

Table 2. Alternatives to Heparin Sodium in Selected Situations¹⁷⁻¹⁹

Situation	Alternative	Dose
Maintain patency of peripheral venous catheters ^{*27-32}	0.9% Sodium Chloride injection may be used in most cases. NOTE: Heparin sodium (1 – 10 units/mL) may be needed in small children and infants; their catheters may clot more often than an adult's due to smaller vein size and catheter bore.	Intermittent: flush before and after medication administration ²⁷⁻³² Maintenance: flush every 8 – 12 hours when the device is not in use ²⁷⁻³²
Maintain patency of central venous catheters ^{*28,33,34} Tunneled catheter or implantable port catheter	Intermittent: 0.9% Sodium Chloride injection Maintenance: 0.9% Sodium Chloride injection	Intermittent: flush before and after medication administration. ^{28,33,34} Maintenance: flush every 8 – 24 hours, depending on the type of catheter used. Tunneled catheters may be flushed once daily to once weekly; implantable port catheters may be flushed after each use or every 30 days. ^{28,33,34}
Maintain patency of central venous catheters ^{*28,33,34} Percutaneous central venous catheter or peripherally-inserted central venous catheter	Intermittent: no alternative; recommend conservation of heparin sodium. Maintenance: no alternative; recommend conservation of heparin sodium. NOTE: There are no published data on the use of 0.9% Sodium Chloride injection alone for these catheters.	Intermittent: flush before and after medication administration with 0.9% Sodium Chloride injection 2.5 – 5 mL. May be followed by heparin (10 – 100 unit/mL) 1 – 5 mL depending on the type of catheter used. ^{28,33,34} Maintenance: flush with heparin (10 – 100 unit/mL) 1 – 5 mL every 8 – 24 hours, depending on the type of catheter used. ^{28,33,34}
DVT/PE prophylaxis: Abdominal surgery	Dalteparin, Enoxaparin, Fondaparinux	Dalteparin 2,500 – 5,000 units subcutaneously every day, starting before surgery and continuing for 5 – 10 days postoperatively. Enoxaparin 40 mg subcutaneously every day, starting before surgery and continuing for 7 – 10 days postoperatively. Fondaparinux 2.5 mg subcutaneously every day, starting 6 – 8 hours after surgery and continuing for 5 – 9 days postoperatively.

Situation	Alternative	Dose
DVT/PE prophylaxis: Hip replacement surgery	Dalteparin, Enoxaparin, Fondaparinux	<p>Dalteparin 2,500 – 5,000 units subcutaneously every day, starting before surgery and continued 5 – 10 days postoperatively.</p> <p>Enoxaparin 30 mg subcutaneously every 12 hours, starting 12 – 24 hours after surgery and continuing for 7 – 10 days postoperatively. An alternative regimen is enoxaparin 40 mg subcutaneously every day, starting before surgery and continuing 3 weeks postoperatively.</p> <p>Fondaparinux 2.5 mg subcutaneously every day, starting 6 – 8 hours after surgery and continuing for 5 – 9 days postoperatively.</p>
DVT/PE prophylaxis: Knee-replacement surgery	Enoxaparin, Fondaparinux	<p>Enoxaparin 30 mg subcutaneously every 12 hours, starting 12 – 24 hours after surgery and continuing for 7 – 10 days postoperatively.</p> <p>Fondaparinux 2.5 mg subcutaneously every day, starting 6 – 8 hours after surgery and continuing for 5 – 9 days postoperatively.</p>
DVT/PE prophylaxis: Acute illness with mobility restriction	Dalteparin Enoxaparin	<p>Dalteparin 5,000 units subcutaneously every day for 12 – 14 days.</p> <p>Enoxaparin 40 mg subcutaneously every day for 6 to 14 days.</p>
DVT without PE (outpatient therapy)	Enoxaparin, Tinzaparin	<p>Enoxaparin 1 mg/kg subcutaneously every 12 hours</p> <p>Tinzaparin 175 anti-Xa units/kg subcutaneously every day.</p> <p>Note: Start warfarin therapy when appropriate, usually within 3 days of starting LMWH; continue LMWH therapy until INR is in therapeutic range (usually an additional 5 – 7 days).</p>

Situation	Alternative	Dose
DVT with PE (inpatient therapy)	Enoxaparin, Fondaparinux, Tinzaparin	<p>Enoxaparin 1 mg/kg subcutaneously every 12 hours, or 1.5 mg/kg subcutaneously every day.</p> <p>Fondaparinux 5 – 10 mg subcutaneously every day, based on weight: Weight < 50 kg: 5 mg/day Weight 50 – 100 kg: 7.5 mg/day Weight > 100 kg: 10 mg/day</p> <p>Tinzaparin 175 anti-Xa units/kg subcutaneously every day.</p> <p>Note: Start warfarin therapy when appropriate, usually within 3 days of starting LMWH; continue LMWH therapy until INR is in therapeutic range (usually an additional 5 – 7 days).</p>
DVT without PE in cancer patients	Dalteparin	Dalteparin 200 units/kg subcutaneously once daily for 30 days, then 150 units/kg subcutaneously once daily for 5 additional months. Do not exceed 18,000 units/dose.
DVT with PE in cancer patients	Dalteparin	Dalteparin 200 units/kg subcutaneously once daily for 30 days, then 150 units/kg subcutaneously once daily for 5 additional months. Do not exceed 18,000 units/dose.
Acute myocardial infarction with ST-segment elevation	Enoxaparin	Enoxaparin 30 mg IV plus 1 mg/kg subcutaneously initially, then 1 mg/kg every 12 hours for 2 – 8 days, given concurrently with aspirin 75 – 325 mg/day orally. Do not exceed 100 mg/dose for first two doses only, remainder of doses are weight-based.
Myocardial infarction, non Q-wave	Dalteparin, Enoxaparin	<p>Dalteparin 120 units/kg subcutaneously every 12 hours for 5 – 8 days, given concurrently with aspirin 75 – 165 mg/day orally. Do not exceed 10,000 units/dose.</p> <p>Enoxaparin 1 mg/kg subcutaneously every 12 hours for 2 – 8 days, given concurrently with aspirin 100 – 325 mg/day orally.</p>

