Needleless Connectors:
Improving Practice, Reducing Risks

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Abstract

Purpose: To assess the knowledge gap of healthcare workers about practice with needleless connectors.

Background: Catheter-related bloodstream infection (CR-BSI) and lumen occlusion can be directly related to practices of cleaning needleless connectors, IV administration set management, and flushing and clamping methods.

Review of Relevant Literature: Five publications report outbreaks of CR-BSI from hospitals in the US and Australia. A significant increase in CR-BSI rates after an organizational change of products was observed. No randomized controlled trials are available from the USA comparing types or designs of needleless connectors.

Device instructions state some devices can be locked with normal saline. Two randomized clinical trials assessed outcomes with catheter lock solution. Both reported higher rates of occlusion with the use of normal saline only and one documented a higher rate of CR-BSI.

Methods: An invitation to participate in a survey with 22 questions was sent electronically to approximately 4000 healthcare workers with a response from 554 in clinical practice.

Results: The specific type of needleless connector being used was unknown by 25% and correct clamping sequence was chosen by 52.8% of respondents. The majority, 94.3% reported that they always clean these devices before each use, however there are differences in technique.

Conclusions: There is a significant gap of knowledge about the specific needleless connectors being used, the most appropriate cleaning, flushing, and clamping sequence for the specific device.

Implications for Practice: Staff education should focus on the connections between needleless connectors, CR-BSI and lumen occlusion. Frequent product training on needleless connectors, the specific type in use and correct techniques are necessary.

Needleless connectors were first introduced about 20 years ago to protect healthcare workers from needlestick injuries when intravenous (IV) administration sets, syringes and catheters are connected. While this goal was successfully achieved, there has been increasing concern over multiple issues associated with their use. There are numerous device designs and ways they function (L Hadaway & Richardson, 2010), which dictates how each device must be flushed and clamped. Yet the end-user frequently does not understand the importance of these technique-related issues.

These factors, along with the increasing complexity of infusion therapy, can produce confusion for those making purchase decisions and the end-users. We conducted a survey of healthcare personnel responsible for administering infusion therapy to gain a greater understanding of current clinical practices and identify knowledge gaps as applicable to needleless connectors.

The Inside Story

Catheter-associated complications originating inside the catheter lumen can result in the delay or disruption of infusion therapy, slows the patient's progress toward therapeutic goals, increases length of stay and increases cost of care.(Gorski, Perucca, & Hunter, 2010) Introduction of organisms through the catheter lumen produce intraluminal biofilm. After a week of dwell, there is more biofilm on the catheter's intraluminal surface than on the extraluminal surface.(Ryder, 2005) Many recommendations to decrease catheter-related bloodstream infection (CRBSI) focus on the insertion procedure and extraluminal sources of organisms yet the catheter hub requires equal attention to reduce intraluminal introduction of organisms.

Some types of needleless connectors have been associated with unintended consequences of increased risk for bloodstream infection. Five publications report outbreaks of CRBSI during the

initial period using one type of needleless connector followed by a dramatic increase when a new product was introduced. During the initial period, one hospital was using a negative displacement mechanical valve while all others reported using split septum devices. Following a change of products to either negative or positive displacement mechanical valve needleless connectors, routine surveillance documented a significant increase in rates of CRBSI. Some of these reports provided details of returning to their original product with a subsequent reduction in rates of CRBSI.(Field et al., 2007; Jarvis et al., 2009; Maragakis et al., 2006; Rupp et al., 2007; Salgado, Chinnes, Paczesny, & Cantey, 2007) At present, there are no randomized trials comparing different types of needleless connectors, making it difficult to determine the actual risk associated with each type. Table 1 lists the possible reasons for this increase.

Blood is frequently aspirated into the lumen to assess for catheter patency. Additionally, blood can reflux into the catheter lumen due to many factors including rebound of the traditional syringe plunger rod, connection and disconnection of a set or syringe to the needleless connector, empty fluid containers, changes in intrathoracic pressure and excessive muscular contractions leading to catheter compression. (LC Hadaway, 2006) Plasma proteins attach to the catheter surface and produce a fibrin layer.

