

Evidence-Based Practice for Obtaining Blood Specimens From a Central Venous Access Device

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As part of a scheduled policy and procedure review, the department of nursing education at a large urban academic medical center conducted a literature review to determine the most up-to-date evidence for central venous access device (CVAD) blood draws. The literature review revealed that the dead space blood draw was the best practice methodology because the dead space methodology, defined as the point at which blood is in the attached syringe when aspirating without flushing, reduced the potential for infection with minimal blood loss from blood discard.

To ensure that all nurses were using evidence-based knowledge when drawing blood, the nursing education department at NYU Langone Medical Center developed a nursing competency based on the dead space blood draw methodology. While observing oncology nursing competencies for the new dead space method, the nursing staff's perception was that many laboratory values were unexpectedly skewed (i.e., electrolyte levels were either very high or very low). Hospital policy requires repeated testing for any abnormal values, which results in the drawing and wasting of more blood in direct contradiction to the rationale for practice modification.

A quality and performance improvement (QPI) project was initiated to determine the percentage of error with the dead space method. A secondary aim was to determine the appropriate hold time for IV fluid before obtaining the blood specimen, which addresses a gap in the literature regarding the appropriate time that IV infusions need to be held to ensure accuracy of laboratory results. The QPI project demonstrated that the dead space methodology had an error rate of less than 2% (see Table 1).

This article details a review of the literature that examined the level of evidence regarding four blood draw methodologies and describes the rationale for selection of dead space methodology, a description of a dead space procedure, and a QPI project conducted to determine error rate using the dead space methodology.

Background

Laboratory tests such as complete blood count (CBC) and basic metabolic panel (BMP) are an essential part of monitoring eligibility for, and response to, the treatment of patients with cancer. Pharmacologic interventions often impact these tests, causing a wide variation in results. According to Holmes (1998) and Adlard (2008), an adult patient can lose up to 96 ml of blood per week from 6 ml of blood being discarded prior to the obtaining of each blood specimen needed for analysis. Blood loss from multiple blood draws is a problem, particularly as it may induce or worsen anemia, resulting in blood transfusions. Hemoglobin level often is a deciding factor in the continuation of treatment and is frequently decreased because of chemotherapy regimens. Daily testing requires that the amount of blood wasted or discarded be kept at a minimum. For patients with cancer, transfusions may increase the risk of alloimmunization and febrile reactions. In addition, pediatric, frail, older, or heavily treated patients are at higher risk for complications associated with blood loss resulting from CVAD blood draws.

The best methods for blood collection reduce the risk of infections, occlusions, thrombus formation, and blood loss that require therapeutic interventions (Adlard, 2008; Cole et al., 2007; Cosca et al., 1998; Farjo, 2003; Frey, 2003; Holmes,

1998; Keller, 1994; Moureau, 2004). The focus of this article is to examine error rates using the dead space methodology among patients with cancer.

Blood Draw Methods

Blood draw methods identified in the literature include the discard method, the push/pull method, the reinfusion method, and the dead space method (Adlard, 2008; Farjo, 2003; Frey, 2003; Holmes, 1998; Moureau, 2004; Weigand & Carlson, 2005) (see Figure 1).

Literature Review

The literature was reviewed to determine the best method for blood draws among patients with cancer. The competency and standard of care are based on the evidence. This literature review included CINAHL®, MEDLINE®, Ovid, and PubMed databases with key terms including *central venous catheter*, *blood sample*, *blood specimens*, *central venous access devices*, and all combinations of those terms. The current QPI aims to address the gap in the literature about efficacies of blood draw methods among oncology-specific populations.

Adlard's (2008) review cited studies that reported discard volumes accounting for 24%–30% of blood loss among pediatric patients with cancer, resulting in the need for transfusions. Adlard found that 75% of the pediatric bone marrow transplantation (BMT) units reported using the discard method, 14% used the reinfusion method, and 11% used the push/pull method. Adlard pointed out that the selected blood sampling method varied among the units, and the studies were not designed with the rigor needed to be able to make inferences.

Table 1. Error Rate in Dead Space Method

| CVAD | N | Dead Space | Flush | Skewed Values-Dead Space | Error Rate (%) |
|----------|-----|------------|-------|--------------------------|----------------|
| PICC | 151 | 142 | 9 | 2 | 1.41 |
| Mediport | 100 | 80 | 20 | 3 | 3.75 |
| CVL | 34 | 32 | 2 | 0 | 0 |
| Total | 285 | 254 | 31 | 5 | <2 |

CVAD—central venous access device; CVL—central venous line; PICC—peripherally inserted central catheter

In a prospective, descriptive study, Cole et al. (2007) collected data from 70 pediatric patients with cancer using central venous lines (CVLs) to determine the minimal amount of blood that could be withdrawn while still ensuring a reliable blood test result. Patients were stratified into two groups: one after a 3 ml discard and one after a 5 ml discard. Each patient acted as his or her own control. The investigator reported that no difference in measurement error existed among the two groups; however, the investigator did not report anemia among the two groups or the subsequent need for blood transfusions. Cole et al. (2007) noted that the study findings are limited because patients had a wide variability of lines and, therefore, cannot be generalized. However, the fact that 70 children were included in this study is a strength.

