
Survey of home hemodialysis patients and nursing staff regarding vascular access use and care

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Abstract

Vascular access infections are of concern to hemodialysis patients and nurses. Best demonstrated practices (BDPs) have not been developed for home hemodialysis (HHD) access use, but there have been generally accepted practices (GAPs) endorsed by dialysis professionals. We developed a survey to gather information about training provided and actual practices of HHD patients using the NxStage System One HHD machine. We used GAP to assess training used by nurses to teach HHD access care and then assess actual practice (adherence) by HHD patients. We also assessed training and adherence where GAPs do not exist. We received a 43% response rate from patients and 76% response from nurses representing 19 randomly selected HHD training centers. We found that nurses were not uniformly instructing HHD patients according to GAP, patients were not performing access cannulation according to GAP, nor were they adherent to their training procedures. Identification of signs and symptoms of infection was commonly trained appropriately, but we observed a reluctance to report some signs and symptoms of infection by patients. Of particular concern, when aggregating all steps surveyed, not a single nurse or patient reported training or performing all steps in accordance with GAP. We also identified practices for which there are no GAPs that require further study and may or may not impact outcomes such as infection. Further research is needed to develop strategies to implement and expand GAP, measure outcomes, and ultimately develop BDP for HHD to improve infectious complications.

Key words: Home hemodialysis, vascular access, training

INTRODUCTION

Hemodialysis (HD) vascular access infection has long been a source of opportunity for improvement in patient

care. Vascular access infections were responsible for 11% of all hospitalizations for HD patients in 2010, and 31% of these patients were readmitted within 30 days.¹ Furthermore, two recent trials have suggested that there may be increased vascular access complications in HD patients on more frequent therapy.^{2–4}

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The home hemodialysis (HHD) patient commonly connects to his or her dialysis access more frequently than the

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typical in-center HD patient, and also self-cannulates without the assistance of a medical professional. These may introduce greater variation in cannulation technique and care methods than is seen with the in-center HD population. In addition, in contrast to having a trained medical professional respond to signs or symptoms of an infection in the center HD patient, the HHD patients themselves are required to respond rapidly and appropriately to any signs or symptoms of underlying infection. Technique is heavily dependent upon the training provided to the HHD patient by home training nurses, and the HHD patient's willingness to adhere to the training. Although HHD offers patients greater autonomy than in-center therapy, a combination of improper training compounded by nonadherence and technique deterioration over time may result in practice issues unique to these patients.

Best demonstrated practices (BDPs) have not been developed for home dialysis access cannulation. However, more consistent and uniform cannulation practices could be addressed by following generally accepted practices (GAPs) that are endorsed by nephrology-specific groups such as American Nephrology Nurses Association (ANNA) and Kidney Disease Outcomes Quality Initiative (KDOQI), and infection control groups like the Centers for Disease Control (CDC). The GAPs recommended by these groups and the source(s) for each practice are presented in Table 1.

In other cases, further study is needed to help practitioners and nephrology groups establish written guidelines for practices that are not defined nor generally accepted. The hypotheses examined in this study are: (1) HHD training provided by nurses varies; and as a result, (2) HHD patient practices and adherence with training also vary greatly and conflict with GAP.

To test these hypotheses, a survey was developed to characterize potential issues in the care, preparation, and use of the HD vascular access by the HHD patient. The survey specifically targeted evaluation of the training, methods of care, usage of appropriate technology (supplies), and understanding and reporting of infection signs and symptoms among current HHD patients using the NxStage System One.

Results of the survey highlight opportunities where definitive interventions available today may improve training and adherence to GAP and proactively decrease subsequent infection rates. Furthermore, the results highlight other opportunities where longer term research is required to establish additional GAP or BDP where they currently do not exist.

METHODS

Survey development

Two surveys were developed to gather information on (1) the training provided to HHD patients (nurses survey; Supporting Information Appendix S1), and (2) the actual practices utilized by HHD patients (patient survey; Supporting Information Appendix S2) for the preparation, use, and care of the HD vascular access.

Preceding the design of the surveys, a fault tree analysis was constructed to determine the potential issues that could occur when preparing, using, and caring for the vascular access. Survey questions were developed to understand whether patient practice issues were a result of (1) training and reeducation, (2) adherence with training, (3) technology (availability of appropriate tools and supplies), or (4) recognition/reporting of signs and symptoms of infection.