Elimination of heparin lock solution and reducing thrombotic catheter lumen occlusion are often the primary reasons for use of a positive displacement or neutral needleless connector, however there are no studies showing improvement of this complication. Randomized controlled trials have shown an increase in occlusion with positive displacement needleless connectors when normal saline is used for catheter locking. A small trial with 4 and 5 French peripherally inserted central catheters (PICCs) applied the same positive displacement mechanical valve needleless connector to all catheters. Patients were randomized to receive normal saline flush followed by a heparin lock or normal saline for both the flushing and locking procedure. The group with normal saline had 6% (3 of 50) occlusion and the group with heparin lock had no lumen occlusions. Due to the small number of patients in the study, this did not reach statistical significance, however the authors reported that treatment with fibrinolytic agents in 6% of their PICCs annually would be cost-prohibitive.(Bowers, Speroni, Jones, & Atherton, 2008)

A study of 203 pediatric oncology patients with newly inserted tunneled cuffed catheters found higher rates of infection and occlusion in the normal saline-only group. The control group received a twice-weekly flush with normal saline followed by heparin lock solution and the lumen was closed with a solid cannula cap. The experimental group received a once weekly flush and lock with normal saline through a positive displacement mechanical valve needleless connector. Occlusion occurred in 40.2% (41/102) of patients in the control group and 82.2% (83/101) in the experimental group. Bacteremia/fungemia occurred in 8.8% (9/102) in the control group and 23.8% (24/101) in the experimental group.(Cesaro et al., 2009)

Biofilm and fibrin combine to form the intraluminal layer that produces bloodstream infection and lumen occlusion.(Ryder,

Table 1. **Potential Causes of Infection Risks with Needleless Connectors**

Failure to adequately clean and disinfect the connection surfaces and luer-locking threads.
Configuration of the connection surface
Gaps between the centerpiece and outer housing, unreachable with cleaning techniques
Internal "dead" space that allows fluid to become trapped
Lack of training on how these devices function and how they should be cleaned.

2005) Techniques used to manage the infusion system can increase the risk of these complications. The technology of needleless connectors and all connected components must be chosen carefully to function together, thus techniques and technology cannot be separated.

The Healthcare Worker Survey

The significant impact on patient health outcomes with the incorrect use of needleless connectors drove the purpose of this survey which was to learn more about the perceptions, knowledge and practices of healthcare workers who use such devices.

Methods

A survey tool was created that included 8 demographic questions and 22 clinical practice questions. The survey tool was placed on an online survey system. To improve validity, a pilot test of the survey tool was conducted with a small group from the intended audience. Fifteen email addresses were randomly selected from our database and a message was sent to those people asking for their participation in the pilot test. This was to ensure that the questions were understandable by members of the target audience. Due to a poor response from the chosen names, we added another 15 email addresses and sent out another invitation to take the survey. We did receive 10 responses from this process. A few minor alterations in question wording were made based on their comments. Invitations to participate in this survey were sent out through the email database of Lynn Hadaway Associates, Inc., and through invitations posted on three online discussion forums or listservs. We estimate that this invitation reached a minimum of 4000 healthcare workers.

Analyses were available through the online survey system that was chosen. Percentages of those responding to the questions were calculated by this system. Additionally, this system provides the ability to filter responses to all questions based on the responses to a particular question. This allowed for analyses of only those responding positively to the question about being in clinical practice. All responses from those not in clinical practice were eliminated.

