Nurses’ knowledge of intravenous connectors

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Abstract
No published studies assess the knowledge of staff nurses regarding intravenous connectors, yet connectors remain a primary cause of infection and mortality. Anonymous survey (N = 100) in acute hospitals revealed 78% of nurses were uninformed about different connector types and their different care and 43% could not name two complications of connectors. No significant relationship was found between education (r = 0.121, p < 0.05) or nursing specialty (r = −0.059, p < 0.05) and identifying types of connectors. Sixty-four per cent were involved in 5–6 hours of intravenous therapy and maintenance per 12-hour shift, hence connector care is significant. Education about connectors has implications for nursing associated with catheter-related bloodstream infections, occlusion and thrombosis. The Centers for Disease Control includes catheter-related bloodstream infections as a worldwide priority. This study identified a significant need for further nursing education and research regarding the types, maintenance and care of intravenous connectors.

Keywords
connectors, intravenous, vascular access, nursing

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**Introduction**

There is confusion among staff nurses about the different fundamental types of intravenous (IV) connectors used in caring for patients with vascular access. An electronic review of the literature using the terms ‘vascular access’ and ‘connectors’ yielded one article from MEDLINE and 34 from CINHAL in the years 1996 to July 2009. Most of the articles were not research and spoke of either animal models, legal aspects (Scales, 2009) or side effects such as infection, air embolism and occlusion. There are two large studies, in the United Kingdom and Canada, that reveal problems with systems, equipment and protocols and their importance to avoiding errors (Baxter Healthcare, 2007; National Audit Office, 2005) and several professional organisations worldwide produce standards of care for intravenous and vascular access. These organisations include the Association for Professionals in Infection Control and Epidemiology, Inc. (USA), Centers for Disease Control (USA), Evidence Based Practice in Infection Control (UK), Infusion Nurses Society (USA), Oncology Nursing Society (USA), Royal College of Nursing (UK), and Vascular Access Society (The Netherlands). However, there were no studies that assessed nursing knowledge of intravenous connectors. Hence, there is a large gap in the scientific literature with regard to nursing knowledge, care and maintenance of connectors. Most literature is manufacturer devised and/or driven. There are three classifications of fluid displacement connectors and they are referred to as positive, negative and zero (formerly called neutral). Until now, no research studies have been initiated related to knowledge of staff nurses regarding connectors.

**Review of literature**

The intravenous connector is the gatekeeper of the intraluminal fluid pathway and is used in hospital as well as community settings (O’Hanlon et al., 2008). Care and maintenance of IV connectors has been shown to be related to catheter occlusions and catheter-related bloodstream infections (Jarvis et al., 2005; Maragakis et al., 2006; Rupp et al., 2007). Proper care and maintenance of an intravenous connector (Casey et al., 2003; Dougherty and Watson, 2008; Macklin and Chernecky, 2004; Weinstein, 2007) is foremost to successful patient outcomes including the avoidance of occlusion, bloodstream infections and thrombus formation (Gallieni et al., 2008). These issues are important to patients and clinicians because there are related to mortality and tragic patient care errors have occurred (Simmons, 2006). Education is one major tool that can help eliminate problems and increase positive outcomes.

Needlefree IV connectors first entered the healthcare system in 1991. Design focused on simple needlefree connection to reduce the rate of needlestick injuries to healthcare workers (Casey and Elliott, 2007). The first design was what is referred to as split septum. It allows a blunt cannula to connect by entering an existing slit. By the mid 1990s the design had advanced to allow direct luer connection without the added cannula. All of the various connectors had associated reflux with disconnection. This reflux resulted in increased catheter occlusion (Casella and Jarvis, 2007). With every disconnection fibrin layers built up on the inner surface of the intraluminal fluid pathway which led to partial or total occlusion (Rummel et al., 2001). To resolve the occlusion problem the positive pressure connector entered the market in the late 1990s. This design moved the reflux from disconnection to connection. With connection a negative pressure occurs and then with disconnection the pressure is released with a final push. This final push is designed to
clear the catheter. Reduction in occlusion rates with the use of a positive pressure connector has been irregularly reported in the literature (Schilling et al., 2006). However, the intraluminal fluid pathway continues to experience the on-going surface conditioning of fibrin caused by reflux. By the year 2000 positive pressure connector designs had been associated with an increase in catheter-related bloodstream infections (CR-BSIs) (Casey et al., 2003; Marschall et al., 2008). In 2004 an intraluminal protection system entered the market. It has zero reflux with connection or disconnection. Recent evidence reveals that occlusions and CR-BSIs occur less frequently using a zero fluid displacement connector design (Caillouet, 2008).