Using a pre- and postintervention survey design, Cosca et al. (1998) collected data from 50 adult patients with cancer to determine the presence of clots at two time points: blood drawn for discard, prior to drawing the blood specimen, and blood drawn immediately after discarded blood and allowed to dwell in the syringe for five minutes. The aim of that review was to determine if the discard blood specimen could be safely reinfused to avoid blood loss in patients with cancer. Fifty percent ($n = 25$) of the discard specimens had clots at the time of blood draw, suggesting that the clots may have been aspirated. The authors noted that this was a surprising finding. Two of the 50 blood draws contained clots. Because the investigators did not use a randomized clinical design that included controls for blood draws and types of catheters (three types were used in the study), whether the clots came from circulation or the catheter is unclear. Additional research should be conducted to determine the risks as-

sociated with reinfusion of discard blood containing clots, including risks associated with the size of clots.

Holmes (1998) collected data from 25 patients with CVADs to compare errors in blood results after drawing specimens using the push/pull versus discard method. Holmes reported that no clinically significant difference existed. A limitation is that only 25 patients were included in this study and they had unspecified diagnoses, making inferences somewhat questionable. Holmes favored the push/pull method as it decreased blood loss, blood exposure to healthcare personnel, potential contamination of the catheter from multiple manipulations, and erroneous results by eliminating the potential for confusing the laboratory specimen with the discard specimen. While a patient waits for engraftment of the bone marrow after a hematopoietic progenitor cell transplantation, the bone marrow is not producing any new blood cells; therefore, keeping the removal of blood to a minimum helps to lessen anemia risk (Keller, 1994).

Using a descriptive survey design, Keller (1994) collected data from 34 pediatric BMT centers to examine the prevalence of three CVAD blood draw methods and to explore clinician concerns associated with each method. The investigators used an 18-item questionnaire to collect data that included CVAD type, blood draw method used, concerns associated with each, and demographics. The questionnaire demonstrated validity and reliability in BMT settings (Keller, 1994). Clinician concerns included formation of blood clots (95%), risk of infection (45%), blood loss (36%), accuracy of laboratory results (21%), interference with universal precautions (3%), and potential for exsanguination (3%). The investigators concluded that a lack of evidence-based support exists for selection of blood draw methodology.

Holmes (1998) and Adlard (2008) agreed that a significant difference did not exist based on the method of blood sampling. Adlard studied the push/pull method and used the discard method as the control. No difference in laboratory results was found; instead, a high degree

of agreement was found regardless of method. Holmes (1998) also studied the push/pull method and compared it against the discard method, with similar results and no significant differences.

Weigand and Carlson (2005) described a procedure for blood sampling using the dead space from a central line. Although the specific information for the dead space volume should be listed in the manufacturers' instruction manual, generally, the dead space volume is required to be withdrawn until blood is present in the syringe. Weigand and Carlson stated that this amount will

Discard Method

- Withdraw 6 ml or greater
- Discard

The most basic method consists of withdrawing approximately 2 times the volume of the catheter.

Push/Pull Method

- Saline flush
- Aspirate blood 3–5 times prior to obtaining sample

Optimal for minimal blood loss; however, includes risk of hemolysis and alterations in the returned blood

Reinfusion Method

- Withdraw 6 ml or greater
- Withdraw samples
- Reinfuse initial blood drawn

Adds to the risk of introducing organisms into the central venous access device and causing infection and may cause confusion as to which syringe contains the specimen and which contains the blood to be returned to the patient. However, this can be decreased by using a closed system, which would ensure that any blood withdrawn as a waste is never disconnected from the patient and is reinfused.

Dead Space Method

- Withdraw until blood enters the syringe
- Discard

A safe and effective way to decrease blood loss without the risk associated with other methods. This method was selected because it decreases the risk of infection and minimizes blood loss during sampling.

Figure 1. Blood Draw Methods

Note. Based on information from Adlard, 2008; Farjo, 2003; Frey, 2003; Holmes, 1998; Moureau, 2004.

clear the line of any flush solution and the blood that was diluted from the flush solution; also, when withdrawing a specimen for coagulation studies, the amount discarded should be six times the amount of the dead space. The present QPI project seeks to address a gap in the literature regarding the dead space methodology.

