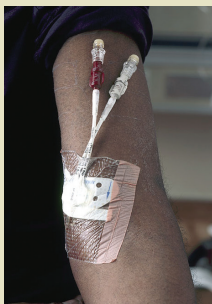


# Central Venous Access Devices: An Investigation of Oncology Nurses' Troubleshooting Techniques

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Experienced oncology nurses use different troubleshooting techniques for clearing occluded central venous access devices (CVADs) with varying degrees of success. The purpose of this study was to explore troubleshooting techniques used for clearing occluded CVADs by experienced oncology RNs and identify the perceived effectiveness of each technique. An invitation for a web-based survey was sent to select RN members of the Oncology Nursing Society. All nurses (N = 224) reported asking patients to raise and/or move their arm. Most nurses asked patients to lie down, cough, and take deep breaths. Respondents considered instilling a thrombolytic agent to be the most effective technique. No associations were found between techniques and respondents' years in oncology nursing, work setting, certification, or academic degree. The findings contribute to knowledge about care of patients with occluded devices and will help formulate direction for additional investigation of CVADs. Establishing the appropriateness of practice-related troubleshooting techniques may eliminate unnecessary steps and save nursing time. Educating nurses on the topic will also help reduce techniques that are not expected to yield results or are contraindicated.

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**V**enous access is of paramount importance to patients with cancer. Numerous facets of cancer treatment and monitoring require dependable blood vessel access, including administration of chemotherapy and other treatment regimens, hydration fluids, parenteral nutrition solutions, blood transfusions, and contrast injections for scannographic tests. Additional factors making reliable venous access an issue for this population are the potential for tissue destruction resulting from extravasated chemotherapeutic agents and the need for ready access for blood sampling. Aside from obvious treatment issues faced by patients with cancer, adequate venous access may be a quality-of-life concern. Anxiety may be associated with repeated and painful venous punctures to provide blood samples for evaluation of laboratory parameters. In addition, the inability to cannulate a peripheral vein for treatment or blood draws can delay much-needed therapy. Central venous access devices (CVADs) answer

this population's need for reliable and convenient venous access. Since the introduction of long-term CVADs in the late 1960s, oncology nurses have assumed much responsibility for the care and management of these devices in patients with cancer.

In addition to care provided immediately following CVAD placement, care is required to sustain CVAD function over time. Ongoing care includes prevention and assessment of complications associated with device maintenance and use. Catheter occlusions are the most common noninfective complication associated with long-term CVADs (Hamilton, 2006; Miller, 2006) and can result from nonthrombotic causes such as drug and lipid precipitation, fibrin sheaths, and catheter tip positioning (Camp-Sorrell, 2011a; Cummings-Winfield & Mushani-Kanji, 2008; Hamilton, 2006; Miller, 2006). Catheter occlusions occur in as many as 36% of all lines (Miller, 2006). The role of oncology nurses includes CVAD assessment and intervention when complications arise.

The purpose of this study was twofold. First, the authors aimed to explore techniques reported by experienced oncology nurses for troubleshooting occluded CVADs. Second, the authors sought to describe nurses' perceived effectiveness of the troubleshooting techniques.

## Background

Although guidelines for the prevention and management of catheter-related infections are available to oncology nurses (Camp-Sorrell, 2011b; Infusion Nurses Society, 2011; Mermel et al., 2009), little is known about an intervention to prevent or manage occlusions such as thrombotic complications. Researchers have investigated the routine use of prophylactic anticoagulation and the administration of thrombolytic agents for partial or full catheter occlusion in patients with cancer using CVADs; however, contradictory results of anticoagulation therapy have been reported (Rawson & Newburn-Cook, 2007; Svoboda et al., 2004; Vescia et al., 2008). National Comprehensive Cancer Network (2014) guidelines are available for the diagnosis and treatment of catheter-related deep vein thrombosis; however, definitive guidelines related to the prevention or troubleshooting of catheter intraluminal complications are not available.

Despite the lack of guidelines, oncology nurses employ a number of techniques when an occlusion is suspected or appar-

ent. Nurses attending a venous access device class, taught multiple times during a 10-year period at the authors' institution, identified noninvasive techniques they used to care for patients with cancer who had occluded CVADs. The literature reveals descriptions of these techniques (Hadaway, 2005; Schulmeister & Camp-Sorrell, 2000), and general guidelines for the care and management of CVADs have been suggested (Gorski, 2003a, 2003b), but a systematic analysis of these techniques was not found in the literature.

