Implementation of an Electronic Catheter Checklist in Outpatient Hemodialysis Facilities:
Results of a Pilot Quality Improvement Project

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Key Points

- Converting CDC’s existing catheter checklists to an electronic format improved the ease of collating data for use in facility QAPI meetings.
- The educational content was formatted for easy access with a mobile device which was readily available for viewing by patients and staff.
- Streamlining the processes used by facilities to perform checklists and audits could increase uptake of this important intervention.

Abstract

Background

Performing catheter care observations in outpatient hemodialysis facilities are one of CDC’s core interventions, which have been proven to reduce bloodstream infections. However, staff have many competing responsibilities. Efforts to increase and streamline the process of performing observations are needed. We developed an electronic catheter checklist formatted for easy access with a mobile device, and conducted a pilot project to determine the feasibility of implementing it in outpatient dialysis facilities.

Methods

The tool contained the following content: 1) patient education videos; 2) catheter care checklists (connection, disconnection, and exit site care); 3) pre-pilot and post-pilot surveys; 4) a pilot implementation guide. Participating hemodialysis facilities performed catheter care...
observations on either a weekly or monthly schedule and provided feedback on implementation of the tool.

Results

The pilot data were collected from January 6 through March 12, 2020 at seven participating facilities. A total of 975 individual observations were performed. The catheter connection, disconnection and exit site steps were performed correctly for most individual steps, however areas for improvement were 1) allowing for appropriate antiseptic dry time, 2) avoiding contact after antisepsis and 3) applying antibiotic ointment to exit site.

Post-pilot feedback from staff was mostly favorable. Use of the electronic checklists facilitated patient engagement with staff and was preferred over paper checklists, as data are easily downloaded and available for use in facility Quality Assurance and Performance Improvement (QAPI) meetings. The educational video content was a unique learning opportunity for both patients and staff.

Conclusions

Converting CDC’s existing catheter checklists to electronic forms reduced paperwork and improved the ease of collating data for use during QAPI meetings. An additional benefit was the educational content provided on the tablet which was readily available for viewing while in the hemodialysis facility by patients and staff.
Introduction

In the United States over 480,000 patients receive in-center hemodialysis at more than 6,500 outpatient facilities (1). Infection is the second leading cause of death among patients on dialysis. Unique characteristics that may predispose to infection risk in this vulnerable population is the immunocompromised state of patients with end stage kidney disease (ESKD), the requirement for frequent access to the bloodstream, and the shared treatment setting with exposure to other patients and staff. This risk is further increased by the high prevalence of central venous catheters, which disproportionately contributes to blood stream infections (BSIs) when compared to arteriovenous fistulas and grafts (2). In 2017, central venous catheters were the vascular access type in 80% of incident patients and remained in use in approximately 19% of patients one year after hemodialysis initiation (1).

Patients on dialysis rely on their providers to follow best practices to prevent infection-related complications, hospitalizations, and death. In order to minimize these complications, the Centers for Disease Control and Prevention (CDC) has developed a list of nine core interventions to prevent BSIs (3). Adherence to these core interventions has been associated with a 54% reduction in BSIs that was sustained over four years (4,5). One of the core interventions is quarterly performance of vascular access care observations, including catheter connection, disconnection and exit site care. CDC currently provides audit tools on its website to print for use in dialysis facilities. Streamlining the processes used by facilities to perform checklists and audits could increase uptake of this important intervention. Understanding patient’s acceptability of electronic audits and whether this format could be used to further engage patients in their care could also improve facility uptake. Recently, members of the
Vascular Access Workgroup, of the American Society of Nephrology’s (ASN) Nephrologists Transforming Dialysis Safety (NTDS) workgroup, developed an electronic chairside catheter checklist (ECC) which was formatted for easy access with a mobile device (e.g. tablet), and conducted a pilot to determine the feasibility in implementing this tool in outpatient hemodialysis facilities.

**Materials and Methods**

**Development of electronic catheter checklist (ECC) and associated materials**

Members of the ECC core development team included a patient with ESKD, a project specialist from the ASN-NTDS, two nephrologists and an infection prevention subject matter expert from the CDC. The ECC core team developed the tool using Google forms. Tablets were provided which contained four icons on the home screen pertaining to the ECC: 1) patient education videos; 2) catheter care checklists; 3) pre-pilot and post-pilot surveys; 4) general information including a pilot implementation guide, a concise information sheet for staff and an informational flyer for patients. [Figures 1-3]

Patient education videos about hand hygiene, catheter-associated BSIs, catheter care technique, and the “clean hands count campaign” were included on the tablets. (6-11). To further engage and educate patients about the catheter care process, a handheld mirror was provided to patients to view the procedures.