Table 2. Clamping Sequence for Needleless Connectors

Clamping the extension set between the patient and the catheter hub can be done at different times. Please mark the following statement that best describes your practice with needleless connectors.		
Answer Options	**Percent**	**n**
I do not have a standard method for clamping or not clamping the line.	6.8%	34
I have never been taught a specific clamping method for the type of device being used.	5.4%	27
I use a negative displacement device and I clamp the line before I disconnect the syringe.	14.8%	74
I use a negative displacement device and I clamp the line after I disconnect the syringe.	2.2%	11
I use a negative displacement device and I never clamp the line.	0.6%	3
I use a positive displacement device and I clamp the line before I disconnect the syringe.	7.6%	38
I use a positive displacement device and I clamp the line after I disconnect the syringe.	20.0%	100
I use a positive displacement device and I never clamp the line.	10.8%	54
I use a neutral displacement device and I clamp the line before I disconnect the syringe.	13.0%	65
I use a neutral displacement device and I clamp the line after I disconnect the syringe.	5.0%	25
I use a negative displacement device and I never clamp the line.	1.8%	9
I do not know the type of device being used and I clamp the line before syringe disconnection on all patients.	9.0%	45
I do not know the type of device being used and I clamp the line after syringe disconnection on all patients.	3.2%	16
answered question	**501**	
skipped question	**53**	

Results

Demographics

A total of 630 surveys were returned. Data analyses were conducted on the completed surveys from 554 participants responding affirmatively to the question of "Are you in clinical practice with responsibility for starting or maintaining IV Therapy?" The majority (96.5% or n-529) of respondents were registered nurses and the remaining group including LP/VNs, nursing and medical assistants, and respiratory and radiographic technologists.

The largest group of participants (n-405 or 74%) was employed by hospitals including teaching, community and critical access facilities. Sixteen percent (n-91) worked in home care or home infusion pharmacies and 5% (n-28) in ambulatory or outpatient center.

Infusion therapy team (n-128 or 23.5%) and PICC/Vascular Access Team (n-127 or 23.3%) were the two largest groups by specialty. The remaining responses were equally distributed among all other specialty settings such as medical, surgical, oncology, critical care, emergency, and pediatrics. Most participants were highly experienced with 73.5% (n-400) having more than 15 years of clinical experience. Only 12 (2%) had less than 2 years experience. Also 208 (38.4%) reported working for the same employer for more than 15 years. Forty-six states were represented in this survey with the largest percent-

ages coming from California, New York, Washington, Pennsylvania, and Maine. There were also 19 responses from other countries such as Canada, United Kingdom, Belgium, Bermuda, and New Zealand.

Results

The survey contained a picture along with the brand name of 16 different needleless connectors currently on the US market with 521 (94%) choosing the brand they use. A follow-up question listed 13 options for clamping during the flushing and locking procedure. Only 74 (14.8%) responded correctly for clamping the line with a negative displacement needleless connector **before** syringe disconnection. For positive displacement devices, 100 (20%) correctly indicated that they clamped the line **after** syringe disconnection. Clamping sequence will not affect the functionality of the neutral displacement devices. Sixty-five (13%) stated they use a neutral device and clamp before disconnection while 25 (5%) stated they used a neutral displacement device and clamped after disconnection. Correct procedure was chosen by 244 (52.8%) of respondents. All responses are listed in Table 2.

The consistent use of the same needleless connector throughout the entire facility or agency was reported by 349 (65.8%) of respondents. Practice variations included:
• One type of needleless connector for short peripheral cath-

Table 3. Cleaning Time for Needleless Connectors

Do you clean the needleless connector for a specific number of seconds before use?		
Answer Options	Percent	n
No, I never time it.	21.2%	110
Yes, it is always at least 3 to 5 seconds	25.0%	130
Yes, it is always 6 to 10 seconds	16.0%	83
Yes, it is always at least 15 seconds	27.5%	143
Yes, it is always at least 30 seconds	7.5%	39
Other (please describe)	2.9%	15
answered question	**520**	
skipped question	**34**	

eters and another type for central venous catheters (CVCs) (n-114 or 21.5%).

- One type of needleless connector in start kits and replaced with a different type with subsequent changes (n-61 or 11.5%)
- One type of needleless connector on the catheter hub with a second type on the IV administration sets (n-63 or 11.9%).
- One type of needleless connector used in the specialty areas (e.g., OR, ICU, ER) and a different type used on the general nursing units (n-52 or 9.8%)

Some respondents chose multiple options, explaining the total percentage exceeding 100%.

