# Anesthesia Toolbox

**10 Question Quiz Instructions**

- The quiz should be 10 questions long.
- 7 of your questions should cover topics/key words covered in the curriculum for your assigned week. Please look at the curriculum to see what topics, key words, required reading, etc are the focus of your week.
- 2 of your questions should cover topics from the prior week as a sort of review.
- 1 question can be of your choice and cover any important topic (might be good to select a common topic or a question that is commonly missed).
- Each question should have **4** possible answers, only one right answer.
- No "all of the above" questions, no "all of the following except" questions.
- Good questions do not just ask for the recall of simple facts. They should be more like a board style stem that presents a scenario. The learner will have to figure out what is going on and decide amongst several management options. At least half of your questions should be of this style.
- Make sure the explanation has sufficient detail. It should include a clear discuss of why the right answer is right and why the wrong answers are wrong. We want the learners to be able to use these explanations as study aids.
- The answer for each quiz question should include a reference or a resource that the learner can go to for a deeper dive on the topic. Book chapters do not work well as we cannot set up links to them. Good references are current, landmark, directly address the key point of the question, or are a recent review article of the topic.
- **Approved Reference Format**
    - **Journal:**
      Carli F, Mayo N, Klubien K, et al. Epidural analgesia enhances functional exercise capacity and health-related quality of life after colonic surgery: Results of a randomized trial. Anesthesiology 2002; 97:540-9
    - **Book:**
      Barash PG, Cullen BF, Stoelting RK: Clinical Anesthesia, 3rd edition. Philadelphia, Lippincott-Raven Publishers, 1997, pp 23-4
    - **Chapter:**
      Blitt C: Monitoring the anesthetized patient, Clinical Anesthesia, 3rd edition. Edited by Barash PG, Cullen BF, Stoelting RK. Philadelphia, Lippincott-Raven Publishers, 1997, pp 563-85
- Include as one of the references the title of the content the questions are attached to (e.g. OB Podcast 8.3 CSE vs Spinal). That way, when the quiz question is encountered in the quiz bank, the learner can click on a link to go to the content.
- The explanation should also include "**Key Learning Points**." This is a very brief recap of the most important point of the explanation.
- After the **Key Learning Points** include **Keywords** – go to open anesthesia (http://www.openanesthesia.org/aba-keywords/ and look for relevant key words to tag the question. This will help the learner filter for questions with certain key words.
- After the **Keywords** the answer to the question should also include the **ABA content code**. Use the Primary certification content outline guide. Use the "find" function to locate the area in the

outline that pertains to the main topic of the question. Then find the appropriate content outline "code" to include. For example, II.D.2.i.7 is the code for Trisomy 21 as a pediatric medical problem with anesthetic implications

Here are two examples of good questions, answers and references in the correct format for the Toolbox:

**Q1**

A 23-year-old female with a chronic large ventricular septal defect and developmental delay presents for dental restoration under general anesthesia. The patient's oxygen saturation is 98% at baseline. You induce general anesthesia uneventfully. During the case her oxygen saturation falls to 89%. Which of the following would be the BEST management plan?

A. Increase ventilation to produce moderate hypocapnia
B. Increase systemic vascular resistance
C. Decrease the inspired oxygen concentration

**Answer C**
Correct Answer: Decrease the inspired oxygen concentration

In general, the severity of the cardiovascular compromise and ventricular remodeling greatly depends on the size of the ventricular septal defect (VSD). Larger shunts result in worse short and long-term outcomes. One easy way to determine the severity of the shunt is by looking at the ratio of pulmonary blood flow to systemic blood flow – the so called Qp:Qs ratio. Small lesions have a Qp:Qs ratio of 1-1.5, and severe lesions have one that is 2:1 or greater.
Patients with a left to right shunt should have a saturation that approaches 100%. If, during the case, there is less flow going left to right or even a shunt reversal the pulse oximeter will show hypoxemia. In this case the low blood oxygenation is not due to a ventilation or oxygenation issue but is due to increased right to left shunting at the level of the heart.

The key to management is to manipulate the Qp:Qs ratio by modulating pulmonary vascular resistance (PVR) and systemic vascular resistance (SVR). In patients with a primary left to right shunt, the goal is to maintain or increase PVR by lowering the FiO2, allow for mild hypercapnia, tolerating acidosis (especially a respiratory one), and using medications that increase PVR such a phenylephrine. Positive pressure ventilation, catecholamine release, and mild hypothermia are generally tolerated well. Drops in SVR are also tolerated well as the promote right to left flow. This becomes a bit more complex if the patient has heart failure which complicates management by adding another layer of complexity.