Subsequently, surveys were developed based on the principles of GAP among the nephrology community. Vascular access practices for both patients and nurses exist within reference documents, current literature, checklists, and manufacturer instructions for use. Adherence to these practices has been shown to contribute to success in decreasing infection and mortality related to central line bloodstream infections.⁵

Home hemodialysis training nurses were asked to report the practices their patients were trained to use for preparation, use, and care of the vascular access, and patients were asked to report the techniques employed in the areas mentioned.

Survey validation

To ensure that the questions could be understood by respondents and that the data collected would be accurate and useful, the survey was reviewed by four groups of home training nurses and a focus group consisting of seven HHD patients/care partners. Further validation of the patient survey included phone interviews of 10 additional patients using the survey as a script. Results and responses from these preliminary exercises were not included in the analyses performed for this article.

Survey distribution

A waiver of informed consent requirement was obtained from a centralized Institutional Review Board prior to distributing the surveys. Patients and nurses were provided surveys containing a randomly assigned unique alphanumeric identifier used to link respondents to their

Table 1 Areas of GAPS and the description and sources of the GAP

Area of GAP	GAP	Reference
Hand washing	Do wash hands for a minimum of 40 sec using soap or an antimicrobial agent	World Health Organization. <i>WHO Guidelines on Hand and Hygiene in Health Care: A Summary</i> , 2009. Geneva, Switzerland: World Health Organization; 2009
Skin antiseptics of the vascular access prior to cannulation	Do wash the access site area for a minimum of 30 sec with antimicrobial agent(s) or scrub (e.g., 2% chlorhexidine)	<i>Core Curriculum for Nephrology Nursing</i> , Fifth Edition, American Nephrology Nurses' Association 2008, Caroline Counts, editor National Kidney Foundation. K/DOQI clinical practice guidelines for vascular access, 2000. <i>Am J Kidney Dis</i> . 2001;37(Suppl 1): S137–S181.
Scab preparation	Do use a sterile scab removal device such as a provided scab picker or sterilized tweezers. Do not use the needle intended for cannulation to remove the scab. Do not pick at the scab with fingernails. Do not use a scrubby sponge for softening or removing the scab.	Fistula First. Cannulation of the arteriovenous fistula (AVF)—Chapter 6. In: <i>Cannulation of the AV Fistula</i> . Web site: http://www.fistulafirst.org/HealthcareProfessionals/WheredoIstartifIamodialysiscenter/CannulationoftheAVFistula/CannulationVideoChapter6.aspx . Accessed January 17, 2014.
Cannulating buttonhole sites	Do cannulate with blunt needles. Do not cannulate with sharp needles once the buttonhole tracts have been successfully established.	Fistula First. Cannulation of the arteriovenous fistula (AVF)—Chapter 6. In: <i>Cannulation of the AV Fistula</i> . Web site: http://www.fistulafirst.org/HealthcareProfessionals/WheredoIstartifIamodialysiscenter/CannulationoftheAVFistula/CannulationVideoChapter6.aspx . Accessed January 17, 2014.
Antibiotic use at catheter exit site	Do use topical antibiotics on insertion sites for catheters. Do not use topical antibiotic ointments or creams on anywhere else other than catheter site in order to reduce fungal infection and antimicrobial resistance.	Fistula First. Cannulation of the arteriovenous fistula (AVF)—Chapter 6. In: <i>Cannulation of the AV Fistula</i> . Web site: http://www.fistulafirst.org/HealthcareProfessionals/WheredoIstartifIamodialysiscenter/CannulationoftheAVFistula/CannulationVideoChapter6.aspx . Accessed January 17, 2014. National Kidney Foundation. K/DOQI clinical practice guidelines for vascular access, 2000. <i>Am J Kidney Dis</i> . 2001;37(Suppl 1): S137–S181. Web site: www.cdc.gov/hicpac/BSI/06-bis-background-info-2011.html
Catheter dressing changes	Do change catheter exit site dressings at each HD treatment and when showering/bathing.	NKF KDOQI 2000 Guideline 15, and <i>Core Curriculum for Nephrology Nursing</i> , Fifth Edition, American Nephrology Nurses' Association 2008, Caroline Counts, editor
Recognition of signs and symptoms of infection	Do train patients to recognize appropriate signs and symptoms and report within 1 day	www.cdc.gov/mmwr/preview/mmwrhtml/rr5005a1.html

GAP = generally accepted practice.

particular centers for the survey analysis. Survey questions were divided into sections of general applicability and access type-specific questions, including categorical questions for arteriovenous fistula (AVF), AVF with buttonhole (BH), arteriovenous graft (AVG), and catheter access. Patient demographics, health information, and information regarding patient-specific occurrences or frequency of vascular access infections were not obtained.

