

TABLE 1. Central venous catheter complication rates in pediatric intestinal failure: infection and dysfunction

Type	Tunneled CVC (rate/1000 catheter days [citation])		PICC* (rate/1000 catheter days [citation])
	Pre	Post	
Infection/CLABSI			
Ethanol	13.9	1.6 [61]	3.95 [7]
	4.74	0.36 [88]	2.6 [12]
	5.5	3.1 [87]	5.3 [11]
Taurolidine		3.7 [80]	
		1.5 [58]	
		2.8 [7]	
		4.2 [12]	
Care bundle [†]	4.16	0.25 [72]	
	12.7	4.3 [73]	
Anticoagulation [‡]	8.6	1.1 [74]	
	1.41	0.4 [22]	
	4.8	2.9 [27]	
	7.9	4.4 [90]	
Dysfunction	Pre	Post	
Fracture or breakage			2.76 [7]
Ethanol	0.48	4.15 [88]	1.56 [12]
	1.8	1.53 [87]	0.2 [11]
		5.6 [80]	
		3.68 [7]	
		0.26 [12]	
Occlusion			3.95 [7]
Ethanol	0.82	2.94 [88]	7 [12]
	0.6	0.3 [87]	1 [11]
		6 [80]	
		2.21 [7]	
		5.5 [12]	

CLABSI = central line-associated blood stream infection; CVC = central venous catheter; PICC = peripherally inserted central catheter.

*Reported baseline PICC rates without evaluation of intervention.

[†]Ethanol usage not reported.

[‡]All patients had a catheter-related thrombus, ethanol usage not reported.

for long-term parenteral nutrition (PN) delivered via a central venous catheter (CVC) (1). Long-term central venous access is required while working toward enteral autonomy, the ultimate goal of intestinal rehabilitation. Even with advances in the care of central venous access and decreases in complication rates, CVC related complications pose potentially life-threatening risks and remain a key factor in long-term outcomes 9 (Tables 1 and 2). IF patients often require repeated vascular interventions and commonly develop central line-associated complications, which can result in loss of access (2). With the decline in IF associated liver disease, the common indications for intestinal transplant have shifted with loss of central access playing a major role (3). Loss of access above the diaphragm, in fact, can be a contraindication for multivisceral transplant. The recent establishment of multidisciplinary intestinal rehabilitation programs (IRP) with advances in infection prevention, anticoagulation, and monitoring have been shown to decrease these risks (4,5). With the aim of improving care and outcomes for all children with a prolonged need for central access the Venous Access: National Guideline and Registry Development (VANGUARD) Initiative recently published guidelines for the

TABLE 2. Central venous catheter complication rates in pediatric intestinal failure: venous injury and malposition

Type	Tunneled CVC (rate/1000 catheter days [citation])	PICC Rate (rate/1000 catheter days [citation])
Venous injury		
Stenosis	0.59 [7]	0.87 [7]
Thrombosis	0.15 [7]	0.55 [7], 0.2 [11]
Malposition		
Malposition or Dislodgement	0.15 [7]	1.9 [7]
	0.44 [7]	1.66 [7]
	2.4 [80]	

CVC = central venous catheter; PICC = peripherally inserted central catheter.

preservation of central venous access in children (6). The objective of the present position paper is to review the current literature and provide recommendations regarding important aspects of CVC management for children with IF.

METHODS

Relevant literature was reviewed using PubMed/MEDLINE databases applying the following terms: intestinal failure, short bowel syndrome, central venous catheter, central venous access, parenteral nutrition, central line-associated bloodstream infection, and catheter-related thrombus. Literature searches were conducted through January 31, 2020. Non-English literature was excluded. Sections were completed by individual authors with review and editing of the drafts by the coauthors. The available literature and expert opinion were used by the authors to formulate recommendations for each section. These recommendations were modified and ultimately agreed upon by the Intestinal Rehabilitation Special Interest Group members via electronic and phone communication. A grading method was not used for the recommendations secondary to the limited quantity and quality of the pediatric IF data available. An image library was compiled to show both normal and abnormal findings associated with central venous access (see Supplemental Digital Content Figure 1, <http://links.lww.com/MPG/C152>).

TYPES OF CENTRAL VENOUS ACCESS

Options for central venous access include tunneled CVC, peripherally inserted central catheter (PICC), and implanted central venous access devices or port, each with their own risks and benefits. Tunneled CVC are the most common type of long-term central access for IF patients owing to their stability, durability, longevity, accessibility, and potentially decreased risk of infection (7,8). Traditionally used for short-term central access, PICC lines have been associated with lower rates of central venous thrombosis and with increased risk of peripheral clots, venous stenosis, line breakage, and site infection or phlebitis (8–10). Evidence of infection rates comparing PICC lines and tunneled CVCs is conflicting, with two pediatric IF studies showing decreased or equivalent infection rates and an adult study reporting an increased rate and shorter time to first infection with PICC lines (8,11,12). Cuffed PICC lines carry lower rates of infection, malposition, and thrombus formation compared with uncuffed PICC lines (13). Despite a lower infection risk, ports are typically reserved for patients who require infrequent access as accessing a port requires a needle stick, and over time, with repeated punctures, the membrane or septum that the needle passes through can breakdown (14). The benefits of a