Longstanding and large ventricular septal defects result in pressure and volume load of the right ventricle from constant left to right blood flow. Moreover, the left ventricle has to pump a larger volume as part of the ejection fraction is recirculated through the lungs via the shunt to the right ventricle. Therefore, both right and left ventricular failure is common in those patients. Also, an

opening in the ventricular septum allows air, infectious, or particular matter bypass the lungs leading to paradoxical systemic emboli.

Goldberg JF. Long-term follow-up of “simple” lesions—atrial septal defect, ventricular septal defect, and coarctation of the aorta. Congenit Heart Dis. 2015 Sep-Oct;10(5):466-74. PMID 26365715

CV Podcast 19: Adult Congenital Heart Disease

**Key Learning Point:** Unrepaired ventricular septal defects and produce left to right or right to left flow. Increased right to left flow increases shunt and worsens hypoxemia. Treatment is to increase pulmonary vascular resistance and lower systemic vascular resistance to reduce the shunt fraction.

**Keywords:** congenital heart disease, shunt

**ABA Content code:** II.D.2.g

**Q2**

A 28-year-old male with repaired tricuspid atresia presents for a laparoscopic appendectomy. The medical records state the patient had a multi-stage repair resulting in Fontan physiology. Which of the following represents the BEST perioperative management for this patient?

A. Allow for permissive hypercapnia
B. Consider performing an open appendectomy
C. Keep the central venous pressure as low as possible

**Answer B:**
Correct Answer: Consider performing an open appendectomy

Congenital heart lesions that have single ventricle physiology include tricuspid atresia, hypoplastic left heart, unbalanced AV canal, double outlet RV, and many more. They all get repaired with a Fontan procedure or something similar.
Following a Fontan repair blood from the superior and inferior vena cava directly enters the pulmonary arteries without going through the heart first. This blood then flows through the lungs and enters a form of common atrium. From there the blood flows across an AV valve into a single ventricle and is finally ejected into the aorta and the systemic circulation. In this arrangement blood flows along a pressure gradient between the CVP and common atrium, through the lungs without getting pushed along by a right sided ventricle.

Rearranging the circulation from parallel, to one where pulmonary and systemic blood flow are in series, results in the need for a pressure gradient between the venous side and the atrium to create blood flow across the lung. One of the key management points in these patients is to maintain that pressure gradient by lowering pulmonary vascular resistance (PVR). PVR, ventricular diastolic function, and systemic vascular compliance, play a major role in regulating cardiac output.

PVR can be lowered by several factors:

- High FiO2,
- Mild hyperventilation,
- Avoid acidosis
- Maintain normothermia
- Keep mean pulmonary pressures low, for example with low tidal volumes or even better spontaneous breathing
- Avoid catecholamine releases, such as with pain or anxiety
- Use medications that lower PVR such as inhaled nitric oxide - or at least use vasopressors that lack alpha adrenergic activity, such as vasopressin.

It is also important to maintain low atrial pressure by avoiding volume overload, maintaining sinus rhythm, and supporting ventricular contractility. Of course, hypovolemia is also bad, as it lowers CVP and thereby the driving force for blood flow across the lungs. Consequently, patients poorly tolerate fasting, a pneumoperitoneum, positive pressure ventilation, and sedation leading to hypercarbia. In this patient, an open appendectomy may be preferable to a laparoscopic procedure

Cheema A, Ibewke S, Nyhan D, Steppan J. When your 35-year-old patient has a sternotomy scar: anesthesia for adult patients with congenital heart disease presenting for non-cardiac surgery. Int Anesthesiol Clin. 2018 Fall;56(4):3-20. PMID 30204603

CV Podcast 19: Adult Congenital Heart Disease

**Key Learning Point:** Congenital heart disease with single ventricle physiology is often repaired with a Fontan or similar procedure. The repair results in a direct connection of the venous circulation to the pulmonary arteries. Blood flows through the lungs to a common atrium. All measures that increase pulmonary vascular resistance and pressures impede blood flow across the lungs and thereby lower cardiac preload and ultimately cardiac output.

**Keywords:** congenital heart disease

**ABA Content code:** II.D.2.g