Surveys were distributed from January 1, 2013 to March 31, 2013. All completed surveys received by May 10, 2013 were included in the analysis. Responses were returned directly to a third party where data were entered and reserialized, maintaining the association between the patients and nurses of a given center while preserving anonymity of the respondents and their dialysis centers.

STATISTICAL METHODS

Data were analyzed in aggregate and on a site-by-site basis to determine if certain practices were center specific or common among all centers. Results of the aggregate analyses are reported. In order to discern whether a patient practice issue was related to nurse training or patient adherence, analysis compared responses from both patients and nurses. Data are quantitative (categorical or ordinal) and expressed as frequency and percent.

Associations between patient adherence and the training provided by nurses were assessed for all items which were found to have GAP for care and use of an AVF, AVG, or catheter. Percentages of nurses training in accordance with GAP and patients adherent to GAP were calculated for each individual question related to a particular GAP. Additionally, percentages were calculated in aggregate for GAP which require multiple steps to be completed in succession in order to be compliant (i.e., skin antisepsis procedures at the location of access). Correlation coefficients were not calculated because these data are not independent from one another.

RESULTS

Manual or electronic surveys were distributed to all HHD patients ($n = 301$) and home training nurses ($n = 55$) at 19 randomly selected centers with HHD programs using the NxStage System One and consisting of at least eight active patients, as reported in the NxStage Medical Inc. internal census. Distribution was based on a targeted 33% response rate with a goal of 100 patient responses. All respondents were age 18 or older. The survey response

Table 2 Patient reported access type

Access type	N = 129 (%)
Fistula with buttonhole ^a	91 (71)
Fistula without buttonhole	10 (8)
Graft	8 (6)
Catheter ^a	20 (16)

^aTwo patients reported use of two access types.

rate for HHD patients was 42% ($N = 127$), which was much higher than anticipated. Two patients reported use of two types of access and are represented in discussions of both access categories. Patients or partners were permitted to answer the survey questions. The response rate for home training nurses was 76% representing 17 of the 19 HHD centers selected to participate. Of the 127 patients responding, 87 (69%) had been on HHD for more than a year, 36 (28%) for less than 1 year, and 4 (3%) did not respond. Vascular access details are presented in Table 2.

For AVF/AVG patients, GAPs exist for access site skin washing, skin antisepsis, BH scab removal, and use of sharp needles. For catheter patients, GAPs exist for antibiotic usage, exit site care, and dressing change. For all patients, GAPs exist for recognition and response to signs and symptoms of infection. The percentage of total patient and nurse responses that meet GAP is shown in Table 3.

AVF/AVG patients as well as nurses were asked to provide details regarding the application motion, duration of contact, and drying time for various available skin antisepsis agents used to prepare the access site for cannulation. Product-specific instructions for use of common skin antisepsis agents are provided in Table 4. Responses for multiple antisepsis agents were noted for patients (up to two agents) and nurses (up to three agents). Issues of nonadherence with manufacturer instructions for use or industry best practices were noted for nearly all agents (Table 3). Figure 1 presents the association of the training provided by nurses and patient adherence to GAP for the use of the most commonly reported skin antiseptic agents for AVF/AVG patients.

Cannulation of an established BH track with a sharp needle is not recommended as GAP. However, 50% of nurses overall (across 16 of 17 centers) indicated that they permitted the practice, and 63% of patients reported having done so. The frequency of this usage could not be established from the responses provided.

