin (0.02–0.04 units/min)	20 units/100 mL	0.2 unit/mL

Antibiotic Prophylaxis

Antibiotics are given prophylactically before all cardiac surgical operations to prevent surgical site infection or endocarditis. Treatment is initiated intravenously within the hour preceding surgical incision; a good time to begin infusing the

antibiotic is during surgical skin preparation. According to the Society of Thoracic Surgeons guidelines, the principal recommended prophylactic antibiotic for adult cardiac surgery is a first-generation cephalosporin, usually cefazolin. 2 g of cefazolin is a reasonable preoperative prophylactic dose for a patient weighing more than 60 kg, with a second dose of 1 g administered after 3–4 hours.

In patients who are allergic to penicillin or cephalosporins, vancomycin is recommended as the primary alternative. Vancomycin is given in a dose of 1 to 1.5 g or a weight-adjusted dose of 15 mg/kg. It is recommended that vancomycin be given intravenously over 1 hour and that the infusion is concluded within 1 hour before surgical incision. In patients at high risk for staphylococcal infection, vancomycin is added to cefazolin.

Special Equipment

- Body-warming devices: There are many varieties of body-warming devices. These can be subdivided into active or passive devices, based on whether they generate heat or are merely reflective. Active warming systems include forced-air warmers, resistive warming blankets, water-filled mattresses, and circulating water garments. An active warming system is mandatory during open-heart surgery in order to reverse hypothermia after CPB and maintain normothermia. The anesthesia provider should make sure that the controller device is plugged to a power source, and the blanket or pad is on the bed.
- Pacemaker: A functional pacer box is always required in the operating room. It should be tested for proper functioning, and fresh batteries should be available in the event of a depleted battery.
- Defibrillator: A defibrillator must be available during open-heart surgery (Fig. 8.11). Adhesive defibrillator pads can be used for defibrillation or

Fig. 8.11 Transcutaneous pacing/defibrillator device; it is essential that the functionality of the device is confirmed prior to commencing the procedure

transcutaneous pacing and should be applied to the patient in minimally invasive cases where sternotomy is to be avoided, in redo sternotomy cases, or if a malignant arrhythmia can be anticipated prior to sternotomy. This is best accomplished prior to surgical skin preparation and draping. One electrode is placed on the lateral side of the lower chest close to the cardiac apex, and the other over the right scapula.

Regardless of whether adhesive pads or traditional paddles are used, the anesthesia provider should verify that the defibrillator is in working order and all necessary supplies are available. During the sternotomy portion of a heart case, the surgeon typically uses internal paddles.

- Operating room table: The anesthesia provider should make sure that the table is plugged to a power source, and the table control is functioning well. Also, two clean arm boards should be available for use before the arms are tucked.
- Transesophageal echocardiogram (TEE): TEE is now the standard of care for cardiac surgeries. It provides superior visualization of the heart, valves, and major vessels branching from the heart. It also allows for real-time observation of cardiac function during heart surgeries without interfering with the surgical field. It is useful in the heart room as a monitoring and diagnostic tool. Part of the cardiac OR preparation is to set up the TEE machine. Please refer to Chap. 12 for further information on TEE.

  Setup TEE machine:

  (i) Plug in the electrical cord to a power source and turn the machine on.
  (ii) Connect a clean TEE probe to the machine and lock it into the receptacle.
  (iii) Type in the patient's demographics.
  (iv) Enter the name of the anesthesiologist performing the TEE exam and the name of the responsible surgeon.
  (v) Enter the planned *procedure*.
  (vi) A screenshot of the demographics dialog screen can be acquired as a still image for easy review later.
  (vii) Verify that ultrasonography gel is available.
  (viii) Verify that a TEE mouth guard/soft mouth block is available.

Patient Preparation

(a) Immediate Preoperative Assessment

After setting up the OR, the anesthesia provider will see the patient in the preoperative holding area. This may be the first time the provider who will perform the anesthetic encounters the patient face to face. By this time, the patient should be dressed in a patient gown and have undergone a chlorhexidine bath. After introductions and a brief explanation of the anesthesia provider's role, a focused preoperative assessment is carried out by a combination of record review, patient and/or family interview, physical examination, and communication with other cardiac surgery team members. Next, the anesthesia provider

