Anesthesia Toolbox

Detailed Instructions for Revising Questions

- If the question would take too much time to fix, mark the question for deletion and do not spend any time on it. Simply state after the question number – **SUGGEST DELETE**
- Some questions are only good enough to be used as a "Check for Understanding" as part of a Toolbox piece of content (e.g. online module or lecture) and not useful to include as part of the Toolbox. Mark these questions as **DO NOT INCLUDE in QBANK**. These questions do not require as much detail in the explanation or may be a very simple question. These questions should not be too easy!
- Mark the question as HIGH YIELD if this is an especially great question to include in the quiz bank.
- Each question should have **3** possible answers, only one right answer. Reduce the answer choices if necessary. This is the new ABA format for questions.
- 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.
- Make sure the marked answer is correct.
- Edit the explanation, make sure it as sufficient detail. It should include a clear discussion 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 explanation should also include "**Key Learning Points**." This is a very brief recap of the most important point of the explanation (one to two sentences).
- 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.
- Include as one of the references the title of the Toolbox content the questions are attached to or any relevant Toolbox content (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 Toolbox content and review the concept.
- After the references 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.
- After the ABA code please 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.

Here are two examples of good questions, answers and references

1) 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 ventilator tidal volume and PEEP
B. Decrease systemic vascular resistance
C. Decrease pulmonary vascular resistance

Answer C

Correct Answer: Decrease pulmonary vascular resistance

The severity of cardiovascular compromise and ventricular remodeling greatly depends on the size and chronicity of the ventricular septal defect (VSD). Larger shunts result in worse short and long-term outcomes. One way to determine the severity of the shunt is by looking at the ratio of pulmonary blood to systemic blood flow – the Qp:Qs ratio. Small lesions have a Qp:Qs ratio of 1-1.5, and severe lesions have a ratio of 2:1 or greater.

Patients with a left to right shunt will often have an oxygen saturation that approaches 100%. During the case, if there is less flow going left to right or even a shunt reversal the pulse oximeter will show relative hypoxemia. In this case, the reduced blood oxygenation is not due to a ventilation or oxygenation issue but is due to increased right to left shunting.

The key to management of patients with shunts 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 slightly increase PVR by lowering the FiO2, allowing for mild hypercapnia, tolerating acidosis (especially a respiratory one), and using medications that increase PVR such as phenylephrine. Small drops in SVR are also tolerated well as they promote right to left flow. This becomes a bit more complex if the patient has heart failure. 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. A drop in SVR in these patients may lower coronary perfusion pressure to the right and left heart. Patients with hypertrophied ventricles may not tolerate drops in coronary perfusion pressure.

In this patient, new onset hypoxemia most likely signals a reversal in flow across the VSD to right to left. The goal is to reduce PVR to reduce the right to left shunt. Thus, management would include increasing inspired oxygen, allow for mild hypocapnia, avoid increases in tidal volume, avoid acidosis and hypothermia, and use of pulmonary vasodilators. Right to left shunt also increases the risk of paradoxical al 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 with increased right to left shunt worsens hypoxemia. Treatment is to decrease pulmonary vascular resistance and increase systemic vascular resistance to reduce the shunt fraction.

Keywords: congenital heart disease, shunt

ABA content code: II.D.2.g

Keywords: congenital heart disease, shunt

2) A 25-year-old female with a repaired Tetralogy of Fallot presents for a hysteroscopy and fibroid resection. Despite the repair of her congenital heart disease she has severe pulmonary hypertension. Which of the following represents the BEST perioperative management for this patient?
    A. Support right ventricular contractility
    B. Allow permissive hypercapnia
    C. Lowering left ventricular afterload

Answer: A
Correct answer: Support right ventricular contractility

Unrepaired Tetralogy of Fallot pathology consists of a ventricular septal defect, right ventricular outflow tract obstruction, an overriding aorta, and right ventricular hypertrophy. Repair is usually accomplished in the first year of life. Although many patients do not have any problems post-repair, post-repair residual problems can include residual right ventricular outflow obstruction, pulmonary valve insufficiency, pulmonary hypertension, and right ventricular failure. These patients are at risk for conduction abnormalities (the original ventricular septal defect and repair is in close to the conduction system) and ventricular arrhythmias.

This patient has severe pulmonary hypertension which could have been caused by a later repair. She very likely has right ventricular hypertrophy and right ventricular failure. This patient requires careful preoperative work up to evaluate her cardiac status.

Hemodynamic goals for patients with pulmonary hypertension are to support right ventricular function and to lower pulmonary artery pressures. It is important to avoid large decreases in systemic vascular resistance (SVR). Decreased SVR lowers pressure in the aortic root and the coronary perfusion pressure of the left AND right ventricle. The remodeled right ventricle is hypertrophied and stiff due to longstanding pulmonary hypertension and thus requires a higher coronary perfusion pressure.

The management of pulmonary hypertension is often fairly straight forward. The two key factors are to lower pulmonary vascular resistance (PVR) and to support right ventricular function.

Lower PVR by:

- High FiO2

- Mild hyperventilation
- Avoid acidosis
- Maintain normothermia
- Keep mean pulmonary pressures low (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

The right heart can by supported by:

- Maintaining preload (euvolemia)
- Supporting contractility
- Maintaining coronary perfusion pressure
- Lowering systemic vascular resistance (avoid if significant RVH)
- Maintaining a normal sinus rhythm.

Ministeri M, Alonso-Gonzalez R, Swan L, Dimopoulos K. Common long-term complications of adult congenital heart disease: avoid falling in a H.E.A.P. Expert Rev Cardiovasc Ther. 2016;14(4):445-62. PMID 26678842

Steppan J, Diaz-Rodriguez N, Barodka VM, et al. Focused review of perioperative care of patients with pulmonary hypertension and proposal of a perioperative pathway. Cureus. 2018 Jan 15;10(1):e2072. PMID 29552434

CV Podcast 19: Adult Congenital Heart Disease

Peds Lecture 6.1: Congenital Heart Disease

Key Learning Points: Adults with repaired congenital heart disease can present with significant residual problems. Pulmonary hypertension, right ventricular hypertrophy, and right ventricular failure are common problems in patients with adult congenital heart disease. Hypotension can decrease coronary perfusion of the right ventricle and worsen or precipitate right heart failure.

Keywords: congenital heart disease, Tetralogy of Fallot Rx

ABA content code: II.D.2.g