When asked about the type of needleless connector used on CVCs, the majority (n-214 or 41%) indicated that a positive displacement needleless connector was used, however 21.9% (n-114) did not know the type in use. For short peripheral catheters, 27.6% (n-146) reported using a positive displacement needleless connector with 25.4% (n-132) not knowing the type in use.

Questions about cleaning or disinfecting the needleless connector indicated wide variations in clinical practice. Alcohol is the most common agent used for cleaning needleless connectors with only 12.4% (n-65) using chlorhexidine/alcohol combination products. Several responses indicated the use of alcohol for needleless connectors on peripheral catheters but used chlorhexidine/alcohol for all CVCs, for patients receiving chemotherapy or when blood cultures were drawn from the catheter.

When asked how often the needleless connector is cleaned prior to each use, 94.3% (n-494) chose "always" and 4.6% (n-24) chose "usually". These responses appear to be in conflict with a subsequent question asking for more details about the cleaning process. Only 58.5% (n-306) chose the option of "I clean before each injection or connection using a new swabbing pad before each connection." Thirty percent (n-157) indicated that the cleaning was performed before the first injection and the needleless connector not allowed to touch anything between subsequent injections. Cleaning multiple times with the

same swabbing pad was chosen by 55 (10.5%) of respondents.

The most common swabbing technique was to wrap the pad around the needleless connector and work in a circular motion multiple times (n-306, 58.4%). Wiping back and forth multiple times across the top and sides received about a quarter of the responses. This question generated the most added comments with many emphasizing the need for friction and the need to clean the top and sides of the needleless connector. The length of time for cleaning the needleless connector was distributed fairly evenly across all answers. (Table 3) Many participants added comments about counting the number of twists or swipes with the cleaning pad rather than the number of seconds. When asked about the time used for allowing the needleless connector to dry after cleaning, 39.3% (n-205) said they do not time it. About one-third said 3 to 5 seconds, and the remainder allowed longer periods up to 30 seconds. Comments again included a difference for short peripheral catheters versus CVCs, home care versus the hospital, or assessing the dryness by how it appears.

The majority of participants change needleless connectors every 7 days. (Table 4) When asked to estimate the number of times a needleless connector is accessed before it is changed, 41.7% (n-209) chose the option of 26 to 100 times, however about a fourth of the respondents did not know.

The survey contained questions about practices connecting IV sets and syringes to needleless connectors. More than 80% (n-410) stated that all intermittent medication sets have a new sterile cap placed on the end when disconnected from the catheter. Attaching to a needleless connector or Y-site on the same IV set was the practice of 10% (n-52) while covering with the package of the swabbing pad or no covering was chosen by 2.2% (n-11). This question generated numerous comments, primarily from those working in ambulatory care, that each IV set is discarded once it is disconnected.

Prefilled syringes for flushing catheters was the choice of more than 95% (n-485), however about 3% (n-14) still use multiple dose vials and bags of IV solution as the source for flushing solution. Of those that must fill syringes, only 58 or

Table 4. Frequency of Changing Needleless Connectors

How often do you change needleless connectors on the catheter hub?		
Every 24 hours	6.1%	30
Every 48 hours	2.7%	13
Every 72 hours	30.3%	148
Every 96 hours	19.1%	93
Every 7 days	41.8%	204
answered question	**488**	
skipped question	**66**	

11.4% indicated that they label the syringe with its contents. After filling the syringe, only 90 (17.8%) indicated that the syringe was used within one hour, as mandated by USP requirements for compounding sterile products.(ASHP, 2004)

Additional practices with needleless connectors included:

• About half use 10 mL of normal saline for flushing after blood samples are taken from a CVC, with about a third adding comments that 20 mL was used for this purpose.