With regard to general catheter exit site care, all responding nurses trained patients to wash their hands

Table 3 Percent of nurse and patient responses by GAP

Item assessed	Description of GAP	% nurses not training consistent with GAP	% patients nonadherent to GAP
Skin washing			
Skin preparation (washing)	Antimicrobial agent(s) should be used	8	15
Length of wash time	30–60 sec	26	14
Skin antiseptics			
Alcohol	In accordance with IFU for application motion, time, dry time, and use of sterile pad	90	98
Povidone iodine		89	90
Chlorhexidine		77	82
ExSept Plus® (sodium hypochlorite 0.114%) (Angelini, Gaithersburg, MD)		86	82
Buttonhole use			
Buttonhole scab softening and removal	No scrubby sponge for softening Sterile scab removal devices (see supplement for options)	10	8
Catheter exit site care			
Antibiotic ointment use at catheter exit site	Recommended	36	50
Frequency of catheter dressing changes	After each HD treatment	39	60
Signs and symptoms of infection			
Site redness/warmth	Patients should recognize and report appropriate signs and symptoms within 24 h	0	21
Site drainage		0	9
Site discomfort/tenderness		2	32
Chills/shaking		2	29
Fever		0	21

GAP = generally accepted practice; HD = hemodialysis; IFU = instructions for use.

with antibacterial soap or antiseptic gel before changing their exit site dressings and 85% of patients reported always adhering to this practice.

Published GAPs require that the following symptoms of infection (site redness/warmth, site discomfort/tenderness, site drainage, fever, chills and shaking) be recognized and reported by patients within 24 hours. As shown in Table 3, a low percentage of patients followed GAP; however, nearly all nurses (83–95%) believed that these signs or symptoms of infection were being reported to the clinic in a timely manner.

For some areas surveyed, there are no formal existing GAPs recognized by ANNA, KDOQI, or CDC. In these cases, patient practices are varied, regardless of whether nurses were unified in training methods or not.

Mask usage

Fifty percent of nurses trained patients to wear masks during cannulation of the fistula or graft while only 30%

of patients indicated that they consistently used masks for cannulation. The use of masks by catheter patients was much more consistent, with 85% of patients always using a mask when changing the exit site dressing and 90% always using a mask when connecting to bloodlines.

Taping of needles

Twenty-eight percent of patients placed tape directly over the puncture site and 14% of nurses did not instruct patients to avoid this technique.

Dressing removal time (AVF/AVG patients)

Despite lack of GAP, 98% of nurses trained patients to remove dressings within 8 hours. By contrast, 74% of patients reported leaving the dressing on for longer than 8 hours.

Table 4 Recommended cleaning motion, length of cleaning/contact time, and drying time for commonly used skin antiseptics agents

Agent—in order of commonly used or recommended practice	Cleaning motion	Length of cleaning time	Drying time	Reference or GAP source	Additional information
1. ChlorPrep (chlorhexidine gluconate 2% and 70% alcohol)	Use repeated back-and-forth strokes of the applicator. Completely wet the treatment area with antiseptic.	30 sec	Allow the area to air dry for approximately 30 sec before cannulating. Do not blot or wipe away.	CDC; KDOQI; ANNA Core Curriculum; Fistula First; Handbook of Dialysis	Rapid and persistent antimicrobial activity for up to 48 h
2. Povidone iodine (Betadine) (Purdue Products L.P., Stamford, CT)	Circular starting at the center, moving outward to 2 in	2–3 min	Allow the area to completely dry. Cannulate when dry.	Same as above	Bacteriostatic; requires 2–3 min of application for effectiveness
3. Alcohol and Betadine combined	Same as listed separately	Same as listed separately	Allow alcohol to be on 60 sec before Betadine. Do not blow to dry alcohol. Repeat with Betadine pad.	Same as above	Use alcohol first to loosen skin oil and debris; the Betadine kills the bacteria
4. Alcohol 70%	Rub/scrub either back and forth, up and down, or circular	(1)–2 min	Do not allow to dry. Cannulate immediately after applying.	Same as above	Short bacteriostatic time; cannulate when wet
5. ExSept Plus® (sodium hypochlorite 0.114%)	Circular starting at the center, moving outward to 2 in	Time it takes to do the recommended motion for the first site and then do the same for the second site	Allow to dry for 2 min (until completely dried) before cannulation	Policies and procedures at some centers	Antimicrobial; for exit site dressing changes as well (CVC and PD catheters)
6. Hibiclens (4% chlorhexidine gluconate, 4% alcohol) (Molnlycke Health Care, Norcross, GA)	Wet hands with warm water	Wash for 15 sec for personnel handwash	Allow to dry thoroughly before cannulation	Hibiclens Package Insert	Hibiclens is an antiseptic antimicrobial skin cleanser possessing bactericidal properties
7. Hydrogen peroxide (H ₂ O ₂) Not recommended	No recommendation	No recommendation	No recommendation	Not recommended by any source	No bacteriostatic or antimicrobial properties