Because CVADs are routinely placed in patients with cancer for treatment and monitoring of disease and are cared for by oncology nurses, the gap in knowledge about care for patients with CVADs needs to be explored. The lack of definitive guidelines for troubleshooting and the dissemination of insufficiently tested recommendations for CVAD occlusion necessitate the need to study noninvasive nursing interventions used to troubleshoot occluded CVADs.

## Methods

A cross-sectional, exploratory survey design was used to investigate the venous access troubleshooting techniques of experienced oncology nurses. Prior to embarking on the main study, a pilot study was undertaken to evaluate the (a) ease of completing the online survey, (b) clarity of instructions, and (c) data collection process. A descriptive, exploratory design was used. A convenience sample (N = 26) from an National Cancer Institute-designated comprehensive cancer center in west central Florida was invited to complete the electronic questionnaire for the pilot study. No changes were made to the survey or data collection process based on pilot study results. The pilot study and main study were approved by the institution's scientific review committee and institutional review board.

A list of potential participants was purchased from the Oncology Nursing Society (ONS). RN members of ONS who met the following criteria were included in the query and solicited to complete the questionnaire: (a) more than five years of oncology experience, (b) primary specialty of biotherapy or chemotherapy and outpatient infusion, and (c) registered a U.S. mailing address with permission for it to be distributed.

The investigator-developed Central Venous Access Devices: Troubleshooting Techniques Questionnaire (CVAD: TTQ) was used to collect data from experienced oncology nurses who care for patients with CVADs. The CVAD: TTQ asked about practice-related techniques, perceived effectiveness of the techniques, and referrals to other practitioners. Overall comments also were solicited.

The 14 practice-related techniques in the CVAD: TTQ were based on the personal clinical experiences of two members of the research team, anecdotal feedback from nurses who attended CVAD classes taught by two researchers during a 10-year period, the book *Policies and Procedures for Infusion Nursing* (Infusion Nurses Society, 2011), and recommendations or descriptions in the literature. The practice-related questions used the ordered-category responses of always, most of the time, about half the time, sometimes, and never. The perceived effectiveness of practice-related techniques was measured by 14 questions using the ordered category responses extremely, very, moderately, slightly, and not at all.

TABLE 1. Demographic Characteristics of Nurses Surveyed (N = 224)

Characteristic	$\bar{X}$	Range
Years in nursing	20.7	2–41
Years in oncology nursing	14.8	2–35
Characteristic	n	%
<b>Current work setting</b>		
Hospital-based infusion clinic	57	25
Freestanding infusion clinic	28	13
Private physician office infusion	133	59
Other or missing data	6	3
<b>Employment status</b>		
Full-time	169	75
Part-time	49	22
PRN	6	3
<b>Highest academic degree</b>		
High school diploma	22	10
Associate's	57	25
Bachelor's	109	49
Master's	28	13
Doctorate	3	1
Other responses	5	2
<b>Nursing certifications maintained<sup>a</sup></b>		
OCN <sup>®</sup>	178	79
Advanced oncology certification	12	5
Certified registered nurse infusion	7	3
Other certification	27	12

PRN—per diem nurse

<sup>a</sup> More than one answer could be chosen and not all respondents answered this question.

Note. One nurse with two years of experience was included from the Oncology Nursing Society database.

The CVAD: TTQ further explored nursing CVAD management with the following items: (a) referral of troubleshooting to another healthcare professional (five-level ordered category response), (b) identification of other types of healthcare professionals who may receive referrals (open ended), (c) frequency of dye studies obtained (five-level ordered category response), and (d) a request for additional comments (open ended). Seven demographic questions about nursing experience and work setting appeared at the end of the questionnaire. No personal identifying information was requested.

Nurses from the Oncology Nursing Society's mailing list who met the inclusion criteria (n = 4,720) received a letter requesting study participation. That letter included a link to the survey located on the institution's server and a password to access the survey. Two weeks after the initial mailing, a follow-up thank you postcard was mailed to serve as a message of appreciation to those who had completed the survey and as a reminder to those who had not. Participants were asked to complete the survey within one month. Survey completion implied consent.

