Addendum of Newer Anticoagulants to the SIR Consensus Guideline

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Appropriate periprocedural management of the hematologic parameters in a patient undergoing percutaneous image-guided intervention is highly complex, considering the wide range of procedures and patient demographics. This is further complicated by both the use of short-term and long-term anticoagulants and the increasing use of antiplatelet agents and other medications. Unfortunately, there is currently a general paucity of objective medical data regarding the periprocedural management of patients with abnormal coagulation parameters.

In the absence of strong evidence regarding periprocedural management of this patient category, members of the Standards of Practice Committee of the Society of Interventional Radiology (SIR) have proposed general recommendations that may be useful to the practicing interventionalist. The various classes of medications that affect patient coagulation parameters were critically reviewed. When the evidence of literature was weak, conflicting, or contradictory, consensus for the parameter was reached by a minimum of 12 Standards of Practice Committee members by using a modified Delphi consensus method (1). For the purposes of these documents, consensus is defined as 80% Delphi participant agreement on a value or parameter.

A time lapse of 5 half-lives of a particular agent (equivalent to about 3% of residual drug activity from the initial dose) is frequently used as a means of normalizing a patient's bleeding risk (2,3). However, the use of laboratory coagulation thresholds is preferable, as half-lives may vary considerably in individual patients due to factors such as the potential presence of drug-drug interactions, idiosyncratic factors, differences in drug metabolism, or genetic influences. Additionally, the exact time point of drug discontinuation may be uncertain or unreliable. Nevertheless, when appropriate laboratory coagulation parameters are unavailable, disproportionally costly, or logistically cumbersome, the use of 5 half-lives to normalize bleeding risk can be adequate.

In this table formatted document, we summarize some of the current medications and available literature regarding periprocedural coagulation parameter surveillance and medical management of patients undergoing percutaneous image-guided procedures (**Tables 1 and 2**). Because of the lack of randomized controlled studies or other high-level evidence on this topic, a Delphi panel of experts constructed a set of consensus guidelines to serve as a reference for the practicing interventionalist. Although it is likely that individual practice parameters will vary from this document, each practitioner should monitor outcomes and look for trends, both positive and negative, which may suggest modifications or adjustments to these parameters. For example, the risk of a cardiovascular or thromboembolic event must be weighed against the risk of bleeding for a given patient undergoing a specific procedure. For that reason, the management of patients undergoing image-guided interventions is a continually evolving paradigm, with local factors, such as procedure type and patient selection, influencing these general consensus guidelines.

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Table 1. Periprocedural Coagulation Parameter Surveillance and Medical Management of Patients Undergoing Percutaneous Image-Guided Procedures

Category	**1**	**2**	**3**
Procedure	Nontunneled venous catheter	Angiography (arterial intervention with access size up to 7-F)	TIPS
	Dialysis access interventions	Venous interventions	Renal biopsy
	Central line removal	Chemoembolization/radioembolization	Radiofrequency ablation
	IVC filter placement	Uterine fibroid embolization	Nephrostomy tube placement
	Venography	Transjugular liver biopsy	Biliary interventions (new tract)
	Catheter exchange (biliary, nephrostomy, abscess drainage catheter)	Tunneled venous catheter	
	Thoracentesis	Subcutaneous port device placement	
	Paracentesis	Abscess drainage	
	Thyroid biopsy	Biopsy (excluding superficial and renal)	
	Joint aspiration/injection	Percutaneous cholecystostomy	
	Superficial aspiration, drainage, and/or biopsy (excluding intrathoracic or intraabdominal sites)	Enteric tube placement, initial	
		Spinal procedures (vertebroplasty, kyphoplasty, lumbar puncture, epidural injection, facet block)	
Tests	INR: recommended	INR: recommended	INR: recommended
	aPTT: recommended	aPTT: recommended	aPTT: recommended
	Platelet count: not routinely recommended	Platelet count: recommended	Platelet count: recommended
	Hematocrit: not routinely recommended	Hematocrit: not routinely recommended	Hematocrit: not routinely recommended
Thresholds	INR: correct to $\leq$ 2.0	INR: correct to $\leq$ 1.5	INR: correct to $\leq$ 1.5
	Platelets: $\leq$ 50,000/μL recommend transfusion	Platelets: $\leq$ 50,000/μL recommend transfusion	Platelets: $\leq$ 50,000/μL recommend transfusion
	aPTT: no consensus	aPTT: no consensus (trend toward correcting for values $\geq$ 1.5$\times$ control, 73% consensus)	aPTT: correct so that value is $\leq$ 1.5$\times$ control

Table 2. Current Medications and Management Recommendations (4–11)