Development of the Procedure

The NYU Langone Medical Center uses the Marker Model (Smith-Marker, 1988) to develop evidence-based best practice standards, policies and procedures, guidelines, and care pathways. The Marker Model provides a framework for standardized development, ensuring a collaborative process drawn from diverse clinical expertise across settings. Professional practice at the organization is founded on the standards model, which uses a theory- and evidence-based cognitive approach. The standards model facilitates and relies on a participative management style and interdisciplinary collaboration. The Patient Care and Nursing Standards/Quality Improvement, Departmental and Interdisciplinary Structure Standard includes processes for identification of need, structure standards development, standards development, outcome standards development, approval, implementation of standards, and education of standards.

A standardized dead space method procedure was developed (see Figure 2), consistent with the review of the literature and recommendations made by Weigand and Carlson (2005). The procedure defines actions and behaviors for blood draws using the dead space methodology and incorporating AACN guidelines. The AACN guidelines serve as a reminder that the dead space will vary based on the catheter in use (information found in the materials provided from the manufacturer). The guidelines were more specific to arterial lines rather than CVADs. This article addresses the best practice for obtaining blood samples by providing a standardized procedure for CVADs.

Using a combination of Langone Medical Center's procedure for central venous catheter blood and arterial catheter blood sampling, the author, in collaboration with the nursing education department at NYU Langone Medical Center oncology nursing practice coun-

cil, developed a procedure for hematology- and oncology-related specimens to be collected from adult and pediatric patients when a CVAD is present.

The new procedure incorporated changes such as the nurse wearing a facemask while accessing the lumen of a CVAD and not discarding or wasting a large volume of blood prior to obtaining a specimen. Facemask use, although the standard of care for pediatric patients with cancer, had not previously been the standard for the adult patient population.

Quality and Performance Improvement Project

The goal of the QPI project was to prevent blood volume loss by obtaining the smallest amount possible whenever laboratory specimens were required. The implementation of this standardized procedure required exclusive use of the dead space method unless no immediate blood returned from the CVAD. The first step involved the nurse discontinuing any IV fluids for a full minute; then attaching an empty syringe and withdrawing the dead space fluid, without flushing the line, until twice the dead space was reached. If the CVAD was heparinized and coagulation studies were to be drawn, then, if no other tests had been ordered, the dead space would be multiplied by six. Otherwise, the coagulation tests were drawn after all other specimens had been collected. Once the dead space fluid was obtained, the nurse discards the waste syringe and attaches a vacutainer for specimen collection. In the case of no blood return, the nurses were instructed to use the flush method, similar to the discard method. After IV fluids had been held for one minute, the CVAD is flushed with 10 cc NS (normal saline); 10 cc of blood is then aspirated and discarded prior to obtaining specimens. The flush method was written into the standardized procedure (see Figure 3) as an alternative method for withdrawal issues. The Infusion Nurses Society ([INS], 2006) recommended different techniques to obtain specimens from an implanted port. Those techniques differ from other varieties of CVAD; however, the aim of standardizing care prompted treatment of implanted ports the same as any other CVAD.

The INS (2006) suggested discontinuation of all IV fluids; although, a standardized period of time for discontinuation has not been established, and the lit-

1. Verify order from doctor or nurse practitioner.
2. Gather necessary supplies.
3. Identify patient.
4. Explain procedure to patient.
5. Wash hands, don gloves.
6. Stop any IV infusions.
7. Disconnect IV tubing from access port and place a nonvented cap at the end of the tubing.
8. Allow one minute to pass prior to withdrawing any blood.
9. Place sterile 4 x 4 under sampling port.
10. Cleanse access port with alcohol swab for 10 wipes or 3 seconds (whichever occurs first).
11. Attach syringe to reflux valve.
12. Aspirate two times the volume of the dead space to discard as waste. If the line is heparinized and coagulation studies are required, draw six times the dead space.
13. Remove discard syringe from lumen.
14. Attach vacutainer to lumen.
15. Obtain blood specimens via vacutainer.
16. Remove vacutainer.
17. Flush line with 10 cc NS.
18. Reattach any IV fluids that had been infusing prior to blood sampling.
19. Dispose of vacutainer and waste syringe in appropriate receptacles.
20. Label tubes with patient name and medical record number after identifying patient using two identifiers.
21. Place specimens in specimen bag and send to laboratory via pneumatic tube system.

NS—normal saline

Figure 2. Dead Space Method

erature does not provide any additional information regarding it. For the QPI project, it was decided that one minute would be an adequate amount of time. Because of time constraints related to the urgent need for the new procedure, the INS listserv, which enables many individuals and organizations to offer their input on the issue, was not used. Instead, the collaborating group determined one minute was sufficient, which proved as such in the QPI project when accurate laboratory results were found.

