**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.

**DIFFICULTY**

- IV UFH can be supplemented to maintain adequate systemic anticoagulation needed to prevent thrombus formation.
- UFH levels may contribute to the pump stopping due to inadequate purge, particularly in use ≥ 14 days.

**TOPIC**

- Purge 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.

**BOTTOM LINE**

- Use UFH 25 U/mL in D5W as default purge.
- Supplement IV UFH as needed.
- Account for both sources of heparin.
- Have a standardized protocol for anticoagulation with Impella.
- Use saline in purge solution.
- Use other anticoagulants (DTI, LMWH, fondaparinux) in purge.
- Use fondaparinux or DOAC for HIT in Impella patients.
- Bicarbonate-based purge (25mEq per 1500 ml D5W) when UFH not feasible due to bleeding, active HIT or consistently supertherapeutic UFH levels.

**Purge Solution**

- 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.
- Patients requiring biventricular support with Impella RP and 2.5, CP or 5.0, the same purge solution should be utilized for both devices.

**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 (Echpella), UFH cannulation bolus should be reduced to account for UFH in purge solution.

**Standard**

- UFH 25 units/ml in 500-1000 mL D5W
- BBPS*
  - HIT (with systemic DTI)
  - Bleeding (in absence of systemic IV UFH)

**Non-standard**

- D5W Only
  - Only if BBPS not available

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**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 comprehensive, optimized care.
- Avoid cleaning the luer with isopropyl alcohol.
- Contact the Abiomed Clinical Support Center 1-800-422-8668 if questions arise.

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**Ongoing monitoring**

- Hemolysis (Plasma-free Hgb).
- HIT.
- Purge pressure (mmHg).
- UFH (per local protocol).
- <300: Assessment or dose change to UFH 25 U/m in D20W.
- >1100: assess for kinks in purge line.
- Bleeding or persistently supertherapeutic.
- Ongoing monitoring.
- Continue to monitor, remove device if severe.
- Stop systemic IV UFH.
- Change to BBPS.
- Initiate systemic IV DTI.

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**Systemic IV UFH**

- Not based on high-quality data
- No assay has been shown to be superior

**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 q6h</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 q4M</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 q4M</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)

### Anticoagulation Therapy with Impella® Heparin Infusion

<table>
<thead>
<tr>
<th>Total Heparin Delivered to Patient (Rate)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000.00 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

### Calculate Impella Delivered Heparin Rate

**Heparin Concentration in Purge from AIC**

| 25.00 U/ml |

**Purge Flow Rate from AIC**

| 15.00 mL/hr |

**Impella Delivered Heparin Rate**

| 375.00 U/hr |

Total desired UFH-purge delivered UFH = systemic IV UFH rate
1000 u/hr – 375 units/hr = 625 units/hr

**Results**

<table>
<thead>
<tr>
<th>Systemic IV Heparin Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>625.00 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**—millequivalent
- **mL**—milliliter
- **D5W**—dextrose 5% water
- **PCO**—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

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**References:**

6. Benjamin Laliberte, PharmD, BCPS, Brent N, Reed, PharmD., BCPS-AQ Cardiology, FAHA, Use of an argatroban-based purge solution in a percutaneous ventricular assist device, American Journal of Health-System Pharmacy, Volume 74, Issue 9, 1 May 2017, Pages e163-e169, [https://doi.org/10.2146/ajhp100212](https://doi.org/10.2146/ajhp100212).

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This content was developed independently by the Anticoagulation Forum. Support for this project provided by Abiomed.

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Last updated 1/2022