Practical Management of Anticoagulation for Impella Percutaneous Mechanical Circulatory Support

**Background**
- There are many percutaneous ventricular assist devices (e.g., Intra-aortic balloon pump, Impella, TandemHeart).
- Impella devices are most widely used and are the focus of this resource.
- Indications: for hemodynamic support during high-risk PCI and/or ongoing cardiogenic shock.
- Mechanism: catheter-based transvalvular microaxial pump that aspirates blood from left ventricle into the aorta.
- Heparin-based purge solution is essential to create a positive purge pressure, lubricate bearings, and prevent ingress of blood into the motor.
- IV UFH can be supplemented to maintain adequate systemic anticoagulation needed to prevent thrombus formation.

**Best practices for Impella anticoagulation**
- Use only programmable pumps with pump library.
- Ensure use of institutional Impella-specific anticoagulation protocol.
- Use standardized, evidence-based reversal and peri-procedural protocols when needed in Impella patients.
- Use premixed commercial heparin infusion bags whenever possible to avoid errors.
- Utilize multidisciplinary approach to Impella management.
- Require tracking and reporting of adverse events associated with Impella.
- Review and update local Impella protocols at least annually to ensure contemporary, optimized care.

**BOTTOM LINE**

<table>
<thead>
<tr>
<th>DO</th>
<th>DON’T</th>
<th>CONSIDER</th>
<th>CAUTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Use UFH 25 U/mL in D5W as default purge</td>
<td>• Use saline in purge solution</td>
<td>• Bicarbonate-based purge (25mEq per 1000mL) when UFH not feasible due to bleeding, active HIT or consistently supratherapeutic UFH levels</td>
<td>• D5W alone in the purge if bicarbonate not available</td>
</tr>
<tr>
<td>• Supplement IV UFH as needed</td>
<td>• Use other anticoagulants (DTI, LMWH, fondaparinux) in purge</td>
<td>• Device controller automatically adjusts purge flow rate to target purge pressure</td>
<td>• High dextrose concentrations</td>
</tr>
<tr>
<td>• Account for both sources of heparin</td>
<td>• Use fondaparinux or DOAC for HIT in Impella patients</td>
<td>• Fibinolytic administration via the purge</td>
<td>• Fibrinolytic administration via the purge</td>
</tr>
<tr>
<td>• Have a protocol for anticoagulation with Impella</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Outlet Area**

- Device controller automatically adjusts purge flow rate to target purge pressure 300-1100 mmHg. Flow rate ranges from 2-30 mL/hour.
- Heparin is the default purge solution due to unique ionic charge that prevents deposition of denatured proteins and thrombi in the purge gaps.
- The default concentration is 25 units/mL. Lower concentrations may not adequately protect the motor and higher ones may lead to over-anticoagulation.
- For patients requiring biventricular support with Impella RP and 2.5, CP or 5.0, the same purge solution should be utilized for both devices.

**Purge Solution**

- UFH 25 units/mL in 500-1000 mL D5W
- BBPS
  - HIT (with systemic DTI)
  - Bleeding (in absence of systemic IV UFH)
- DSW Only
  - Only if BBPS not available

**Systemic IV UFH**

- Depending on the purge flow rate, the patient may need additional IV heparin for adequate levels of anticoagulation (see table 1).
- If IV UFH is added to existing heparin-based purge, both sources of heparin must be accounted for as both will contribute to systemic AC.
- If concomitant ECMO is indicated (Ecpella), UFH cannulation bolus should be reduced to account for UFH in purge solution.

**TABLE 1 – Monitoring of UFH**

<table>
<thead>
<tr>
<th>ASSAY</th>
<th>FREQUENCY</th>
<th>TARGET RANGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACT</td>
<td>Baseline, then q4h after each assessment or dose change until at target x 2, then q 6h</td>
<td>161-180 sec</td>
</tr>
<tr>
<td>aPTT (Lab Specific)</td>
<td>Baseline then q6h after each assessment or dose change until at target x 2 then qAM</td>
<td>Aim for low intensity equivalent to anti-Xa of 0.2-0.4 (e.g., 40-60 seconds)</td>
</tr>
<tr>
<td>Anti-FXa</td>
<td>Baseline then q6h after each assessment or dose change until at target x 2 then qAM</td>
<td>0.2-0.4 IU/ml</td>
</tr>
</tbody>
</table>
**EXAMPLE: using 80 kg patient**

Total desired UFH dose = 12 units/kg/hr (typical low-intensity ACS heparin protocol)
12 units X 80 kg = 960 units/hr UFH

Calculator will round to nearest 100 units (in this case, 1000 units/hr)

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**Anticoagulation Therapy with Impella® Heparin Infusion**

Total Heparin Delivered to Patient (Rate)

<table>
<thead>
<tr>
<th>Rate (U/hr)</th>
<th>U/Hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000.00</td>
<td>U/Hr</td>
</tr>
</tbody>
</table>

Determine heparin from purge solution

Purge concentration in units/ml X purge flow rate in ml/hour = purge UFH in ml/hr

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**Calculate Impella Delivered Heparin Rate**

Heparin Concentration in Purge from AIC*

<table>
<thead>
<tr>
<th>Concentration (U/ml)</th>
<th>Input purge UFH concentration</th>
</tr>
</thead>
<tbody>
<tr>
<td>25.00</td>
<td></td>
</tr>
</tbody>
</table>

Purge Flow Rate from AIC*

<table>
<thead>
<tr>
<th>Flow Rate (mL/hr)</th>
<th>mL/Hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>15.00</td>
<td></td>
</tr>
</tbody>
</table>

Impella Delivered Heparin Rate

<table>
<thead>
<tr>
<th>Rate (U/hr)</th>
<th>U/Hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>375.00</td>
<td>U/Hr</td>
</tr>
</tbody>
</table>

Total desired UFH – purge delivered UFH = systemic IV UFH rate

1000 u/hr – 375 units/hr = 625 units/hr

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**Results**

Systemic IV Heparin Rate

<table>
<thead>
<tr>
<th>Rate (U/hr)</th>
<th>U/Hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>625.00</td>
<td>U/Hr</td>
</tr>
</tbody>
</table>

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**Abbreviations:**

- UFH—unfractionated heparin
- IV—intravenous
- DTI—direct thrombin inhibitor
- LMWH—low-molecular weight heparin
- DOAC—direct acting oral anticoagulant
- HIT—heparin-induced thrombocytopenia
- mEq—milliequivalent
- mL—milliliter
- DSW—dextrose 5% water
- PCI—percutaneous coronary intervention
- L—liter
- CP—cardiac power
- mmHG—millimeters mercury
- BBPS—bicarbonate-based purge solution
- ECMO—extracorporeal membrane oxygenation
- Ecpella—ECMO with Impella
- ACT—activated clotting time
- aPTT—activated partial thromboplastin time
- IU—international units
- qAM—every morning
- Hgb—hemoglobin
- kg—kilogram

**Calculations:**

- Total desired UFH dose: 12 units/kg/hr \times 80 kg = 960 units/hr
- Calculator will round to nearest 100 units (in this case, 1000 units/hr)
- Purge concentration in units/ml \times purge flow rate in ml/hour = purge UFH in ml/hr
- Total desired UFH – purge delivered UFH = systemic IV UFH rate

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**References:**


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