or extrapolated from surgical data. The relatively rare occurrence of infectious complications in IR makes large-volume, randomized controlled trials impractical. Nonetheless, antibiotic agents are an integral part of the periprocedural management of patients, and the operator must therefore be familiar with the most current clinical recommendations.

The Executive Summary (**Appendix A** [available online on the article's Supplemental Material page at *www.jvir.org*]) summarizes the updated clinical recommendations and qualifying statements. Levels of evidence have been assigned to the current recommendations on the basis of the type, quality, quantity, and consistency of the evidence, in accordance with the current American College of Cardiology/American Heart Association Clinical Practice Guideline Recommendation Classification System enabling comparison of the strength (class) and level (quality) of each recommendation with categories used by other guideline developers (2,3). This aligns with recommendations promoted by the Institute of Medicine in 2011 (4,5).

METHODOLOGY

SIR produces its Standards of Practice documents by using the following process. Topics of relevance and timeliness are conceptualized by the Standards of Practice Committee members, Service Lines, SIR members, or the Executive Council. A recognized expert or group of experts is identified to serve as the principal author or writing group for the document. Additional authors or societies may be sought to increase the scope, depth, and quality of the document depending on the magnitude of the project.

An in-depth literature search is performed, and a critical review of peer-reviewed articles is performed with regard to the study methodology, results, and conclusions. The qualitative weight of these articles is assembled into an evidence table (**Table E1** [available online on the article's Supplemental Material page at *www.jvir.org*]), which is used to write the document such that it contains evidence-based data. When the evidence of literature is weak, conflicting, or contradictory, consensus for the parameter is reached by a minimum of 12 Standards of Practice Committee members by using a modified Delphi consensus method (**Appendix D** [available online on the article's Supplemental Material page at *www.jvir.org*]) (6,7). For the purposes of these documents, consensus is defined as 80% Delphi participant agreement on a value or parameter.

The draft document is critically reviewed by the writing group and Standards of Practice Committee members by telephone conference calling or face-to-face meeting. The finalized draft from the Committee is sent to the SIR Operations Committee for approval. Any comments by the Operations Committee are discussed by the Standards of Practice Committee, and appropriate revisions are made to create the finished standards document before its submission for peer review, acceptance, and publication.

INTRODUCTION

Unlike the incision site/wound infections incurred during surgery, the infectious complications in IR are most likely the result of bacterial inoculation into the bloodstream. Common mechanisms include (*i*) contamination of a needle, catheter, or wire by contact with a nonsterile surface or residual skin flora during vascular access (8); (*ii*) traversal of small vessels located along the trajectory of a needle creating channels of communication for bacteria to enter the bloodstream (9); (*iii*) intravasation of bacteria into the bloodstream from an obstructed viscus or abscess cavity (10); and (*iv*) proliferation of bacteria on the inside or outside of an indwelling catheter tract. Antibiotic prophylaxis for IR procedures therefore aims to clear bacterial contamination from the bloodstream to prevent a systemic inflammatory reaction (ie, sepsis) or the seeding of foreign material (eg, a stent) or necrotic tissue created during embolization or ablation.

Percutaneous access limits the size and number of breaks in the body's natural defense system but does not wholly obviate pathogen entry points into the body. As the breadth and complexity of procedures and patients continues to expand, procedural and preprocedural precautions aimed at limiting the spread of infection are critical components to the comprehensive management of IR patients. Standard precautions in the interventional suite emulate those in the operating room and include maintenance of maximal sterile precautions, including operating in a sterile environment, adherence to aseptic technique, and an emphasis on hand hygiene (8,11).

PROCEDURE CLASSIFICATION

Although the pathogenesis behind infectious complications in IR is different than in surgery, IR procedures have in the past been categorized by using definitions established by the National Academy of Sciences/National Research Council surgical wound classification originally defined in 1964 (12). More recent studies have found that the definitions used in this classification scheme to describe infectious adverse events, including sepsis and systemic inflammatory immune response, have inadequate sensitivity and specificity, leading to discrepancies in incidence and observed mortality (13). Newer definitions have been outlined in the Third International Consensus Definitions for Sepsis and Septic Shock ("Sepsis 3"), including the sepsis-related organ failure assessment score to describe organ dysfunction/failure (13,14). **Table 1** lists the surgical wound classification scheme and definitions of infectious adverse events, defining relevant terms used throughout this document.

ANTIBIOTIC TIMING AND DOSAGE

Prophylactic antibiotic agents are, by definition, those that are administered before creation of an incision or puncture wound. Recommendations from the governing body on hospital and patient safety standards (The Joint Commission) are that intravenous (IV) antibiotic agents be administered within 1 hour of an incision (15). A recent large surgical study (16) has reiterated support for the 60-minute time frame and found no evidence to narrow the window. A repeat dose of antibiotic agents should be administered if a period of 2 hours has lapsed from the initial dose (17). In contrast, the administration of antibiotic agents after a procedure has been associated with 4 times the number of infectious complications, equivalent to rates encountered when no prophylaxis is administered (18).

In the setting of renal dysfunction, a single dose of antibiotic agent used in IR, such as cefazolin, ciprofloxacin, piperacillin/tazobactam, ampicillin/sulbactam, and trimethoprim/sulfamethoxazole, can be given safely, but subsequent doses may need dose or timing adjustment (19,20). Ceftriaxone, clindamycin, and moxifloxacin do not require dose adjustment in renal dysfunction (19). Vancomycin should always be dosed according to pharmacy protocol, and aminoglycosides (eg, gentamycin) should be avoided in patients with renal dysfunction (20).

General Pediatric Antibiotic Dosing

In adult patients, drug doses are standardized. However, in children, drugs are prescribed based on the patient's age, weight, body surface area, and/or clinical condition (21). For pediatric antibiotic regimens, doses are usually weight-based, and therefore careful calculation is required to ensure correct dosage. Pediatric patients therefore are at a higher risk than adults for experiencing the effects of dosing errors; this may result in subtherapeutic antibiotic dosing causing treatment failure and the emergence of resistant organisms (22) or supratherapeutic dosing and toxicity. Many institutions performing pediatric interventional procedures have an antibiotic dosing standardization that minimizes the risk of calculation errors and reduces the time required for dose calculation by the prescriber (21). **Appendix C** (available online on the article's Supplemental Material page at *www.jvir.org*) describes pediatric prophylactic antibiotic dosing considerations.

Neonatal/Infant Antibiotic Dosing

Pharmacodynamic and pharmacokinetic data for antibiotic and antifungal agent administration in neonates and infants is limited, as this patient population has often been excluded from clinical trials (23). Special considerations are required for neonates and infants when administering and monitoring antibiotic regimens. This is because differences in gastric pH, intestinal transit time, immaturity of secretion, bile and pancreatic fluid, variable renal function, and interventions such as extracorporeal membrane