Methods

The project took place at NYU Langone Medical Center, a Magnet®-designated hospital located in the New York metropolitan area. The QPI project seeks to understand the error rate for the dead

1. Verify order from doctor or nurse practitioner.
2. Gather necessary supplies.
3. Identify patient.
4. Explain procedure to patient.
5. Wash hands, don gloves.
6. Stop any IV infusions.
7. Disconnect IV tubing from access port and place a nonvented cap at the end of the tubing.
8. Place sterile 4 x 4 under lumen to be used for sample.
9. Cleanse lumen with alcohol swab for 10 wipes or 3 seconds (whichever occurs first); allow to dry.
10. Attach 10 cc NS flush to reflux valve.
11. Flush lumen per standard.
12. Withdraw 10 cc of blood into the flush syringe.
13. Remove from lumen and attach vacutainer.
14. Draw specimens via vacutainer.
15. Remove vacutainer.
16. Flush lumen with 10 cc NS.
17. Reattach any IV that had been infusing prior to obtaining blood sample.
18. Dispose of vacutainer and waste syringe in appropriate receptacles.
19. Label tubes with patient name and medical record number after identifying patient using two identifiers.
20. Place specimens in specimen bag and send to laboratory via pneumatic tube system.

NS—normal saline

Figure 3. Flush Method

space method of blood draw and to determine if the dead space method is the safest and most effective blood draw method. The study used 285 blood samples drawn from a variety of patients ($n = 285$) with hematologic or oncologic malignancies. The convenience sample was obtained on the inpatient hematology and oncology unit. The inclusion criteria included the presence of a standard CVAD (i.e., peripherally inserted central catheter [PICC], CVL, or Mediport). All patients who did not have a CVAD were excluded. Of 285 specimens, 254 were obtained via the dead space method, and 31 were obtained using the flush method. The specimens were obtained from PICCs ($n = 151$), Mediports ($n = 100$), and CVLs ($n = 34$).

Inpatient oncology unit nurses attended in-service education sessions regarding the dead space method for obtaining blood specimens. Written copies of the procedure were provided,

outlining the steps to follow for obtaining CVAD blood specimens.

Data collection occurred throughout December 2009 and was performed by any nurse ($n = 30$) caring for a patient who required a blood draw. The nurses completed a form that requested medical record number, type of CVAD, and, if there were any fluids infusing, what type for each specimen collected. The majority of the blood specimens were obtained by the night shift nurses for required morning laboratory tests. Nurses would monitor results and mark if they were normal or skewed. Skewed results led to repeat blood draws by day-shift nurses. Repeat specimens were obtained using the standardized flush method procedure. Then, results were marked in the normal range or as remaining skewed.

Results

The collaborative group determined that an acceptable rate of error would be 5%. The percentage of error using the dead space method was 2%; the level of accuracy was 98%, showing that the dead space method is effective for the adult oncology unit patient population with CVADs. The extremely low percentage of error with the dead space method supports its use in adult patients with cancer. Only 5 of 254 results were skewed, and repeated tests via the standardized flush method were in normal limits, a true percentage of error.

A secondary aim of this study was to determine the length of time required for holding any infusing fluids. One minute proved sufficient because results were not skewed from lumens that had fluid infusing prior to collection. No literature was found regarding the length of time infusing fluid should be held prior to drawing blood specimens; had the time frame increased the number of skewed results, it would have been re-addressed. A shorter time frame may be adequate but was not tested at this time.

The QPI project was performed in an oncology unit; therefore, the results were not compared to textbook norms. Patients' laboratory result trends were considered. For example, if the patients' hemoglobin had been in the 8 g/dl range (normal range 12–15.5 g/dl) for the previous day or two, it would not have been considered abnormal for study purposes. Results were considered skewed with more than a 15% discrepancy from the previous patient's result.

The project was performed using a single institution convenience sample with multiple oncologic diagnoses, therefore, generalizability may be a limiting factor. Pediatric patients with cancer also need to be examined to determine the dead space method's efficacy. Although the dead space method, is being used in practice, the project could be replicated easily. The dead space blood draw method demonstrated feasibility in patients with cancer despite the project's limitations.

Implications for Nursing

The oncology nurse caring for patients with CVADs can impact nursing-sensitive outcomes such as infection rate, decreased blood volume loss from laboratory specimen blood draws, less blood draw-induced hypovolemia and anemia, fewer blood transfusions, and fewer repeated blood draws. Bedside nurses access and use CVADs on a daily basis, therefore, their input is most valuable regarding the use and care of these lines. Keller (1994) stated that nurses are essential in the management of CVADs and that it is in their realm of practice to determine evidence-based practices. This project addressed a gap in the literature regarding the oncology and hematology patient populations, who are at higher risk of negative outcomes related to blood draw methods.

The author gratefully acknowledges Frances Cartwright, PhD, RN, AOCN®, for her editorial assistance and the staff nurses of 16 East NYU Langone Medical Center for their assistance in blood collecting.

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Digital Object Identifier: 10.1188/12.ONF.247-251

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