ANNA = American Nephrology Nurses Association; CDC = Centers for Disease Control; CVC = central venous catheter; KDOQI = Kidney Disease Outcomes Quality Initiative; PD = peritoneal dialysis.

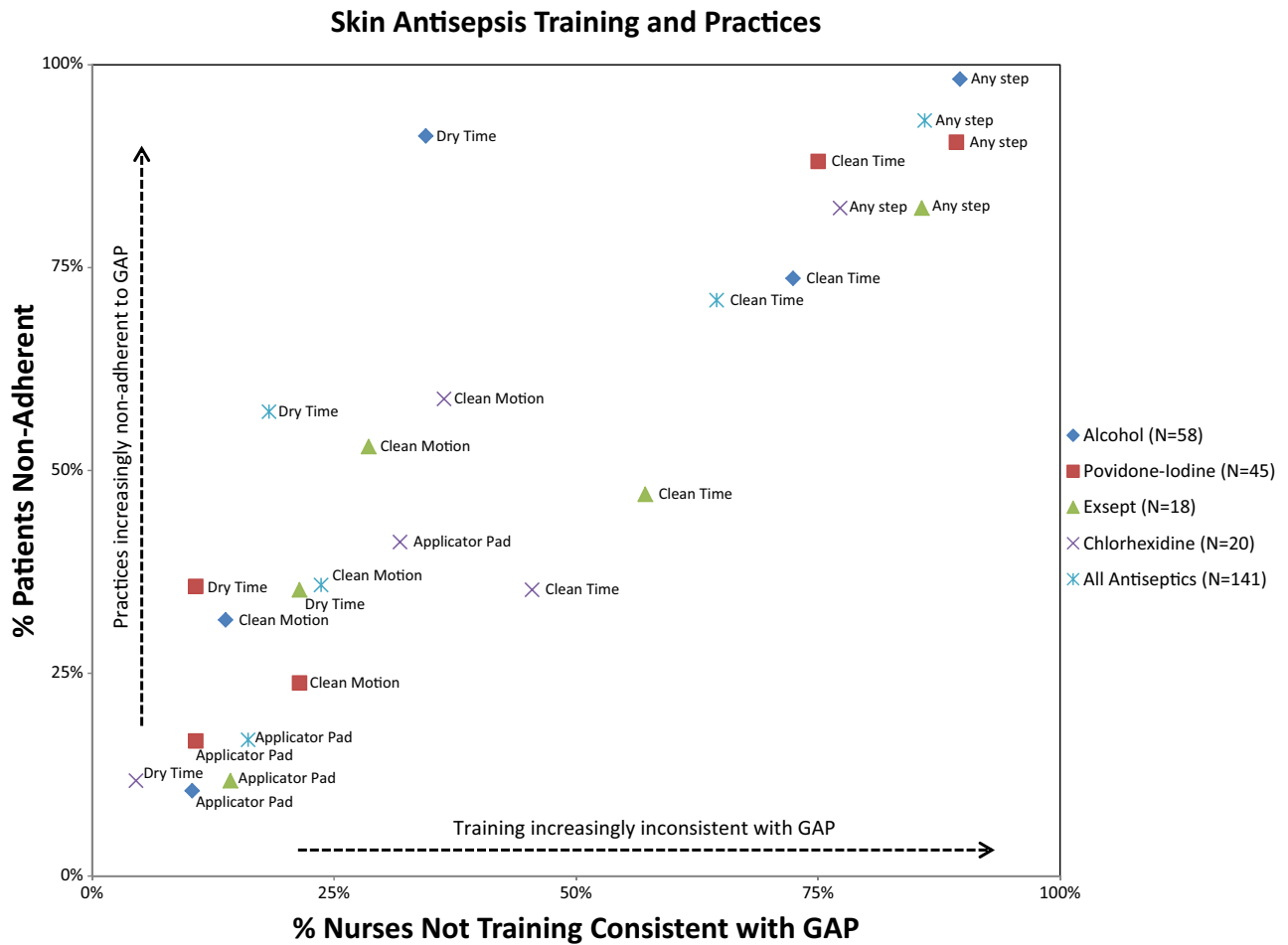


Figure 1 Proportional representation of skin antisepsis use steps for arteriovenous fistula/arteriovenous graft patients (N = 106), comparing nurses training and patient technique. “Any Step” represents the aggregate of all steps required for a particular antiseptic agent (cleaning motion, cleaning time, applicator pad usage, and drying time) where at least one step is trained or performed inconsistently with generally accepted practice (GAP). Sample sizes represent the number of patients providing responses. Some patients indicated use of more than one skin antiseptic agent.

Antibiotic usage (AVF/AVG patients)

Unlike for catheter antibiotic usage, GAPs do not exist for AVF/AVG patients. Forty-three percent of nurses trained patients to use antibiotic ointment following needle removal and bleeding cessation, but only 20% of patients actually used the ointment consistently. Of those patients who used antibiotic ointment, Mupirocin (GlaxoSmithKline, Research Triangle Park, NC), triple antibiotic ointment and Neosporin (Johnson & Johnson Consumer Products Company, New Brunswick, NJ) represented the large majority of the antibiotics used.

Catheter patient showering