• About half always use gloves when flushing or giving medications through needleless connectors with about 15% (n-78) reporting that they never or rarely wear gloves for these procedures

• Wide variations in written policies and procedures for needleless connectors were reported. (Table 5)

Discussion

Data analyses revealed several trends, however the most critical one is lack of knowledge of how these devices work and the impact that the device function has on their clinical practice. This trend was virtually the same across all clinical specialties including those working on infusion and vascular access teams.

Several recent publications highlight the problem of failure to properly clean the needleless connector before use, however the trends show a definite improvement. In 2005, a conference presentation revealed that 31% of nurses reported that they did not clean the needleless connector before use.(Karchmer, Cook, Palavecino, Ohl, & Sheretz, 2005) A 2007 (Delahanty & Myers, 2007) and 2009 (Delahanty & Myers, 2009) survey of I.V. infection control practices published in a well-known nursing journal reported those failing to clean the needleless connector to be 4% and 3%, respectively. Data from this survey above found that 5.8% chose a response that was less than "always", however none chose "never".

The survey from Nursing2009 asked about technique for cleaning the needleless connector and used language similar to this survey. In the Nursing2009 survey, more than half (53%) reported that they wrap an alcohol pad around the needleless connector and move in a circular motion multiple times. This same technique was selected by 58.4% of the participants in our survey. (Delahanty & Myers, 2009)

Flushing and clamping of the catheter with a needleless connector attached is not correctly understood by almost half of the survey respondents, although this is an essential element of proper device performance. Negative displacement needleless connectors require flushing with a positive pressure technique. For needleless connectors with a blunt cannula, this can be accomplished by withdrawing the cannula as the last mL of solution is flushing inward. Another technique calls for flushing, then closing the clamp followed by syringe disconnection. This technique requires that the finger that has pushed the plunger rod should remain in place until the syringe is disconnected. If using a traditional syringe, a small amount of fluid left in the syringe will prevent compression of the gasket at the end of the plunger rod. Releasing the force applied to the plunger before syringe disconnection could produce a rebound effect that would allow blood to reflux into the catheter lumen.

Positive displacement needleless connectors require clamping **after** syringe disconnection. Blood reflux can still occur with these devices, especially if the empty fluid container is not disconnected immediately. This type of needleless connector holds a larger amount of fluid than the negative displacement type. Upon disconnection, this fluid is pushed out to the catheter tip to overcome the blood reflux and move it back into the circulation. Clamping before syringe disconnection will prevent the internal mechanism from working as it is designed.

Neutral displacement needleless connectors are not dependent on the correct clamping sequence, thus the clamp can be closed before or after syringe disconnection without affecting the function of the needleless connector.

Protection of the male luer end of the intermittent I.V. administration set is achieved by placing a new dead-end cap on the set with 82% in the Nursing2009 survey(Delahanty & Myers, 2009) and 80% in this survey giving this response. Prefilled syringes for catheter flushing are used by 93% of the respondents in the Nursing2009 survey (Delahanty & Myers, 2009) and by 95% in this survey.

There is a need for standardization within each facility or agency, as this will reduce staff confusion. Appropriate training on numerous needleless connectors adds a burden for everyone. Simply looking at a needleless connector provides no indication about its function – negative, positive or neutral fluid

Table 5. Policies and Procedures

Does your employer have a written policy and procedure for needleless connectors that include any of the following? Mark all that apply		
Answer Options	**Percent**	**n**
Cleaning technique	75.4%	370
Clamping technique	47.5%	233
Frequency of change for needleless connectors	82.3%	404
Hand hygiene with use of needleless connectors	70.5%	346
There is no written policy and procedure	11.8%	58
answered question	**491**	
skipped question	**63**	

displacement – thus increasing the possibility for the nurse to use an incorrect clamping sequence. Training staff on multiple needleless connectors can be difficult and time consuming. Nursing turnover rates range from 15% to 36% and the average separation rate for all healthcare employees is 29.6%.(Spetz, Rickles, Chapman, & Ong, 2008) Additionally temporary staff account for about 5% of all nursing care hours.(Jones, 2008) Temporary staff may not be knowledgeable of the devices used in each facility. High turnover rates and use of temporary staff would indicate the need for frequent repetition of this training, further adding to the costs for each facility.