To prevent the re-entry of blood associated with negative IV connectors, the nurse during disconnection is required to apply pressure to the syringe barrel, close the catheter clamp and then remove the syringe. In addition, when the nurse initiates a procedure she must insert the syringe into the connector, put pressure on the syringe barrel and then open the clamp, otherwise the reflux that was minimised with disconnection will occur when the clamp is opened. The clamping sequence with positive pressure connectors is just the opposite. In order for the negative pressure to occur the clamp must be open with connection and not clamped until after disconnection. If the clamping sequence used with negative system connectors is used with a positive pressure connector it prevents the final disconnection push and over time can lead to suboptimal connector action. The zero fluid displacement design requires no special clamping sequence.

Knowing whether a positive or negative pressure system is being used is important. There are institutions that have several different IV connectors available for use by nurses and healthcare personnel. Also, the use of ‘pulled’ nurses or agency nurses can make appropriate care difficult and inconsistent. Occluded central venous access devices (CVADs) can cause an increase in the use of thrombolytics and cost for patients and the institution, as well as a delay in treatment, and a decrease in patient satisfaction.

Occlusions are also associated with increased CR-BSI. Micro-organisms, especially *Staphylococcus aureus* and *Staphylococcus epidermidis*, the two most common micro-organisms associated with CR-BSIs (Gallieni et al., 2008), adhere to fibrin. The intraluminal protection provided by the IV connector with zero fluid displacement has made a recent positive impact on complication reduction but will not be discussed in this article as its use was not widespread during the implementation of this study.

The problem of CR-BSI is well defined by the Centers for Disease Control &Preventions (CDC) in relation to devices with connectors (O’Grady et al., 2002). Patients with long-term vascular access devices and those who are immunosuppressed are at increased risk for acquiring CR-BSIs, also called catheter-associated bloodstream infections (CA-BSIs), by microbes that frequently gain access through an IV connector septum (Menyhay and Maki, 2006). The cost of CR-BSIs has been calculated to be approximately £24,111 or $40,000 per episode (Rello et al., 2000; Soufir et al., 1999), making it a relevant cost issue. Recent research studies have begun to explore the use of antiseptic caps (Menyhay and Maki, 2006), external coated catheters (Bassetti et al., 2001) and disinfectable, needlefree connectors (Yébenes et al., 2004) to reduce CR-BSIs. Several studies reveal that specific connectors increase bloodstream infections (Field et al., 2007; Karchmer et al., 2005; Rosenthal 2006; Rupp et al., 2007).

In general, to prevent catheter-related complications, patient care relies completely on nurses appropriately swabbing prior to access, with the intervention based on specific device type, and flushing after usage. The purpose of flushing is to clean the intraluminal surface of
fibrin and prevent surface conditioning. One flushing option is using a pulsatile (push–pause) method creating turbulent flow (Dougherty, 2000).

**Purpose**

Two main purposes of this study were to describe the current nursing knowledge regarding connectors and identify the most effective teaching modalities for nurses to increase compliance with maintenance of connectors.

**Theoretical framework**

Orem’s Self-Care Deficit Nursing Theory (Orem, 1995) was the framework for this study. According to this theory nurses use their specialised capabilities to create helping systems. In order to be helpful the nurse must understand the differences and similarities between connectors. Once the nurse has this knowledge she/he can use it in a wholly compensatory system of helping patients who have an existent or potential problem with self-care deficit of vascular access where use of a connector is employed.

**Definition of Terms**

IV connector = device that connects to the IV catheter hub and allows needlefree access to the catheter; reflux = blood movement into the catheter as a result of connection to or disconnection from the IV connector; negative IV connector = movement of blood into the catheter with disconnection; positive IV connector = movement of blood into the catheter with connection; zero fluid displacement IV connector = no movement of blood into the catheter with either connection or disconnection.

**Methodology**

An anonymous questionnaire (Table 1) to collect data on nursing knowledge of IV connector devices, designed by the principal investigators, was distributed to intensive care, medical-surgical, and specialty units within one community and one tertiary hospital in the south-eastern United States. A 16-item self-developed questionnaire related to connectors was reviewed by an expert panel of advanced practice nurses in research, oncology, and vascular access. A cover letter was attached to each anonymous questionnaire stating the purpose of the study, that this study used a non-identifier method of gathering data, the questionnaire could only be filled out once by each nurse, that the study was voluntary, and the need for subjects to be English speaking, able to write English, be 21 years or older and a RN or LPN. A locked survey collection box was posted at nursing stations at each hospital. The questionnaires were returned to this central location on the nursing units and collected by the principal investigators during the timeframe of one week. The subjects were made aware of this survey by verbal announcements at report time and during unit meetings. The survey included questions concerning the nurse’s background, their current knowledge of connectors, and ways to improve or deliver education to the nursing staff. The nursing staff who completed the questionnaire consisted of registered and licensed practical nurses. The surveys were collected and the data were recorded and
Table 1. Nursing knowledge questionnaire about IV connector devices