Despite lack of GAP, 16 of 17 facilities allowed showering in addition to bathing. Ninety percent of catheter patients reported showering for general hygiene. Eighty-eight percent of nurses taught patients to cover catheter exit sites when bathing or showering, and 70% of patients reported doing so. Finally, 69% of nurses recommended changing the exit site dressing immediately after showering, but only 15% of patients reported following this practice.

Lastly, survey responses indicated that 50 of 123 patients (41%) had either never redemonstrated

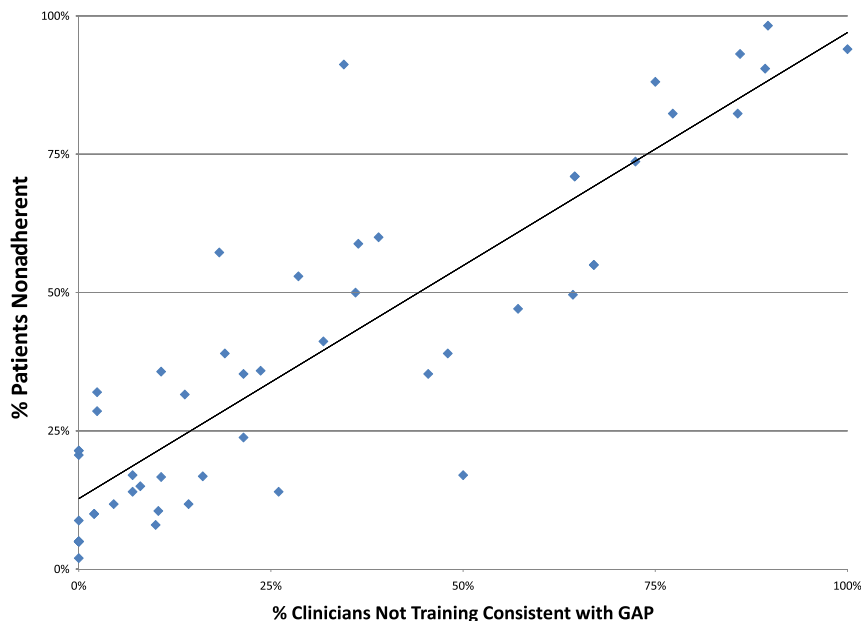


Figure 2 Relationship of nurses training and patients performing procedures inconsistent with generally accepted practice (GAP). Each marker on the graph represents a vascular access use or care-related procedure for which GAPs exist for each access type. A total of 49 individual or aggregated GAPs were examined.

competency in access cannulation technique or had not done so in over 1 year. This finding was evident across all clinics surveyed. Twenty-three of 42 (55%) nurses noted they require patients to redemonstrate their cannulation techniques or catheter access procedure at least once a year, with 8 of 42 (19%) reporting that patients are not required to review their techniques at all. Redemonstrating of technique is a practice that has been discussed in recent publications but is not presently a guideline or GAP.^{6,7} Figure 2 shows the relationship of individual aspects of training by nurses and the related patient practices inconsistent with GAP for AVF, AVG, and catheter use.