There is an unmistakable need for clearly written policies and procedures for all infusion therapy. A survey of critical care units found that hand hygiene was included in 80% of catheter insertion policies and procedures but only 36% of catheter maintenance policies and procedures included hand hygiene.(Warren et al., 2006)

The National Patient Safety Goals from Joint Commission now require a standardized protocol for how to clean and disinfect all catheter hubs and injection ports.(JointCommission, 2009) While studies that prove the most effective method and length of time for cleaning the NC are lacking, we know that scrubbing with mechanical friction is a critical element. One in vitro study showed that 3-5 seconds was not sufficient(Menyhay & Maki, 2006), while another small in vitro study showed that 15 seconds was adequate to stop the passage of organisms into the lumen of the needleless connector.(Kaler & Chinn, 2007) More studies are needed to create solid recommendations about a specific length of time and technique, however it is clear that a simple wipe is not sufficient.

Consistency with using the same needleless connector throughout the organization will eliminate confusion among end-users. Stocking and using multiple brands with different internal mechanisms produces incorrect methods for flushing and clamping the device, critical elements to achieve good outcomes with these products. Variations in practice between peripheral and central catheters are common, however no studies support these variations. Both types of catheters enter the bloodstream but the length of dwell time and frequency of access varies. The rates of CRBSI from peripheral catheters are known to be very low, however the absolute numbers are very high due to the large number of peripheral catheters sold. Additionally, the knowledge of pathogenesis with peripheral catheters is not as well understand as with central catheters.(Zingg & Pittet, 2009) The impact of practices with needleless connectors on short peripheral catheters is unknown.

The Infusion Nursing Standards of Practice (INS, 2011), revised approximately every 5 years by the Infusion Nurses Society, and guidelines from the Centers for Disease Control(O'Grady, Alexander, Burns, & Dellinger, 2009), the Society for Healthcare Epidemiology of America(Marschall et al., 2008), Association for Practitioners in Infection Control(Dolan et al., 2009) and Infectious Disease Society of America(Mermel et al., 2009) must be used when writing internal policies and procedures. These evidence-based documents contain the most germane information to guide clinical practice.

A knowledgeable and competent clinical staff is essential to patient safety and positive outcomes with all catheters and infusion therapy. The goal is to totally eliminate CRBSI and numerous studies have demonstrated that this can be done.(Berenholtz, Pronovost, Lipsett, Hobson, & Earsing, 2004; Pronovost, 2008) To meet this goal, nursing staff must know the causes and correct prevention methods. Training all staff on the correct use of products is required in addition to the education about prevention methods. Intraluminal causes require the same level of attention as extraluminal causes.

There are several limitations to this report. Recall bias was one of these limitations as data collection relied on self-reporting of practices. This is an undesirable method, however there are no studies that have actually measured these clinical practices by other methods. Surveys were returned on a voluntary basis, also relying on self-selection rather than randomized selection. This voluntary return practice yielded a 14% response rate where 70% survey response is generally seen as adequate to make assumptions. Thus, additional research into these identified practice variations is needed.

Patient safety and cost containment are major concerns for all healthcare, moreover keeping patients safe will reduce costs. Product decisions should be chosen to "hard-wire" the system for best practices.(Delahanty & Myers, 2009) Simplify decisions required by the nursing staff at the bedside by standardizing procedures and products. Remove all devices that are no longer recommended and stock all devices in locations that prevent the nurse from doing the wrong thing simply because the products are not available. Patients depend upon the staff and the system to keep them safe. Product decisions are a critical component of this safety.