Checkbox<sup>®</sup>, a web browser-based application, was used to administer the CVAD: TTQ. This application was housed securely on an institutional server. SPSS<sup>®</sup>, version 17.0, was used for analyses. Psychometric properties of individual items and CVAD: TTQ as a whole, previously assessed in the pilot study, were assessed further in the main study. Internal consistency was assessed using the Cronbach alpha (0.7 for use of technique, 0.768 for effectiveness of technique) and a review of item-to-total correlations. No items were found to have an

## Implications for Practice

- ▶ Use astute assessment and sound judgment to identify and successfully manage central venous access device (CVAD) complications.
- ▶ Provide nursing education, even for experienced oncology nurses, to ensure safe and effective management of CVAD complications.
- ▶ Investigate the actual effectiveness of interventions frequently used by oncology nurses to manage CVAD complications.

item-to-total correlation of less than 0.3; therefore, none were deleted from the final scale. For research questions 1 and 2, descriptive statistics were calculated for each item.

To determine the relationship between CVAD troubleshooting techniques and number of years in oncology nursing, current work setting, certification, and academic degree, item responses were converted to a 1-5 scale, with higher scores indicating extremely effective or always. Pearson Product Moment correlations between items and years in nursing were calculated. For work setting, certification, and academic degree, mean item responses were compared using analysis of variance. Years in oncology nursing were used as a covariate in these latter comparisons (work setting, certification, and academic degree).

TABLE 2. Frequencies and Means of Practice-Related Techniques for Clearing Central Venous Access Devices (N = 224)

Technique	Always		Most of the Time		About Half of the Time		Sometimes		Never		$\bar{X}$	SD
	n	%	n	%	n	%	n	%	n	%		
Ask the patient to raise or move arm.	150	67	52	23	10	5	12	5	–	–	4.25	0.8
Ask the patient to take a deep breath.	126	56	56	25	12	5	24	11	6	3	4.21	1.1
Ask the patient to lie down.	82	37	64	29	41	18	35	16	6	3	3.83	1.2
Ask the patient to cough.	90	40	59	26	28	13	41	18	6	3	3.83	1.2
Do you ever use back and forth technique to flush?	69	31	59	26	24	11	43	19	29	13	3.43	1.4
Do you ever instill a thrombolytic agent?	23	10	94	42	41	18	53	24	13	6	3.27	1.1
Ask the patient to sit up.	41	18	39	17	40	18	75	34	29	13	2.95	1.3
Ask the patient to roll shoulders forward.	39	17	41	18	21	9	72	32	51	23	2.75	1.4
Do you ever use technique of gently flushing?	35	16	41	18	18	8	83	37	47	21	2.71	1.4
Ask the patient to reposition side to back or back to side.	35	16	34	15	25	11	76	34	54	24	2.64	1.4
With implanted ports, do you ever change the needle?	17	8	17	8	21	9	156	70	13	6	2.42	1
Do you ever instill heparin and wait?	15	7	40	18	20	9	75	34	74	33	2.32	1.3
Ask the patient to perform Valsalva maneuver.	11	5	10	5	14	6	55	25	134	60	1.7	1.1
Do you ever flush rapidly against resistance?	4	2	7	3	9	4	38	17	166	74	1.42	0.8

TABLE 3. Effectiveness of Practice-Related Techniques for Clearing Central Venous Access Devices

Technique	Extremely Effective		Very Effective		Moderately Effective		Slightly Effective		Not Effective		$\bar{X}$	SD	Effective Ranking
	n	%	n	%	n	%	n	%	n	%			
Ask the patient to raise or move arm (n = 224).	2	1	28	13	136	61	58	26	–	–	2.88	0.6	6
Ask the patient to take a deep breath (n = 218).	16	7	63	28	101	45	38	17	–	–	3.26	0.8	4
Ask the patient to lie down (n = 222).	23	10	76	34	96	43	27	12	–	–	3.43	0.8	2
Ask the patient to cough (n = 218).	7	3	44	20	103	46	60	27	4	2	2.95	0.8	5
Do you ever use back and forth technique to flush (n = 195)?	19	9	55	25	86	38	33	15	2	1	3.29	0.9	3
Do you ever instill a thrombolytic agent (n = 211)?	100	45	85	38	24	11	2	1	–	–	4.34	0.7	1
Ask the patient to sit up (n = 195).	2	1	8	4	90	40	86	38	9	4	2.53	0.7	11
Ask the patient to roll shoulders forward (n = 173).	1	1	8	4	85	38	78	35	1	1	2.6	0.6	10
Do you ever use the technique of gently flushing (n = 177)?	4	2	18	8	54	24	80	36	21	9	2.46	0.9	12
Ask the patient to reposition side to back or back to side (n = 170).	2	1	22	10	75	34	69	31	2	1	2.72	0.7	8
With implanted ports, do you ever change the needle (n = 211)?	4	2	15	7	51	23	114	51	27	12	2.31	0.9	14
Do you ever instill heparin and wait (n = 150)?	5	2	27	12	57	25	56	25	5	2	2.81	0.9	7
Ask the patient to perform Valsalva maneuver (n = 90).	2	1	4	2	34	15	41	18	9	4	2.43	0.8	13
Do you ever flush rapidly against resistance (n = 58)?	–	–	7	3	25	11	23	10	3	1	2.62	0.8	9