DISCUSSION

The current survey uncovered several problems that could increase risk of infection in the HHD patient population: nurses were not uniformly instructing HHD patients according to GAP; patients were not performing access cannulation according to GAP; and patients were not following all training procedures. Furthermore, and most troublesome, when aggregating all steps surveyed, not a single patient or nurse reported performing all steps in accordance with GAP.

Home hemodialysis patients and nurses are following GAP to varying degrees for access washing, skin antisept-

sis, BH scab preparation/removal, antibiotic ointment usage, catheter exit site care, and recognizing and reporting of symptoms of infection (Table 3). Successfully following some steps in cannulation is not sufficient to perform the entire process correctly. Critically, patients must perform all the steps in accordance with GAP to minimize infection risk. When aggregating adherence over multiple GAPs, results are striking (Figure 1). Ninety-four percent of patients perform at least one skin antiseptics step inconsistent with GAP. Equally concerning, 75% or more nurses were also providing at least one training step inconsistent with GAP. Additional analysis of substeps for particular antiseptics agents showed cleaning time and drying time to be the primary contributors for most agents (Figure 1). In addition, 39% of AVF/AVG patients and 55% of catheter patients perform at least one step (washing or scab preparation in the case of AVF/AVG patients, antibiotics or dressing change for catheter patients) inconsistent with GAP. Not a single AVF/AVG or catheter patient performed all necessary steps in accordance with GAP. The proportion of nurses training inconsistent with GAP is related to a similarly large proportion of patients performing inconsistently (Figure 2).

In most instances, nurse training is more consistent with GAP than patient practice. In these cases, patient technique may be deteriorating over time, as 64% of nurses do not require patients to demonstrate technique

in person more than once a year. Unsurprisingly, only 50% of patients report having demonstrated technique in person within the prior year.

Lastly, issues with recognition and timely reporting of signs and symptoms of infection could be preventing early treatment of infections contributed by patient practices inconsistent with training or GAP. While on average individual signs and symptoms of infection are recognized successfully (Table 3), 43% of patients would not recognize and report in a timely manner *all* signs and symptoms of infection, as is necessary to avoid progression to an infectious hospitalization. This occurs despite nearly all (95%) surveyed nurses training consistent with GAP. Patients may be reluctant or unwilling to incur the hassle of diagnosis and treatment upon reporting early symptoms.

These findings raise many questions and issues that have the potential opportunity to reduce vascular access infections. In fact, though there is evidence for some GAP, there is no sufficient evidence that implementation of the entire GAP will influence the rate of vascular access infection. Although further research is needed to assess current guidelines and develop additional guidelines, it is important to first establish overwhelming adherence to the current GAP by implementing basic strategies such as (1) corrective nurses training, (2) ongoing patient retraining protocols, and (3) and the implementation of simple checklists (such as those used effectively and commonly by hospital, airline, and construction teams) to be followed by patients before each treatment and on a weekly basis. Retraining and return demonstrations have been shown to improve learning in educational settings,⁷ and the use of checklists has been shown to be an effective method to standardize practice and improve outcomes.^{5,6,8} Once the present guidelines are followed routinely, the renal community can appropriately analyze which practices are most effective using techniques of continuous quality improvement.

The survey examined several practices for which GAPs do not exist. Without further evidence-based guidelines, it is not surprising that trainers and patients are not always clear exactly how to interpret or implement practices. Prophylactic use of antimicrobial and antifungal ointments on AVF/AVG access sites is an example. KDOQI has not recommended topical antibiotic use, and the CDC notes that concerns exist regarding antimicrobial resistance and their ability to cover the spectrum of potential pathogens. No studies have demonstrated that oral or parenteral antibacterial or antifungal drugs reduce the incidence of catheter-related bloodstream infections among adults.⁹ By contrast, studies examining specific topical antibiotics¹⁰ have reported that use of Mupirocin

by patients using BH cannulation decreased the incidence of *Staphylococcal bacteremia*.

For these and other items where there are currently no consensus GAP, more investigation is needed to measure the impact of specific interventions on infection rates to determine new evidence-based GAP or BDP.