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| 1  What is your highest level of nursing education?  
   A) LPN/LVN  B) Associate  C) Diploma  D) Bachelor  E) Master  F) Doctorate |
| 2  Which shift is the primary shift you work?  
   A) Day (7 a.m.–3 p.m.)  B) Day–Evening (7 a.m.–7 p.m.)  C) Evening (3 p.m.–11 p.m.)  
   D) Evening–Night (7 p.m.–7 a.m.)  E) Night (11 p.m.–7 a.m.) |
| 3  What is your time commitment for your primary position at the current facility?  
   A) Part-time  B) Full-time  C) PRN |
| 4  What is your area of nursing specialty?  
   A) Critical Care  B) Telemetry  C) Medical-Surgical  
   D) Oncology  E) IV Therapy  F) Other_________ |
| 5  How many hours during your shift are you involved with IV therapy (infusion and maintenance)?  
   A) 0 hrs  B) 1–2 hrs  C) 3–4 hrs  D) 5–6 hrs. |
| 6  Have you been educated within the last year on your institution’s policy in regards to the use of IV connectors?  
   A) Yes  B) No |
| 7  What is the primary incentive that would make you want to learn more about IV connectors?  
   A) money  B) time off  C) flexible schedule  
   D) availability of resources  E) other___________________________ |
| 8  What do you feel is the most effective method in educating the staff on your unit about IV connectors?  
   A) posters  B) handouts  C) e-mail  
   D) hands-on demonstration  E) staff meeting  F) computer based/online training  
   G) other __________ |
| 9  Please rate how supportive your manager is of staff education in regards to daily nursing care.  
   1  2  3  4  5  
   Not Supportive  Occasionally Supportive  Very Supportive  Supportive |
| 10 Prior to entering this study, did you know there are four different types of IV connectors (split septum, standard swabbable luer, positive pressure, zero) that can be connected to the hub of an IV line?  
   A) Yes  B) No |
| 11 Do you believe that all four different types of IV connectors (split septum, standard swabbable luer, positive pressure, zero) are maintained the same way?  
   A) Yes  B) No |
| 12 Please write which type of IV connector (not the name brand) you use in your facility.  
   ________________________________ |
| 13 Please name two complications related to improper maintenance of these IV connectors.  
   1._____________________  2. _____________________ |
| 14 What percentage of the time do you follow your institution’s policy regarding nursing care and maintenance of these IV connectors?  
   A) 0–25%  B) 26%–50%  C) 51%–75%  D) 76%–100% |
analysed by the principal investigator and sub-investigators. Once the data were recorded and analysed, all surveys were shredded.

This research protocol met criteria for exempt review. This study was reviewed by the Human Assurance Committee at the Medical College of Georgia and both hospital sites. There was no informed consent associated with this study since a non-identifier questionnaire was used.

**Sampling**

The convenience sample consisted of 100 volunteer nurse participants. Inclusion criteria included: subjects of 21 years of age or older, women of child-bearing age were not excluded, and all subjects were able to read, write and speak English. Exclusion criteria included: subjects less than 21 years of age and subjects who were not able to read, write or speak English.

**Instrumentation**

A self-developed 16-item questionnaire included items related to education level, shift worked, full versus part-time status, area of specialty within nursing, number of hours involved in IV therapy per shift, preferred methods of education, and IV connectors.

**Results**

Data were entered based on the development of a research code book. Frequency and correlational data were analysed using SPSS© Inc. statistical software.

The sample consisted of 98% registered nurses (6% Diploma, 44% ADN, 45% BSN, 5% MSN) and 2% licensed practical nurses. Most nurses (56%) worked the 7a.m.–7p.m. shift. Other shifts included 7a.m.–3p.m. (24%), 7p.m.–7a.m. (18%) and 11p.m.–7a.m. (2%). Seventy per cent were full-time, 15% part-time and 15% prn (pro re nata, as needed). Most nurses worked in critical care (41%) followed by telemetry (37%), medical-surgical (15%) and the IV Therapy Team (7%).

