Table 2. Clinical Evidence of Complications Associated with Use of Needleless Connectors

Year, Author	Source (study or clinical report)	Patient Population/ Facility	Number of Lumens	Reported Outcomes
2004, Jacobs[4]	Two sequential cohorts	Pediatric patients/ children's hospital	312 CVC lumens (153 patients) • Group 1: 151 lumens with split-septum NCs and heparin lock • Group 2: 161 lumens with positive displacement mechanical valve NCs and saline lock	Total and partial occlusion: 15.2% CRBSI: 8.8 per 1,000 catheter days Total and partial occlusion: 11.8% CRBSI: 15.5 per 1,000 catheter days
2006, Maragakis[7]	Report of CRBSI increase after product change from negative displacement to positive displacement mechanical valve NCs	Six adult critical care units in a 946-bed tertiary care academic medical center	Number of lumens not provided	CRBSI over nine months with negative displacement mechanical valve NCs: 1.5 per 1,000 catheter days CRBSI over nine months with positive displacement mechanical valve NCs: 2.4 per 1,000 catheter days, a 60% increase ($P = 0.03$); increase in polymicrobial CRBSI: from 6.5% to 14%
		Pediatric and neonatal ICU and oncology patients	Number of lumens not provided	CRBSI over nine months with negative displacement mechanical valve NCs: 1.55 per 1,000 catheter days CRBSI over nine months with positive displacement mechanical valve NCs: 2.79 per 1,000 catheter days, a 79% increase ($P = 0.01$); increase in polymicrobial CRBSI: from 8% to 26%
2006, Schilling[11]	Four sequential cohorts	Pediatric patients/ children's hospital	599 CVC lumens (360 patients) • Group 1: 150 lumens with split-septum NCs with heparin lock • Group 2: 150 lumens with negative displacement mechanical valve NCs with heparin lock • Group 3: 149 lumens with positive displacement mechanical valve NCs with heparin lock • Group 4: 150 lumens with positive displacement mechanical valve NCs with saline lock	Total and partial occlusion: 26 (17.3%) CRBSI: five infections; 5.3 per 1,000 catheter days Total and partial occlusion: 13 (8.7%) CRBSI: three infections; 4.1 per 1,000 catheter days Total and partial occlusion: 11 (7.4%) CRBSI: three infections; 4.8 per 1,000 catheter days Total and partial occlusion: 12 (8%) CRBSI: seven infections; 10.9 per 1,000 catheter days
2007, Field[3]	Report of CRBSI increase after product change from split-septum NC to negative and positive displacement mechanical valve NC	Hematology and oncology patients with newly inserted tunneled, cuffed CVCs in a regional public hospital in Australia	132 lumens in 98 patients; 8,007 catheter days	CRBSI with split-septum NC: 2.6 per 1,000 catheter days CRBSI with mechanical valve NCs: 5.8 per 1,000 catheter days

Table 2. Continued

Year, Author	Source (study or clinical report)	Patient Population/ Facility	Number of Lumens	Reported Outcomes
2007, Rupp[9]	Report of CRBSI increase after product change from split-septum NCs to positive displacement mechanical valve NCs	Patients in a 689-bed academic medical center. Continuous active surveillance data from eight ICU and step-down units, nine nursing units, and two cooperative care units	Number of lumens not provided	CRBSI over 26 months (38,250 catheter days) with split-septum NCs: 3.87 per 1,000 catheter days CRBSI over six months (10,340 catheter days) with positive displacement mechanical valve NCs: 10.64 per 1,000 catheter days CRBSI over six months following return to split-septum NCs: 5.59 per 1,000 catheter days
2007, Salgado[10]	Report of CRBSI increase after product change from split-septum NC to negative displacement mechanical valve NC	Patients in a 59-bed long-term acute care facility	Number of lumens not provided; over 24 months, 20 patients with split-septum NCs and 66 patients with negative displacement mechanical valve NCs	CRBSI with split-septum NCs: 1.79 per 1,000 catheter days CRBSI with negative displacement mechanical valve NCs: 5.95 per 1,000 catheter days
2008, Bowers[34]	Small randomized clinical trial	102 patients with single-lumen PICCs with positive displacement, luer-activated mechanical valve NCs	• Control group: 52 single-lumen PICCs, with heparin lock 100 U/mL, 3-mL heparinized saline flush per PICC • Experimental group: 50 single-lumen PICCs with saline lock	Catheter lumen occlusions: none Catheter lumen occlusions: 3 (6%), not statistically different, but judged too costly
2009, Cesaro[35]	Randomized controlled trial	203 pediatric oncology patients with newly inserted tunneled cuffed catheters receiving chemotherapy or stem cell transplantation	• Control group: 102 catheters (149 lumens) flushed twice weekly with 3 mL saline followed by heparin 2,000 U/mL, closed with a solid end cap • Experimental group: 101 catheters (151 lumens), flushed and locked weekly with saline through a positive displacement mechanical valve NC	Catheters with lumen occlusions: 41 (40.2%) Cases of bacteremia/fungemia: 9 (8.8% of catheters) Catheters with lumen occlusions: 83 (82.2%) Cases of bacteremia/fungemia: 24 (23.8%)
2009, Jarvis[5]	Report of CRBSI increase after product change from split-septum NCs to negative and positive displacement mechanical valve NCs	Patients in three U.S. and two Australian hospitals receiving CVC treatment in 16 ICUs, throughout one entire hospital, and in one oncology unit. Bloodstream infection data were collected during use of both product types, using CDC definitions and surveillance methods	Number of lumens not provided	CRBSI with split-septum NCs: 389 per 63,295 catheter days (6.1 per 1,000 catheter days) CRBSI with mechanical valve NCs: 1,104 per 116,317 catheter days (9.5 per 1,000 catheter days) CRBSI in the 14 ICUs following return to split-septum NCs: 152 per 26,359 catheter days (5.8 per 1,000 catheter days)

CDC = Centers for Disease Control and Prevention; CRBSI = catheter-related bloodstream infection; CVC = central venous catheter; NC = needleless connector; PICC = peripherally inserted central catheter.