Disclosure

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Online Survey of Nursing Practices with Needleless Connectors

1. Are you in clinical practice with responsibility for starting and managing intravenous (IV) therapy on your patients?
   a. Yes
   b. No

2. My profession is
   a. Registered Nurse
   b. Licensed Practical/Vocational Nurse
   c. Nursing Assistant
   d. Medical Assistant
   e. Other

3. Type of employer
   a. Teaching hospital
   b. Community hospital
   c. Critical access hospital
   d. Ambulatory care center or outpatient infusion center
   e. Home care or home infusion pharmacy
   f. Skilled nursing facility, any long term care facility
   g. Physician's office
   h. Other Please explain

4. What is your Clinical Specialty?
   a. Medical
   b. Surgical
   c. Oncology
   d. Pediatrics
   e. Adult Intensive Care-all types
   f. Neonatal or Pediatric Intensive Care
   g. Infusion Therapy Team
   h. PICC or Vascular Access Insertion Team
   i. Radiology
   j. Emergency Department
   k. Other

5. How many years have you been in practice?
   a. Less than 2 years
   b. 2 to 5 years
   c. 5 to 10 years
   d. 10 to 15 years
   e. more than 15 years

6. How many years have you been working for your present employer?
   a. Less than 2 years
   b. 2 to 5 years
   c. 5 to 10 years
   d. 10 to 15 years
   e. more than 15 years

7. For respondents from United States, mark the state where you work

8. If you are outside the United States, please check country
   a. Canada
   b. United Kingdom
   c. Australia
   d. New Zealand
   e. Brazil
   f. Saudi Arabia
   g. Korea
   h. China
   i. Japan
   j. Other – please specify

9. Do you think you have adequate access to the inservice training programs provided by your employer?
   a. Yes
   b. No

10. I do not have access to inservice training programs because I work
    a. Part time
    b. Through a staffing agency
    c. Night shift
    d. Float pool
    e. Weekends only
    f. Other

11. A needleless connector is defined as a device placed directly on a catheter hub or built onto an IV administration set for the purpose of allowing the connection of IV sets or syringes without the use of needles. These devices may also be known as injection caps or ports, valves, LADs, or PRN adaptors. Considering the specific needleless connector(s) you currently use in clinical practice, please indicate the statement(s) that apply. Check all that apply
    a. The same brand of needleless connector is used consistently throughout the entire facility.
    b. The IV administration sets have one type of needleless connector but I must add a different type to the catheter hub.
    c. Short peripheral catheters use one type of needleless connector while central venous catheters require a different type.
    d. Specialty areas (e.g. OR, ICU, ER) use a different type of needleless connector than the general nursing units.
    e. None of these apply

12. Please identify the specific device(s) you are currently using. Check all that apply
    (Product pictures with the product names were provided online)

13. Considering the needleless connector on short peripheral catheters in your patients, does this device create
    a. Negative fluid displacement or pressure
    b. Positive fluid displacement or pressure
    c. Neutral fluid displacement or pressure
    d. Don't know/not sure

14. Considering the needleless connector on central venous catheters in your patients, does this device create
    a. Negative fluid displacement or pressure
    b. Positive fluid displacement or pressure
    c. Neutral fluid displacement or pressure
    d. Don't know/not sure

15. How often do you clean the needleless connector prior to each use?
    a. Never
    b. Rarely
    c. At times
    d. Usually
    e. Always

16. What cleaning agent is used on the needleless connector?
    a. Alcohol
    b. Chlorhexidine/alcohol
    c. Povidone-iodine
    d. Other – please describe

17. Please indicate the statement that best describes your practice to clean the needleless connector before use?
    a. I clean before each injection or connection using a new swabbing pad before each connection. (For example, clean before flushing with saline and again before flushing with heparin)
    b. I clean before each injection or connection using the same swabbing pad.
    c. I clean it once before I make the first injection or connection on each patient and keep the connector from touching anything between subsequent injections.
    d. I clean only when the connector appears dirty (e.g. visible blood on the surface)
    e. I do not clean it.
    f. Other please describe

18. Please indicate the swabbing technique that you use most frequently.
    a. Swipe the pad once across the top of the injection cap
    b. Wrap the pad around the injection cap and work in a circular motion multiple times
    c. Wipe back and forth multiple times across the top and sides
    d. Other –please describe

