

## Guidelines for Using Bivalirudin During Cardiopulmonary Bypass Surgery

During cardiopulmonary bypass procedures, systemic anticoagulation to prevent thrombosis in the patient as well as the circuit is utilized. Heparin is the most common agent used, but in selective circumstances, alternate form of anticoagulation may be considered.

In patients with heparin induced thrombocytopenia (HIT), heparin resistance, or significant thrombosis while on therapeutic heparin, alternative anticoagulation management using a direct thrombin inhibitor (DTI) may be desired.

Patients with organ failure will have elimination rates substantially longer than observed in healthier individuals. Bivalirudin has the shortest elimination half-life among all DTI's with lower dependence on renal or liver function for removal (~80% enzymatic) which is a benefit in patients who have a high risk of bleeding, organ failure, or who may require an invasive procedure. Bivalirudin can also be removed by hemofiltration.

Of note, bivalirudin is primarily metabolized by thrombin and blood proteases, which results in loss of effect and potential coagulation when blood is stagnant, such as at the cardiopulmonary bypass (CPB) circuit filter, in the surgical field, or at the cannulas tips when off CPB. Thus, gelling of pooled blood in the surgical may occur with bivalirudin and may not reflect insufficient levels of anticoagulation.

The dosing presented below is a guide to aid in the initiation of bivalirudin infusion during CPB surgery; however alterations may occur based on the clinical presentation of the patient (e.g. patient's renal function, bleeding and clotting risks, ability to transfuse). The Anticoagulation Service can be contacted for assistance with dosing in CPB.

For ON PUMP Procedures

**Bivalirudin initial dosing guide:** (*Note this is not the package insert dose*)

- Draw baseline ACT (High Range) prior to bivalirudin administration
- Establish ACT goal range (usually 2.5 times baseline)
- **Initial dose:** 1mg/kg bolus followed by infusion at 2.5 mg/kg/hr
- **CPB Priming:** 50mg
- Consider lower doses in renal, liver, and /or significant heart dysfunction

Note: The cell saver or other parts of the circuit where blood is collected but not directly circulating should have sodium citrate added.

For OFF PUMP Procedures

- **Initial dose:** 0.75mg/kg bolus followed by infusion at 1.75 mg/kg/hr

### Dose adjustments

- **Subtherapeutic ACT level:** Adjust infusion rate by 0.25 to 0.5 mg/kg/hr to keep ACT at goal
  - May bolus 0.1 to 0.5 mg/kg during CPB to keep ACT at goal at discretion of surgeon
- **Supratherapeutic ACT level:** Consider lowering the bivalirudin infusion rate. If more emergent removal of anticoagulation effects is desired, start ultrafiltration to enhance bivalirudin removal

### Methods to avoid complications

- Use closed systems whenever possible to minimize stasis in the CPB circuit
- Use saline flush in the veins instead of blood to avoid stasis
- Run low blood levels in the venous reservoir to avoid stasis
- Give cardioplegia every 15 minutes to maintain CPB line patency
- Flush blood-filled and clamped CPB lines every 15 minutes to maintain CPB line patency

- Minimize hypothermia when possible to prevent suppressed enzymatic metabolism of bivalirudin during cooling

#### **Transitioning off CPB**

- Stop bivalirudin infusion at least 15 minutes and up to 60 minutes before planned end of CPB
- Consider ultrafiltration 30 to 60 minutes prior to going off CPB to remove bivalirudin
- Once off CPB, move the arterial cannula to the right atrium to minimize the risk of stroke
- Continue ultrafiltration with ACT monitoring
- Low dose recombinant activated factor VII (rVIIa) may be a potential rescue option (see rVIIa in Adult Cardiothoracic Surgery Guideline)

#### **References**

1. Dyke CM, Smedira NG, Koster A et al. A comparison of bivalirudin to heparin with protamine reversal in patients undergoing cardiac surgery with cardiopulmonary bypass: The EVOLUTION-ON study. *J Thorac Cardiovasc Surg* (2006);131:533-9
2. Koster A, Dyke CM, Aldea G et al. Bivalirudin during cardiopulmonary bypass in patients with previous or acute heparin-induced thrombocytopenia and heparin antibodies: results of the CHOOSE-ON trial. *Ann Thorac Surg* (2007);83:572-7
3. Veale JC, McCarthy HM, Palmer G, and Dyke CM. Use of bivalirudin as an anticoagulant during cardiopulmonary bypass. *J Extra Corpor Technol* 2005;27:296-302

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