## Findings

A total of 224 nurses participated in the study (less than 5% response rate). The nurses were employed for an average 20.7 years, with almost 15 years of oncology experience. Participants represent an experienced and educated group, with 63% educated at a bachelor's level or higher and almost 96% certified—with the majority (84%) holding certification in oncology (see Table 1).

## Practice-Related Techniques

All nurses (N = 224) reported asking patients to raise and/or move their arm. Most said they asked patients to lie down (n = 222), cough (n = 218), and take deep breaths (n = 218) (see Table 2). Respondents considered instilling a thrombolytic agent to be the most effective technique, followed by these noninvasive techniques: (a) ask patient to lie down, (b) use back-and-forth technique to flush, and (c) ask patient to take deep breaths (see Table 3). No associations were found between techniques and years in oncology nursing, work setting, certification, or academic degree.

More than half the nurses (n = 123) responded to using other techniques not mentioned in the survey, and most provided

multiple responses. Seventy-nine nurses listed having patients turn their head, chin, and/or shoulder, as well as change their position or do light exercise. Fifteen nurses noted having the patient laugh, sing, or talk. In response to the item asking about other medications used, 28 nurses answered and the majority (n = 11) used IV saline. Two nurses listed using thrombolytic agents longer than recommended (i.e., three hours then repeat the next day, if needed, for 24 hours); two reported using dexamethasone to confirm IV placement; and three listed a plan for future maintenance, including increasing heparin flush to 1,000 units (n = 2) and using low-dose warfarin (n = 1) if the problem persisted. Almost all respondents (n = 208) referred patients to another healthcare provider. The majority of referrals were to radiology (n = 119), another nurse (n = 58), or the surgeon or radiologist who placed the line (n = 39).

## Discussion and Limitations

Nurse participants expressed a clear preference for certain troubleshooting techniques, and not all techniques were perceived as effective. Sixty-seven percent of nurses reported a technique not expected to yield results (e.g., instill heparin and

wait). Heparin is used to inhibit coagulation and prevent fibrin build-up (Camp-Sorrell, 2011b), not to dissolve thrombotic occlusions. About 25% of nurses mentioned using a contraindicated technique, such as flushing rapidly against resistance. Resistance—such as that formed by fibrin buildup—increases pressure, which in turn raises the risk of catheter or septum rupture or separation during the flushing procedure (Camp-Sorrell, 2011b). Future research should investigate the actual effectiveness of frequently used interventions for managing occlusion. Priorities should include decreasing occlusion rates as an end point and standardizing definitions of occlusions (Camp-Sorrell, 2010).

Sample size was a significant limitation because response rate to the electronic survey was low. At the time of the study, email addresses were not available for purchase. Offering an electronic invitation for a web-based survey may result in a higher response rate. For example, Nirenburg, Reame, Cato, and Larson (2010) reported findings of a web-based survey sent via email to 309 ONS members, in which a response rate of 50% was received.

## Implications for Nursing and Conclusion

Astute assessment and sound judgment are needed to identify and successfully manage CVAD complications (Cummings-Winfield & Mushani-Kanji, 2008), particularly for oncology nurses, who provide the majority of patients' CVAD care and management. These findings contribute to knowledge about the care of patients with occluded devices and will help formulate direction for future investigation of CVADs. Testing and establishing appropriate troubleshooting techniques may eliminate unnecessary steps and save time. In addition, nursing education is needed to stop the use of techniques not expected to yield results or that are contraindicated, such as instilling heparin and flushing rapidly against resistance.

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