Sixty-four per cent of nurses stated that they were involved in at least 5–6 hours of intravenous therapy and maintenance per 12-hour shift with another 16% involved in 3–4 hours per 12-hour shift. Eighty per cent had been educated in the last year on the institution’s IV policy, which contains general connector information.
Primary learning incentives included availability of resources (41%), money (23%), other (22%), flexible scheduling (9%) and time off (5%). The most preferred method for educating staff about connector maintenance was overwhelmingly hands-on (68%). Other education methods included 3% for posters, 3% handouts, 2% computer-based training, 1% email and 1% staff meeting education (Figure 1). There was no relationship between nursing specialty and education method (Pearson’s $r = 0.000$, $p < 0.05$). Managerial support for education was ranked as very supportive (50%) and mostly supportive (33%).

When it came to identifying the type of IV connector used in the respective facility, 54 out of 85 subjects stated one of the four types (30 standard luer, 13 split septum, 10 positive, and 1 zero) with 31 naming connector types that do not exist. There were 15 subjects who gave no answer. The researchers have no way of determining whether the subjects who named one of the four types answered correctly but the researchers do know that zero connectors were not used at either site and that split septum connectors were not used at one site. There was no significant relationship between education and identifying types of connectors ($r = 0.121$, $p < 0.05$) or nursing specialty and identifying types of connectors ($r = -0.059$, $p < 0.05$). Naming two complications related to improper maintenance of connectors revealed 21% clots, 8% loose site and 5% each for leaks and occlusions. There were 43% who did not answer this question. There were 85% of staff who felt they followed their institution’s policy regarding care and maintenance of connectors 76–100% of the time. A vast majority (92%) believed maintenance of connectors had to do with decreasing bloodstream infections though there was no significant relationship between nursing specialty and decreased bloodstream infections ($r = 0.128$, $p < 0.05$). The majority of nurses (95%) stated they cleansed the connector with alcohol prior to accessing the IV line, which was policy, but we do not now if it was effective or efficient.

During the study 78% of nurses reported that they were not aware that there were four category types of intravenous connectors (split-septum negative pressure, standard swabable

![Figure 1. Education methods for connectors](image)
luer negative pressure, positive pressure, and zero) and 30% believed all types were maintained the same way (Figure 2). All five education levels of nurses (from LPN to Master’s degree) reported that they did not know there were four category types of connectors (Figure 3). Education seemed to begin to make a difference at the Master’s level, though the findings were not statistically significant ($r = 0.000, p < 0.05$).
Discussion

Educational degree, shift worked, or work status were not factors associated with knowledge regarding the identification and maintenance or care of connectors. Although nurses are supportive of decreasing poor patient outcomes, such as CR-BSIs, they lack the knowledge associated with identification, assessment, and implementation of IV connectors that would impact outcomes. This supports Orem’s theory where the nurse must first understand the differences and similarities between connectors. With staff nurses and management supportive of educational needs the timing is appropriate to offer hands-on education in efforts to increase patient care outcomes, in particular to decrease catheter related bloodstream infections and occlusions. This is an area of nursing specifically suited to Clinical Nurse Specialists, nurse educators, and researchers. The fact that nurses lack knowledge in the area of IV care including connectors is a crisis especially since this care encompasses approximately 50% of their patients’ care per shift. We hope nurse executives, the Joint Commission, World Health Organization, IV nurses, advanced practice nurses, staff nurses, nurse educators, and nursing organisations worldwide rise up to meet this need for education on connectors and more broadly into vascular access therapy in general.

In conclusion, a significant need was identified for further nursing education regarding the types, maintenance, and care of connectors. The health care environment is inundated with the use of modern technology and computer-based training. This research indicated that the back to basics approach using hands-on demonstration is the preferred method of education for attaining competency in the usage of connectors by nurses. Currently there is a great need to educate nurses on connectors in order to decrease bloodstream infections and occlusions, which can result in positive patient outcomes worldwide.

Limitations

This study was carried out in only two hospitals in the south-eastern United States. There are no reliability or validity data on the questionnaire. The sample was one of convenience and is too small in size to detect differences.

Conclusion

A large-scale international study, using an updated (i.e. adding the zero device) yet similar questionnaire and targeting nurses, physicians, and students, is warranted to determine knowledge deficits and best education practices to increase knowledge in these three healthcare providers. Once the deficits and education mode(s) are determined then programmes can be established to meet these needs with research initiatives implemented and outcome criteria assessed for effectiveness. Since the Institute for Healthcare Improvement (IHI) 100,000 Lives Campaign (Institute for Healthcare Improvement, 2007) ranks CR-BSIs as a National United States priority it is imperative that nurses rise to the challenge and take the lead to assist in solving this problem.

Abbreviations

CA-BSI = catheter-associated bloodstream infection; CDC = Centers for Disease Control & Preventions; CR-BSI = catheter-related bloodstream infection; CVAD = central venous access devices; IV = intravenous.
References


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