19. Do you clean the needleless connector for a specific number of seconds before use?
    a. No, I never time it.
    b. Yes, it is always at least 3 to 5 seconds
    c. Yes, it is always 6 to 10 seconds
    d. Yes, it is always at least 15 seconds
    e. Yes, it is always at least 30 seconds
    f. Other – please describe

20. Do you allow the needleless connector to dry for a specific number of seconds before use?
    a. No, I never time it.
    b. Yes, it is always at least 3 to 5 seconds
    c. Yes, it is always 6 to 10 seconds
    d. Yes, it is always at least 15 seconds
    e. Yes, it is always at least 30 seconds
    f. Other – please describe

21. Clamping the extension set between the patient and the catheter hub can be done at different times. Please mark the following statement that best describes your practice with needleless connectors.
    a. I do not have a standard method for clamping or not clamping the line.
    b. I have never been taught a specific clamping method for the type of device being used.
    c. I use a negative displacement device and I clamp the

line before I disconnect the syringe.

d. I use a negative displacement device and I clamp the line after I disconnect the syringe.
e. I use a negative displacement device and I never clamp the line.
f. I use a positive displacement device and I clamp the line before I disconnect the syringe.
g. I use a positive displacement device and I clamp the line after I disconnect the syringe.
h. I use a positive displacement device and I never clamp the line.
i. I use a neutral displacement device and I clamp the line before I disconnect the syringe.
j. I use a neutral displacement device and I clamp the line after I disconnect the syringe.
k. I use a negative displacement device and I never clamp the line.
l. I do not know the type of device being used and I clamp the line before syringe disconnection on all patients.
m. I do not know the type of device being used and I clamp the line after syringe disconnection on all patients.

22. After disconnecting an IV administration set used for intermittent medication infusion, how do you maintain the end of the set?
a. Place a new sterile cap on the end of the set.
b. Attach it to a needleless connector or Y-site injection port higher on the same set
c. Cover it with the package of a swabbing pad.
d. Drape the set over the IV pole with no covering for the end of the set
e. Other – please describe

23. How often do you change needleless connectors on the catheter hub?
a. Every 24 hours
b. Every 48 hours
c. Every 72 hours
d. Every 96 hours
e. Every 7 days

24. On average, how many times do you think that a needleless connector is accessed on your patients before it is changed? Each entry is one access. For example, flushing + medication + flushing would be 3 accesses.
a. 5 to 25
b. 26 to 100
c. 101 to 200
d. 201 to 300
e. Do not know

25. What system is used for flushing catheters?
a. Prefilled syringes
b. Single dose vials
c. Multiple dose vials
d. Bag of IV solution

26. When you fill syringes with flush solution, do you add a label to the syringe with its contents?
a. Never
b. Rarely
c. At times
d. Usually
e. Always
f. Does not apply because we have prefilled syringes

27. When you fill syringes with flush solution, do you
a. Use the syringe immediately or within one hour
b. Prepare all flush syringes at the beginning of your shift
c. Use flush syringes prepared by other nurses
d. Does not apply because we have prefilled syringes.

28. After drawing a blood sample from a central venous catheter, how do you determine the volume of normal saline for flushing?
a. Follow the policy and procedure for use of 5 mL
b. Follow the policy and procedure for use of 10 mL
c. Flush until the needleless connector appears clear
d. Flush with a small volume, usually 1 to 3 mL
e. Flush with the smallest volume possible because of the patient's age or fluid restriction
f. Other please explain

29. Do you wear clean gloves when flushing or administering medications through a needleless connector?
a. Never
b. Rarely
c. At times
d. Usually
e. Always

30. Does your employer have a written policy and procedure for needleless connectors that include any of the following? Mark all that apply
a. Cleaning technique
b. Clamping technique
c. Frequency of change for needleless connectors
d. Hand hygiene with use of needleless connectors
e. There is no written policy and procedure