should make sure that a blood product transfusion consent and an anesthesia consent have been obtained, and if not, obtain such consent(s) from the patient or his/her healthcare power of attorney. The anesthesia provider should verify that the surgical consent matches the patient's understanding of the surgery being performed. Informed consent is a crucial part of the preoperative interview and must be obtained for all patients prior to administering any sedation. The anesthesia provider begins by describing the planned anesthesia technique, including procedure descriptions in layman's terms. Then, the anesthesia provider discusses the risks in appropriate detail without any minimization, since cardiac surgery is associated with serious and frequent complications including stroke, myocardial infarction, death, acute kidney injury and transfusion of blood products. A realistic description of the risks involved is tailored to the patient; some patients require more details of potential risk than others. While it is primarily the responsibility of the surgical team to advise the patient on the type of prosthetic valve to be used (in cases involving valve surgery), it is prudent for the anesthesia provider to confirm this information with the patient and surgeon before sedation, lest there is a misunderstanding. Similarly, anesthesia providers should inform themselves about the possibility of radial artery harvesting. Should the radial artery be required as a bypass conduit (usually the left radial artery), the anesthesia provider should not access that vessel under any circumstances.

Important considerations for the cardiac surgery patients on the day of surgery:

- Change in physical condition since the most recent visit to the preoperative clinic
- Current dyspnea or chest pain
- Swallowing problems, esophageal disease, or prior upper gastrointestinal surgery, since TEE is standard of care
- Prior difficulty with anesthesia by the patient or family members
- Previous exposure to heparin or a history of heparin-induced thrombocytopenia
- Blood dyscrasias or abnormal bleeding tendencies not related to anticoagulation, antiplatelet therapies, or direct thrombin inhibitors
- For redo cardiac surgery cases: additional peripheral IV access is advisable due to the increased risk of bleeding
- Check for availability of cross-matched blood with the blood bank
- Patients on beta blockers should receive their daily beta-blocker dose with a sip of water if hemodynamically feasible
- A documented negative pregnancy test in women of child-bearing age who have not undergone surgical sterilization

(b) Transportation to the operating room

Once the above assessments have been performed, the patient can be transferred to the operating room. If the patient has an intra-aortic balloon pump or a ventricular assist device, is intubated, or is on multiple vasoactive drips, he/she may have to be evaluated in the unit where they have been admitted.

Transporting such patients to the operating room may be challenging and may require the help of additional personnel. Patients who have an in-dwelling intra-aortic balloon pump can be transported with the help of a perfusionist directly to the operating room. Critically ill cardiac patients usually cannot be separated from their cardiovascular infusions and need to be transported with those infusions running. Emergency drugs must be available during transportation.

(c) Preparing the patient for induction
An arterial and central line should be established next. This can be achieved in the holding area or in the operating room. For most cardiac surgical cases, it is a matter of patient safety to establish an arterial line prior to induction.

If the invasive lines are placed prior to induction, they should be placed with the use of local anesthetic, blood pressure recording, EKG and pulse oximetry, light sedation, supplemental oxygen, and full sterile barrier precautions in the case of central line placement. Ultrasound-guided techniques are the method of choice as they are deemed safer and faster compared to surface landmarks only. In stable and asymptomatic patients, the central line can also be placed after the induction of anesthesia.

Once the patient has been transferred to the OR, the monitors and defibrillator pads (if using) are applied, and all IV access is secured. A "time-out" pre-induction verification is performed. The patient is reidentified, surgery and surgical site are verified, patient allergies are checked, the risk of blood loss is estimated, and the availability of cross-matched blood is confirmed. Any concerns for airway or adequacy of IV access should be addressed at this point. The OR staff must verify that no essential surgical equipment is missing. Once no outstanding concerns are present, the patient is ready for anesthesia induction.

Further Reading

1. Engelman R. (2007-reaffirmed 2011) The Society of Thoracic Surgeons Practice Guideline Series: Antibiotic Prophylaxis in Cardiac Surgery, Part II: Antibiotic Choice. Ann Thorac Surg. 2007;83:1569–76.
2. Gravlee GP, Shaw AD. A Hensley's practical approach to cardiothoracic anesthesia. Philadelphia: Wolters Kluwer Health/Lippincott Williams & Wilkins; 2019.
3. Kaplan J. Kaplan's cardiac anesthesia for cardiac and none cardiac surgery. Philadelphia: Saunders; 2017.
4. Shaw A. Fluid Management in Cardiac Surgery. Colloid or Crystalloid? Anesthesiology Clin. 2013;31(2013):269–80.