CPB FMEA # 32 Inadequate venous return caused by abnormal anatomy

Friends-

The FMEA this week is again suggested by material supplied to me by Eric Jenkins, CCT, CCP, FPP and Kevin Griffith, CCP from Ann Arbor. Much of this material comes directly from their PowerPoint presentation "CPB Disaster Management or When Things Go Wrong, Don’t Scream!"

Previously we discussed the problem of venous return from the usual causes in CPB FMEA # 8 Perflist posting. However, this new FMEA addresses the much rarer cause of poor venous return; anatomical abnormality. In extreme cases there can literally be a labyrinth of vessels and shunts channeling venous return blood back to the chambers of the heart. Poor venous return from abnormal anatomy is not a failure of the perfusionist. However its presence should be anticipated and understood by the perfusionist and others as much as the situation will allow so that a team effort can be initiated to deal with the problem. The risk to the patient comes from inadequate perfusion due to this abnormality and the reluctance of the surgeon to adequately address the issue.

As a pediatric perfusionist, I commonly dealt with abnormal venous anatomy and its effect on venous return. But an adult perfusionist and surgeon working primarily with acquired disease patients may not be aware that the venous drainage problem may need better intervention than just cannula adjustment by the surgeon. An incomplete cardiac catheterization may miss a key venous anatomical problem. Inversely an experienced ECHO cartographer in the OR may be of tremendous benefit. Otherwise, the only clue to the problem might be a perfusionist who has had some previous experience with this kind of abnormal anatomy during CPB.

There is no RPN for perfusionists with varying experience. Perhaps there should be. For example a perfusionist with 20+ years of experience could have an Experience RPN = 1, while a perfusionist with less than 1 year experience might have an Experience RPN = 5. (Experience RPNs could also rate surgeons and anesthesiologists.) But that is not really practical. The closest I can come to an Experience RPN is the Detectability RPN. I gave it a Detectability RPN of only 1 if there is a thorough examination before CPB. If not, the only way to determine the problem may be by an experienced perfusionist or some other team member who has dealt with this problem previously.

I selected a Patient Frequency RPN of only 1 because of the rarity of these conditions. But potentially any patient might have this problem. So some might think it deserves a score of 3. That is open to discussion by individual programs.

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FAILURE MODE AND EFFECTS ANALYSIS: CPB FMEA # 32 Inadequate venous return caused by abnormal anatomy

FAILURE: Inadequate venous drainage caused by anatomical abnormality

EFFECT:

1. Inability to establish CPB at normal blood flow.

2. Hypotension

CAUSE:

1. Undiagnosed left SVC

2. Undiagnosed anomalous systemic venous return

3. Undiagnosed interrupted IVC with azygos extension

4. Undiagnosed hepatic veins entering right atrium and/or left atrium directly

5. Undiagnosed arterial to venous (AV) shunt

a. Undiagnosed PDA

b. Uncontrolled systemic to pulmonary shunts

c. Arterial cannula flipped into left ventricle

6. Persistent left superior vena cava (PLSVC) draining into coronary sinus with absence of an innominate vein.   
7. PLSVC draining into the left atrium with the presence of an innominate vein and hypoplastic right SVC.

8. Left atrial isomerism with interrupted IVC and azygos continuation.   
9. Left atrial isomerism with abdominal situs inversus

a. PLSVC draining into a left-sided morphologically RA.

b. IVC located on the left side of the spine with hepatic veins & the right atrium located on the left side.

PRE-EMPTIVE MANAGEMENT:

1. \*Perform thorough anatomical examination by ECHO and/or cardiac catheterization prior to CPB. If the examination is abbreviated, the Detectability RPN would be higher.

2. If the abnormality is severe, consider using neck or femoral venous cannulation if SVC or IVC are intact.

3. If using hard shell venous reservoir, maintain vacuum assisted venous drainage capability to augment venous return.

MANAGEMENT:

1. If caval cannulation will not function adequately, establish CPB by atrial cannulation.

2. Add additional cannulae as anatomy and conditions warrant.

RISK PRIORITY NUMBER (RPN):

A. Severity (Harmfulness) Rating Scale: how detrimental can the failure be:

1) Slight, 2) Low, 3) Moderate, 4) High, 5) Critical

(I would give this failure a Low RPN, 2.)

B. Occurrence Rating Scale: how frequently does the failure occur:

1) Remote, 2) Low, 3) Moderate, 4) Frequent, 5) Very High

(The Occurrence is Low, so the RPN would be a 2 .)

C. Detection Rating Scale: how easily the potential failure can be detected before it occurs:

1) Very High, 2) High, 3) Moderate, 4) Low, 5) Uncertain. (The Detectability RPN equals 1\*. If the examination by catheterization or ECHO is abbreviated, the Detectability RPN would be higher, 3.)

D. Patient Frequency Scale: 1) Only a small number of patients would be susceptible to this failure, 2) Many patients but not all would be susceptible to this failure, 3) All patients would be susceptible to this failure.

(Only a few patients would have abnormal anatomy. So the Frequency RPN would be 1.)

Multiply A\*B\*C\*D = RPN. The higher the RPN the more dangerous the Failure Mode.

The lowest risk would be 1\*1\*1\*1\* = 1. The highest risk would be 5\*5\*5\*3 = 375. RPNs allow the perfusionist to prioritize the risk. Resources should be used to reduce the RPNs of higher risk failures first, if possible. (The total RPN for this failure is = 2\*2\*1\*1 = 4. If the examination by catheterization or ECHO is abbreviated, the Detectability RPN would be higher, 3, making the total RPN 2\*2\*3\*1 = 12.)