Limitations of the study

There were general limitations with some survey questions. Responses were accepted as received in order to maintain anonymity of the respondents. Patients and nurses were able to respond to all questions, even those that were not applicable to them, and could skip any question in the survey. Furthermore, for some questions, respondents were asked to check all that apply. Thus, some question responses provided percentages and total counts that were greater than 100% or the respective sample size. Further, some questions could have been misinterpreted by respondents. For example, the survey did not clarify that the question regarding use of sharp needles in a BH was meant to exclude usage during BH creation.

Other study limitations included a small sampling; responses only represented 17 sites of select size and population. Results may not be generalized to all HHD programs given the small number of sites sampled. Similarly, this survey did not directly link patients with their training nurses and therefore did not have the ability to determine whether nonadherence to GAP was specifically due to nurses training or patient adherence.

FUTURE

This survey was an initial venture into current practices to further educate the nephrology community on the practices common with HHD.

The next logical steps in the approach to improve vascular access use and care following this survey are to (1) immediately promote and implement GAP where lacking; (2) create a registry to collect systematic data with the goal of identifying GAP where none exists today, and validate the effects of training materials and methods in implementing GAP; (3) use continuous quality improvement techniques to measure and improve outcomes; and (4) ultimately develop BDPs for home HD access cannulation.

The registry information may help nurses and manufacturers to better understand the appropriate techniques that will improve vascular access infectious complications, particularly in the HHD patient. In addition, HHD is a

growing but still relatively new therapy with limited experience base. As with other young therapies, best practices and guideline development are still being defined and refined as new data are collected. This information will help guideline-setting bodies to publish recommendations specifically for HHD.

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REFERENCES

- 1 USRDS. 2012 Annual Report for United States Renal Data System. Available from: http://www.usrds.org/2012/pdf/v2_ch3_12.pdf (accessed date: July 3, 2013). 2012.
- 2 FHN Trial Group, Chertow GM, Levine NW, Beck GJ, et al. In-center hemodialysis six times per week versus three times per week. *N Engl J Med*. 2010; **363**:2287–2300.
- 3 FHN Trial Group, Rocco MV, Lockridge RS Jr, Beck GJ, et al. The effects of frequent nocturnal home hemodialysis: The Frequent Hemodialysis Network Nocturnal Trial. *Kidney Int*. 2011; **80**:1080–1091.
- 4 Suri RS, Larive B, Sherer S, et al. Risk of vascular access complications with frequent hemodialysis. *J Am Soc Nephrol*. 2013; **24**:1–8.

- 5 Srinivasan A, Wise M, Bell M, et al. Vital Signs: Central Line-Associated Bloodstream Infections—United States, 2001, 2008, and 2009. Published at Medscape. Available from: <http://www.medscape.com/viewarticle/738526> (accessed date: July 3, 2013). Published 2011.
- 6 Patel PR, Kallen AJ, Booth S, et al. Bloodstream infection rates in outpatient hemodialysis facilities participating in a collaborative prevention effort: A quality improvement report. *Am J Kidney Dis*. 2013; **62**:322–330.
- 7 Dong J, Chen Y. Impact of the bag exchange procedure on risk of peritonitis. *Perit Dial Int*. 2010; **30**:440–447.
- 8 CDC Website. Dialysis Safety. Available from: <http://www.cdc.gov/dialysis/prevention-tools/core-interventions.html> (accessed date: July 3, 2013).
- 9 O’Grady N, Alexander M, Dellinger EP, et al. Guidelines for the prevention of intravascular catheter-related infections. *Clin Infect Dis*. 2002; **35**:1281–1307.
- 10 Nesrallah GE, Cuerden M, Wong JH, Pierratos A. Staphylococcus aureus bacteremia and buttonhole cannulation: Long-term safety and efficacy of mupirocin prophylaxis. *Clin J Am Soc Nephrol*. 2010; **5**:1047–1053.

SUPPORTING INFORMATION

Additional Supporting Information may be found in the online version of this article at the publisher’s web-site:

Appendix S1. Survey developed to collect information on nursing practices used to train home hemodialysis patients for the preparation and use of the vascular access site.

Appendix S2. Survey developed to collect information on home hemodialysis patient practices for the preparation and use of the vascular access site.