Situation	Alternative	Dose
Unstable angina	Bivalirudin, Dalteparin, Enoxaparin	<p>Bivalirudin 0.75 mg/kg IV bolus, followed by 1.755 mg/kg/hour for the duration of the PTCA procedure and for up to 4 hours after the procedure. After the 4-hour infusion, may give an 0.2 mg/kg/hr infusion for up to 20 hours. Start bivalirudin therapy just before PTCA procedure. Give concurrently with aspirin 300 – 325 mg/day orally.</p> <p>Dalteparin 120 units/kg subcutaneously every 12 hours for 5 – 8 days, given concurrently with aspirin 75 – 165 mg/day orally. Do not exceed 10,000 units/dose.</p> <p>Enoxaparin 1 mg/kg subcutaneously every 12 hours for 2 – 8 days, given concurrently with aspirin 100 – 325 mg/day orally.</p>
<p>Patients with porcine allergy</p> <p>Systemic thrombosis or rapid anticoagulation required</p>	<p>Manage patients as if they have heparin-induced thrombocytopenia. Low molecular weight heparins are porcine-derived. Consultations with Hematologists or clinicians who specialize in anticoagulation may be helpful.</p> <p>Alternatives may include: Lepirudin Argatroban</p>	<p>Rapid Anticoagulation³⁵⁻³⁷ Lepirudin Load: 0.4 mg/kg IV bolus Maintenance: 0.15 mg/kg/h IV adjusted to maintain aPTT 1.5 – 2.5 times the median normal laboratory range.</p> <p>Begin warfarin therapy as soon as clinically possible.</p> <p>Argatroban Initial dose of 2 mcg/kg/min adjusted to maintain aPTT 1.5 – 3 times the baseline value. For patients with hepatic dysfunction, use an initial dose of 0.5 mcg/kg/min or avoid use when possible.</p> <p>Begin warfarin therapy as soon as clinically possible.</p> <p>Argatroban is the preferred agent for patients with renal dysfunction.</p>
<p>Patients with porcine allergy</p> <p>Maintain patency of dialysis catheters</p>	<p>Data are limited to case reports and 1 small clinical trial (alteplase)</p> <p>Alteplase Lepirudin</p>	<p>Clearly label all catheters with the agent and dose instilled into each lumen, the date instilled, and a warning “DO NOT FLUSH.”</p> <p>Alteplase 1.5 – 2 mg instilled into each catheter lumen at the end of dialysis.^{38,39}</p> <p>Lepirudin 0.65 mg instilled into each catheter lumen at the end of dialysis.⁴⁰</p> <p>Clinicians should avoid flushing lepirudin into the patient. Lepirudin has a prolonged half-life (15 – 316) hours in patients with renal failure and is not recommended for use in patients with severe renal dysfunction.^{41,42}</p>

Situation	Alternative	Dose
<p>Patients with porcine allergy</p> <p>During active hemodialysis</p>	<p>No anticoagulation</p> <p>Argatroban</p> <p>Lepirudin</p> <p>Clinicians should note that data for using lepirudin or argatroban during dialysis are limited to small case reports.</p>	<p>No anticoagulation Hemodialysis without anticoagulation generally requires closer nursing observation and filter flushes every 15 – 30 minutes.⁴³⁻⁴⁵</p> <p>Argatroban <i>Extracorporeal Administration</i> Argatroban 10 mg into the circuit at the start of hemodialysis followed by a continuous infusion of 5 – 40 mg/hr into the circuit until dialysis is complete.⁴⁶⁻⁴⁹</p> <p>Argatroban is the preferred agent in patients with renal dysfunction.</p> <p>Lepirudin <i>Extracorporeal Administration prior to CVVHD</i> Lepirudin 0.005 mg/kg/h immediately before the filter, adjusted to 1.5 – 2.5 times the control aPTT⁵⁰⁻⁵¹</p> <p>Continue to monitor aPTT 8 hours after the initial dose and beyond due to lepirudin's prolonged half-life (15 – 316 hours) in patients with renal failure.^{41,45,50}</p> <p>Lepirudin has a prolonged half-life (15 – 316 hours) in patients with renal failure and is not recommended for use in patients with severe renal dysfunction.^{41,42}</p>

Abbreviations: aPTT= activated partial thromboplastin time; CVVHD = continuous venovenous hemodialysis; DVT = deep vein thrombosis; INR = international normalized ratio; IV = intravenous; LMWH = low molecular weight heparin; PE = pulmonary embolism; PTCA = percutaneous transluminal coronary angiography.

*Heparin sodium 10 unit/mL and 100 unit/mL flush solutions are available from APP and Hospira,^{11,12} and are also made by other manufacturers.²

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