CPB FMEA # 26 Antiphospholipid syndrome

Friends-

This particular FMEA was inspired by a posting by Gerard Meyers, a Canadian perfusionist who is currently retired. I think that control of anticoagulation/coagulation has the largest variation in accepted practice of all the things we do as perfusionists. Accepted practice ranges from giving 300 u/kg heparin, achieving an ACT of 480+ seconds, giving 3 mg/kg of protamine after bypass and then hoping for the best to performing extensive blood testing with a variety of testing equipment and performing specific responses to the result of the testing. For most of my career I confess that I was in the former group. However in the last 5-10 years of my career my hospital adopted much more sophisticated methods for controlling anticoagulation/coagulation. Fortunately I was not responsible for the new equipment. I had my hands full with the regulatory requirements for blood gas and electrolyte point of care testing. Interestingly, the new tests were not adopted at the heart team’s request for better testing. Rather it was at the request of the ECMO team (of which I was also a member) where bleeding and clotting were a much greater challenge than in CPB. Bleeding in some ECMO patients was so bad that on more than one occasion I affixed the ECMO patient’s chest tube drainage system to a cell saver so I could process the RBCs and return them quickly and continuously just to help the nurses keep up with blood replacement.

Anticoagulation/coagulation problems are difficult enough in a patient with normal blood. But add to that one of the many abnormalities such as antiphospholipid syndrome (APS) as described in this FMEA and the task can be daunting for a perfusionist. I can honestly say that I have never had a patient who, to the best of my knowledge, was diagnosed with APS. However I have had many, many patients with bleeding and coagulation problems that caused life threatening complications. Perhaps some of them might have had APS. Some problems are too frightening to even think about and so complex that I did not even attempt to include them in this FMEA. For example what if the APS patient has a heparin sensitivity and needs to use a non-heparin anticoagulant?

I don’t know if this FMEA offers any solution to APS patients, but it couldn’t hurt to make the heart and ECMO teams aware that this problem exists. Like malignant hyperthermia, this condition is rare and a perfusionist may have only one chance to deal with it during his/her entire career and, hopefully, save the patient. Maybe one of you has already dealt with APS and has a magic bullet for this problem that I don't know about. Please share it with us if you do.

AmSECT Safety Committee

Gary Grist RN CCP, contributor.

<garygrist@comcast.net>

FAILURE MODE AND EFFECTS ANALYSIS: CPB FMEA # 26 Antiphospholipid syndrome

FAILURE: Failure to recognize antiphospholipid antibodies (APA) that can lead to antiphospholipid syndrome (APS), an autoimmune disease which causes varying degrees of clotting to occur in the perioperative period of cardiopulmonary bypass (CPB).

EFFECT:

1. APS is defined by blood vessel thrombosis occurring in the presence of APA.

2. Induction of a transient hypercoagulability state despite ongoing anticoagulant therapy.

3. Catastrophic exacerbation of APS.

4. Bleeding complications in the perioperative period due to excessive anticoagulation and/or thrombocytopenia.

5. Greater than normal morbidity due to clotting or bleeding in the post-CPB period.

4. Cardiac problems associated with APS include

a. heart valve disease, valvular thickening, dysfunction and vegetation The mitral valve is the most often involved.

b. coronary thrombosis

c. ventricular hypertrophy or dysfunction

d. intracardiac thrombi

e. pulmonary hypertension.

5. Estimates of APS morbidity and mortality associated with cardiopulmonary bypass vary, but have been reported as high as 84% morbidity (postoperative thrombosis or bleeding) and 63% mortality.

6. Individual case reports of cardiac surgical patients often describe thrombotic or bleeding complications including early graft occlusion, hemothorax, pulmonary emboli, and limb ischemia.

7. Death due to complications of clotting or bleeding.

CAUSE:

1. Surgery increases the risk of thrombosis from APS that can precipitate varying degrees of clotting due to withdrawal of oral anticoagulants.

2. An autoimmune disease, APS can occur as an isolated condition or can be associated with connective tissue diseases, such as systemic lupus erythematosus (SLE).

3. APS is thought to occur in 1-5% of asymptomatic patients.

7. Minor alterations in anticoagulant therapy, infection, or a surgical insult may trigger widespread thrombosis.

8. Deep hypothermic circulatory arrest during cardiac surgery increases the risk due to the combination of blood stasis and changed enzymatic activity associated with the temperature changes.

9. The outer surface of the red cell membrane is composed of electrically neutral phosphorylcholine. APA reacts to the negatively charged phosphatidylserine phospholipids (PPs) located on the inside of the red cell membrane. PPs are exposed when the red cell hemolyzes. APA patients have varying degrees of clot because of the varying degrees of natural hemolysis in the body or hemolysis while on CPB or ECMO.

PRE-EMPTIVE MANAGEMENT:

1. Antiphospholipid antibodies are detected by functional coagulation assay: the lupus anticoagulant (LAC) and/or by solid phase assays: anti-cardiolipin (aCL), or anti-β2 glycoprotein I (anti-β2GPI) antibody tests. \*In the absence of obvious autoimmune disease these tests may not be performed making APS difficult to detect before thrombosis occurs with a Detectability RPN of 5 resulting in a total RPN of 50.
2. There is no consensus regarding the optimal perioperative management of anticoagulation in APS. However keeping to an absolute minimum the time periods without anticoagulation is recommended.
3. Patients with APS are at increased risk for thrombosis and adequate anticoagulation is of vital importance during CPB.
4. A successful outcome requires multidisciplinary management in order to prevent thrombotic or bleeding complications and to manage perioperative anticoagulation.

MANAGEMENT:

1. APS often interferes with in vitro tests of hemostasis by impeding the binding of coagulation proteins to phospholipid surfaces, especially during CPB when blood contacts the extracorporeal surfaces and the coagulation cascade is stimulated.

2. To prevent clotting, unfractionated heparin is administered before CPB. Heparin concentrations of greater than/equal to 3 u/ml ± 1 are generally accepted as therapeutic for CPB , but individual patient responses to a standardized heparin dose vary.

3. Heparin activity is assessed using the activated clotting time (ACT) which is a phospholipid dependent test. The ACT may be prolonged by the APA. In the normal patient, a heparin level of 3 u/ml ± 1 of blood typically produces a kaolin ACT of more than 450 seconds. Low molecular weight heparin is attractive in this setting as it causes a highly predictable anticoagulant effect for a given dose, decreasing the need for monitoring.

4. Suggested alternative methods for monitoring anticoagulation during CPB in APS patients include empirically doubling the baseline ACT or to reach an ACT twice the upper limit of normal, obtaining heparin concentrations by protamine titration, performing anti-factor Xa assays, or performing heparin/ACT titration curves preoperatively to determine patient specific target ACT levels.

5. Minimizing actions that contribute to hemolysis may reduce the effects of APS in the post-CPB period.

6. Patients need to remain anticoagulated post-CPB because the higher levels of hemolysis caused by CPB can stimulate clotting.

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 Critical RPN,5. This is a rare condition. But if undiagnosed it may result in life-threatening thrombosis or hemorrhage which may not be controlled by any of the usual methods.)

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

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

(The Occurrence is remote, so the RPN would be a 1.)

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 proper screening tests are performed. However in the absence of obvious autoimmune disease these tests may not be performed making APS difficult to detect before thrombosis occurs; causing the Detectability RPN to increase to 5.)

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.

(Some unknown number of patients would be at risk, but not all patients. So the Frequency RPN would be 2.)

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 5\*1\*1\*2 = 10 with proper screening. However if the condition is overlooked, the total RPN would be 5\*1\*5\*2 = 50.)