Medications	Category I Procedure (Low Bleeding Risk)	Category II Procedure (Moderate Risk of Bleeding)	Category III Procedure (Significant Bleeding Risk/ Bleeding Difficult to Detect)
Warfarin (Coumadin)	Withhold 3–5d • INR $\leq$ 2.0	Withhold 5d • INR $\leq$ 1.5	Withhold 5d • INR $\leq$ 1.5
Aspirin*	Do not withhold	Do not withhold	Withhold 5 d before procedure
Heparin (unfractionated)	No consensus • Check aPTT	No consensus • aPTT—trend toward correcting for values $\geq$ 1.5$\times$ control, 73% consensus	Withhold 2–4 h before procedure • aPTT $\leq$ 1.5x control
LMWH (therapeutic dose)	Withhold 1 dose or 12 h before procedure	Withhold 1 dose or 12 h before procedure	Withhold 2 doses or 24 h before procedure
Fondaparinux	Do not withhold	Withhold • 2–3 d (CrCl $\geq$ 50 mL/min) • 3–5 d (CrCl $\leq$ 50 mL/min)	Withhold • 2–3 d (CrCl $\geq$ 50 mL/min) • 3–5 d (CrCl $\leq$ 50 mL/min)
	Thienopyridines*		
Clopidogrel (Plavix)*	Withhold for 0–5 d before procedure	Withhold for 5 d before procedure	Withhold for 5 d before procedure
Prasugrel (Effient)*			
Ticlopidine(Ticlid)*	Withhold for 0–5 d before procedure	Withhold for 7 d before procedure	Withhold for 7 d before procedure
	NSAIDs		
Short-acting (half-life 2–6 h) • **Ibuprofen** • **Diclofenac** • **Ketoprofen** • **Indomethacin**	Do not withhold	Do not withhold	Withold 24 h before procedure
Intermediate-acting (half-life 7–15 h) • **Naproxen** • **Sulindac** • **Diflunisal** • **Celecoxib**	Do not withhold	Do not withhold	Withhold 2–3 d before procedure
Long-acting (half-life $>$ 20 h) • **Meloxicam** • **Nabumetone** • **Piroxicam**	Do not withhold	Do not withhold	Withhold 10 d before procedure

(Continued)

Table 2. Current Medications and Management Recommendations (4–11) (Continued)

Medications	Category I Procedure (Low Bleeding Risk)	Category II Procedure (Moderate Risk of Bleeding)	Category III Procedure (Significant Bleeding Risk, Bleeding Difficult to Detect)
	Glycoprotein IIb/IIIa inhibitors		
Long-acting • **Abciximab (ReoPro)**	Withhold 12–24 h before procedure • aPTT $\leq$ 50 s • ACT $\leq$ 150 s	Withhold 24 h before procedure • aPTT $\leq$ 50 s • ACT $\leq$ 150 s	Withhold 24 h before procedure • aPTT $\leq$ 50 s • ACT $\leq$ 150 s
Short-acting • **Eptifibatide (Integrilin)** • **Tirofiban (Aggrastat)**	Withhold immediately before procedure	Withhold 4 h before procedure	Withhold 4 h before procedure
	Direct thrombin inhibitors		
Argatroban	Do not withhold	Defer procedure until off medication. If procedure is stat. or emergent, withhold 4 h before procedure.	Defer procedure until off medication. If procedure is stat. or emergent, withhold 4 h before procedure.
Bivalirudin (Angiomax)	Do not withhold	Defer procedure until off medication. If procedure is stat. or emergent, withhold • 2–3 h (CrCl $\geq$ 50 mL/min) • 3–5 h (CrCl $\leq$ 50 mL/min)	Defer procedure until off medication. If procedure is stat. or emergent, withhold • 2–3 h (CrCl $\geq$ 50 mL/min) • 3–5 h (CrCl $\leq$ 50 mL/min)
Dabigatran (Pradaxa)	Do not withhold	Defer procedure until off medication. If procedure is stat. or emergent, withhold • 2–3 d (CrCl $\geq$ 50 mL/min) • 3–5 d (CrCl $\leq$ 50 mL/min)	Defer procedure until off medication. If procedure is stat. or emergent, withhold • 2–3 d (CrCl $\geq$ 50 mL/min) • 3–5 d (CrCl $\leq$ 50 mL/min)

There was an 80% consensus on each of these recommendations unless stated otherwise. The management recommendations for each coagulation defect and drug assume that no other coagulation defect is present and that no other drug that might affect coagulation status has been administered.
1-Deamino-8-D-arginine vasopressin may be indicated before image-guided procedures in patients with haemophilia and von Willebrand's disease (12–13).

*One can and should afford exception to emergency procedures. Likewise, patients unable to safely discontinue anticoagulation for any number of medical reasons, including but not limited to, recent coronary or cerebrovascular stents can and should be afforded a degree of variance from the guidelines above.

ACT=activated clotting time, aPTT=activated partial thromboplastin time, CrCl=creatinine clearance, INR=international normalized ratio, IVC=inferior vena cava, LMWH=low-molecular-weight heparin, NSAIDs=nonsteroidal anti-inflammatory drugs, TIPS=transjugular intrahepatic portosystemic shunt.

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