Cardiac Surgery Patient Blood Management (PBM) Turnkey Order Set

Preoperative

- **For non-emergent cases in the absence of platelet function studies, discontinue ticagrelor 3d, clopidogrel 5d, prasugrel 7d before surgery**
- *For elective cases without coronary artery disease, discontinue aspirin for 7 days preoperatively*

- *Clinical communication: minimize phlebotomy*
- *Hemoglobin*
- *Platelet Count*
- *PT/INR*
- *PTT*
- *Send platelet aggregation studies for patients receiving DAPT*

- *For patients requiring DAPT bridging: Cangrelor 30 mcg/kg IV bolus followed by 4 mcg/kg/min IV infusion discontinue 1 hour before OR*

- *For non-emergent patients, DOACS discontinue apixaban 3d, rivaroxban 5d, dabigatran 5d before surgery*
- *For emergent patients on direct oral anticoagulant-choose appropriate antidote:*
  - *Andexanet alfa (for apixaban, rivaroxaban)*
    - *400mg IV bolus, then 4mg/minute IV x 2 hours (≥ 8 hours since last DOAC)*
      OR
    - *800mg IV bolus, then 8mg/minute IV x 2 hours (< 8 hours since last DOAC)*
  - *Idarucizumab 5g IV x 1 (for dabigatran)*
  - *Kcentra/Beriplex 0.12ml/kg/min IV – titrate to goal INR (or alternative prothrombin complex concentrate)*
- *For non-emergent patients on warfarin, discontinue 5 days prior to surgery*
- *For patients on warfarin who cannot wait 5 days, administer FFP according to parameters below*

- *If atrial fibrillation AND high risk for thromboembolic event bridge with IV heparin – weight-based titrate to therapeutic range (see heparin order sheet)*

- **Preoperative Anemia** - *Hgb <12:*
  - Labs:
    - *Total Iron Binding Capacity (TIBC) Panel*
    - *Ferritin*
    - *Fecal Occult Blood Screening*
  - Medications
    - **Ferric gluconate 250mg IV once daily for up to 7 days (see Appendix A for alternate Fe formulations)**
    - **Erythropoetin alfa-epo 40,000 IU IV x 1**
    - *Folic acid tablet 5mg po once daily until surgery (up to 4 weeks)*
    - *Vitamin B-12 1000mcg po once daily until surgery (up to 4 weeks)*

Intraoperative

- **Administer tranexamic acid: Bolus 10mg/kg IV x 1, then continuous IV drip based on serum creatinine:**
  - **<1.6 = 2 mg/kg/hr**
  - **1.6-3.2 = 1.5 mg/kg/hr**
  - **3.3-6.6= 1 mg/kg/hr**

- *Clinical Communication: Limit pre CPB IV fluid to 250ml*

- **Clinical Communication: Utilize Cell salvage**
- *Clinical Communication: Arterial and venous autologous prime*
- *Clinical Communication: Centrifuge pump-salvaged blood*
- **Clinical Communication: Utilize point of care visco-elastic testing (VET) to diagnose and then treat coagulopathy according to a standard transfusion algorithm**
- **Clinical Communication: Hemoglobin threshold to consider PRBC transfusion** *(6.0 g/dl)*
- *For heparin resistance, administer Antithrombin III 500 U IV, repeat x1 PRN to reach desired ACT*

Postoperative

- **Utilize a standard transfusion algorithm**
- **Notify provider if Hgb** *< 7.5 g/dl (consider transfusion in non-bleeding patients only for signs of end-organ malperfusion, such as elevated lactate, significant base deficit)*
- *Notify provider for chest tube drainage of 200ml/hr for more than 1 hour*
- If actively bleeding:
  - **Perform point of care VET and transfuse according to standard algorithm**

  -OR-
  - *PT/INR, PTT*
  - *Fibrinogen*
  - *Platelet count*
  - *Platelet aggregation study*
  - *Hemoglobin*

