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Anticoagulation Management in Temporary Mechanical Circulatory Support Devices

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Introduction

Anticoagulation is needed with most mechanical circulatory support devices to prevent device thrombosis and obstruction of flow at access sites, namely, the common femoral artery, especially in patients with small vessels and peripheral artery disease. However, these patients are also at high risk of bleeding, so close monitoring is required. Temporary mechanical support devices differ in profile, with the Impella (Abiomed) being smaller than the TandemHeart (CardiacAssist, Inc) or extracorporeal membrane oxygenation (ECMO) devices, providing different levels of hemodynamic support. Manufacturers have recommendations for specific devices, but research is ongoing to determine optimal anticoagulation strategies.

Current Recommendations

Intra-Aortic Balloon Pump

The use of anticoagulation with intra-aortic balloon pumps (IABPs) varies. No definitive data exist, but guidelines state that each institution should establish their own protocol based on patient-specific risk factors.[1] Studies have been mostly small, single center, and retrospective, comparing unfractionated heparin (UFH) with either no anticoagulation or selective anticoagulation (ie, patients with another indication for anticoagulation).[2] These studies concluded that there were no differences in thrombotic outcomes; however, some did find lower rates of bleeding in the selective or no-anticoagulation group. Additionally, patients in the cardiac critical care unit were more likely to receive anticoagulation than were patients after cardiac surgery. On average, patients had the IABP in place for 3 to 5 days, which may also affect the decision of whether to administer an anticoagulant. If considering anticoagulation, lower starting doses (10-12 U/kg/h of UFH) and partial thromboplastin time goals (50-70 seconds or 60-80 seconds) should be considered.[2]

Impella

The Impella device requires a heparin-based purge to prevent ingress of blood into the motor. Heparin contains an ionic charge that prevents deposition of denatured proteins and thrombus in the purge gaps. The usual purge solution is 25,000 units of UFH in 1 L of intravenous dextrose 5% in water (D5W). The device automatically adjusts purge flow rates to target purge pressures, so additional systemic anticoagulation may be needed to achieve an anti–factor Xa goal of 0.2 to 0.4 U/mL. When starting systemic anticoagulation, the amount of UFH from the purge solution should also be considered in initial dosing. For patients who require an alternative to UFH, a sodium bicarbonate purge of 25 mEq in 1 L of D5W is recommended and approved by the Food and Drug Administration for this indi-

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cation. Sodium bicarbonate protects the Impella motor and has demonstrated outcomes similar to those with UFH. In patients with heparin-induced thrombocytopenia, systemic anticoagulation is still recommended in addition to the sodium bicarbonate purge. Using alternative anticoagulation in the purge should be avoided because of the lack of ionic charge.[3,4]

TandemHeart

The TandemHeart device uses an infusate solution of 90,000 units of UFH in 1 L of normal saline. Unlike the Impella purge, the TandemHeart infusate runs at a fixed rate of 10 mL/h to give 900 U/h of UFH. Systemic UFH may also need to be added to achieve therapeutic levels of anticoagulation.[5] There are no data available using non-UFH infusates, so if a non-UFH alternative is needed, consider using normal saline in the infusate with the addition of systemic bivalirudin or argatroban.

Extracorporeal Membrane Oxygenation

The most recent Extracorporeal Life Support Organization guidelines[6] still recommend UFH as the first-line agent in patients receiving ECMO, with the use of both a plasma-based test and a whole-blood test for therapeutic drug monitoring. In a study conducted by Colman et al,[7] the use of thromboelastography monitoring in addition to activated partial thromboplastin times resulted in lower rates of bleeding compared with a preprotocol group that used only activated partial thromboplastin times. However, viscoelastic assays need to be studied further before they can be recommended for widespread use in monitoring UFH in patients receiving ECMO. Multiple studies have been published comparing the use of bivalirudin with UFH in patients receiving ECMO, and these studies have shown lower rates of mortality, transfusions, thrombosis, bleeding, and cost. The Extracorporeal Life Support Organization states, however, that large and prospective randomized trials are needed before it can recommend bivalirudin as the primary anticoagulant.[6,8-10] A summary of recommendations can be found in Table I.

Abbreviations and Acronyms

D5W	dextrose 5% in water
ECMO	extracorporeal membrane oxygenation
IABP	intra-aortic balloon pump
UFH	unfractionated heparin

Future Directions

There are still many unknowns when it comes to optimal anticoagulation management in patients with temporary mechanical support devices because of the complexity of this patient population. Ongoing studies are examining whether a sodium bicarbonate purge

TABLE I. Summary of Recommendations

Device	Anticoagulation strategy
IABP	Consider anticoagulation under the following conditions (selective strategy): CCU, IABP 1:2 or 1:3, IABP duration >5 d, or underlying condition of anticoagulation
	UFH target: aPTT of 50-70 s or 60-80 s
Impella	UFH 25,000 U in 1 L D5W purge with or without systemic UFH to a target anti–factor Xa of 0.2-0.4 U/mL
	Alternative: sodium bicarbonate purge 25 mEq in 1 L D5W purge with or without systemic anticoagulation
TandemHeart	UFH 90,000 U in 1 L of NS infusate with or without systemic UFH
ECMO	UFH target aPTT of 1.5-2.5× baseline, TEG R-time of 2-3× baseline, anti–factor Xa of 0.3-0.7 U/mL
	Consider using 2 parameters to monitor for anticoagulant effect
	Consider lower anticoagulation goals in patients receiving VV vs VA ECMO
	Alternative: bivalirudin target aPTT of 1.5-2.5× baseline

aPTT, activated partial thromboplastin time; CCU, cardiac critical care unit; D5W, dextrose 5% in water; ECMO, extracorporeal membrane oxygenation; IABP, intra-aortic balloon pump; NS, normal saline; R-time, reaction time; TEG, thromboelastography; UFH, unfractionated heparin; VA, venoarterial; VV, venovenous.

should be the preferred agent vs UFH. In patients receiving ECMO, studies are looking at lower-dose anticoagulation and even no anticoagulation. Additional larger prospective studies are needed to determine the role of anti–thrombin III supplementation, viscoelastic testing as a method of monitoring UFH effect, and the use of direct thrombin inhibitors.[6]

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