  Treatment:
  - *For INR >1.7, transfuse 2U FFP*
  - *For fibrinogen <150 mg/dL. transfuse 10U cryoprecipitate or administer Fibryga 4g IV over 10 minutes (or alternative fibrinogen concentrate)*
  - *For functional platelets <50 10^3/ul, transfuse 2U platelets*
  - *PRBC transfusion as needed*
  - *Kcentra/Beriplex 0.12ml/kg/min IV titrate if on DOAC preoperatively and PTT elevated (or alternative prothrombin complex concentrate)*
  - *DDAVP 0.3mcg/kg IV x1 for patients with post CPB platelet dysfunction, uremia, or Von Willebrand's Disease, repeat x1 PRN*
- *Hgb < 8 g/dl*
  - *Ferric gluconate 250mg IV once daily for 3 days*
  - *Ferrous Sulfate 324mg po daily x 30 days*

Legend: Orders in Bold are Class I or IIA or equivalent. *Orders in italics were inconsistently Class I or IIA, Class IIB, or supported by evidence published in peer-reviewed journals.*

Abbreviations-DAPT-dual antiplatelet Therapy, DOAC-direct-acting oral anticoagulants, Hgb-hemoglobin, IV-intravenous, CPB-cardiopulmonary bypass, ACT-activated clotting time, PT-prothrombin time, PTT-partial thromboplastin time, FFP-fresh frozen plasma, PRBC-packed red blood cells, DDAVP- deamino-8-D-arginine vasopressin

Notable omissions: Acute normovolemic hemodilution, modified ultrafiltration, and miniaturized CPB circuit have all been employed with blood sparing effect and have evidence to support their use. However, this suggested order set is not meant to be a comprehensive guideline for every possible blood sparing technique. This order set is meant to allow programs to perform the most essential techniques to achieve significant blood conservation and high quality patient blood management. This does not exclude layering additional techniques if local expertise and evidence is supportive. In addition, we feel that optimal retrograde and antegrade autologous priming may obviate the need for modified ultrafiltration or mini-CPB circuits, and is simpler.

Table 1: Comparison of I/IIa or Equivalent Recommendations for Cardiac Surgery Patient Blood Management Guideline and Consensus Publications				
Recommendation	STS/SCA/AmSECT/SABM Guidelines	EACTS/EACT Guidelines	ASA Guidelines	POQI-8/ERAS-C Consensus Statement
Preoperative				
Multidisciplinary patient blood management (PBM) program	✔	✔	✔	
Standard transfusion protocol	✔		✔	
Preoperative anemia screening/identification	✔			✔
For Hb <12 g/dL administer erythropoietin for patients who have preoperative anemia (i), refuse blood transfusion (ii), or are deemed high-risk for postoperative anemia	✔	✔ (non Fe-deficient)	✔	✔ (select)
Iron therapy for iron deficiency anemia	✔			✔
Discontinue low intensity antiplatelet medications (e.g. ASA) 1 week prior to surgery in elective patients without coronary artery disease	✔	✔	✔	
In the absence of PLAGS, stop ticagrelor 3 days, clopidogrel 5 days, prasugrel 7 days prior to surgery	✔	✔	✔	
For non-emergent patients, DOACS should be discontinued 3-5 days prior to surgery	✔		✔	

For urgent cases, utilize platelet aggregation studies to determine timing of surgery for patients on DAPT	✔			
For emergent surgery in patients on novel anticoagulant, administer specific antidote or, if unavailable, prothrombin complex concentrate	✔	✔		
If on oral anticoagulation and high-risk for thromboembolic event, bridge patient with unfractionated heparin		✔	✔	
Intraoperative				
Cell salvage	✔	✔	✔	
Antithrombin III for heparin resistance	✔	✔		
Administer 1-deamino-8-D-arginine vasopressin (DDAVP) for patients with serious bleeding and platelet dysfunction post CPB, are uremic, or have Von Willebrand Disease		✔	✔	
Limitation of hemodilution	✔	✔		
Administer tranexamic acid	✔	✔	✔	
Retrograde/antegrade autologous prime	✔	✔		
Point of care testing to diagnose and treat coagulopathy	✔	✔	✔	
Acute normovolemic hemodilution	✔		✔	

Postoperative				
Multidisciplinary patient blood management (PBM) program	✔	✔	✔	
Standard transfusion protocol	✔		✔	

Legend: check mark = Class I, IIa, or equivalent level of recommendation