Three checklists were developed and based on CDC’s audit tools (6): catheter connection, disconnection, and exit site care. Catheter care videos were embedded in the tool for staff education. A watch was provided so observers could time specific steps.
Pre-pilot data were collected from team leaders on how facilities were currently conducting observations of catheter care, including who was responsible for performing the observations, which paper forms were used, and how many were completed in the three months prior to pilot initiation. Participating patients completed pre-pilot surveys using the tool and provided information on how they would rate their baseline knowledge of catheter connection, disconnection, and exit site care protocols; their duration of catheter-dependence, any past catheter-related infections, and comfort level in reminding staff to perform hand hygiene.

Post-pilot surveys, entered into the tool, collected feedback from team leaders, other staff observers and patients about implementation of the ECC tool, including the perceived benefits of use, barriers encountered and if it contributed to delays in hemodialysis, changed staff technique, or improved patient knowledge or engagement.

**Participating facilities and staff performing observations**

Participation in the pilot was voluntary; individual hemodialysis facilities affiliated with members of the NTDS were invited to participate, and included both for-profit and not-for profit, free-standing hemodialysis facilities, which were situated in different geographical regions of the United States. This project was reviewed by human subjects at CDC and deemed to be non-research. Prior to implementation of the pilot, approval was obtained from the hemodialysis facilities owners.

Participating facilities identified a team leader to teach staff how and when to use the ECC, to speak to patients about the ECC and introduce them to educational materials, to encourage staff use of the ECC throughout the duration of the pilot. Observers included staff familiar with
the steps involved in catheter care such as registered nurses (RNs), physician assistants (PAs), nurse practitioners (NPs), physicians and dialysis technicians. Facilities were asked to complete the checklists at least monthly for each patient. Observers were provided information on how to address a colleague when a step was missed.

In December 2019, the ECC core team conducted two one-hour webinars to provide pilot facilities instructions on how to use tool. A three-month pilot was planned, from January 1, 2020 until March 31, 2020; however, the pilot was stopped prematurely due to the COVID-19 pandemic on March 12, 2020.

Data collection and analysis

Results from all participating hemodialysis facilities were collected by the NTDS vascular access workgroup. No patient identifiers were collected, and each facility was deidentified. Data were downloaded from the ECC tool into Microsoft® Excel and then analyzed using Stata® 14.0.

An observation was defined as completion of a checklist step (i.e., catheter connection, disconnection, or exit site care). The specific steps were summarized and described as completed or not completed. If a staff member required a reminder to complete a step, it was counted as not completed or missed. The number of times checklist results were reviewed (e.g., for quality improvement purposes) or procedure videos were viewed were summarized. All surveys were recorded as a 5-point Likert scale.

Data that were normally distributed and where the sample size was large are reported as means +/- standard deviation (SD). Results are reported as percentages where appropriate. Non-normally distributed data with a small sample size (e.g., the number of catheter patients
per week) were reported as the median [Interquartile range, IQR]. Because this was a
descriptive feasibility project, no statistical analysis was performed.

Results

Of the 10 outpatient hemodialysis facilities invited to participate in the ECC pilot, 7 agreed. The
main reasons cited for declining to participate included lack of adequate staffing and time
restraints. The participating facilities included 5 hospital-affiliated (4 with Emory Healthcare in
Atlanta, GA and 1 with Altru Health System in Grand Forks, ND) units and 2 that were affiliated
with DaVita Kidney Care in New York City, NY (Bronx). The 4 Atlanta clinics performed at least
monthly observations, while the 3 other units performed weekly.

Pre-pilot data

Baseline pre-pilot data provided by the facility team leaders are provided in Table 1. In the 3
months preceding the implementation of the pilot, the total number of catheter-dependent
patients treated weekly at all 7 pilot facilities combined was 176 patients, and the median
number treated per week at each hemodialysis facility was 26 (IQR 17-34) patients. In the pre-
pilot period, the mean number of catheter connections, disconnections and exit site care
observations was 12 per month for each observation type, (range between 1-5 and >20).
Baseline patient pre-pilot survey data provided are provided in Table 2 and Figure 4. A total of
108 patients completed the pre-pilot survey using the tool, and 17 (15.7%) reported having had
a catheter-related infection in the past. The duration of catheter use was < 1 month (13%), 1-6
months (36.1%), 6-12 months (19.4%), and > 12 months (31.5%). Most patients rated their
knowledge of the protocol for catheter procedures as “average”. Almost all patients (92.6%) reported they felt comfortable reminding hemodialysis staff to perform hand hygiene.

**ECC pilot results**

The pilot data were collected from January 6 through March 12, 2020. The observations were performed by either an RN, NP, PA, physician, or dialysis technician. [Figure 5] A total of 954 individual observations were performed during the pilot period using the ECC tool: CVC connection (n=361), disconnection (n=305), or exit site care (n=288), (Table 3). The range of observations in Facilities A-D (observations monthly) was between 21-124, and in Facilities E-G (observations weekly) was between 212-273 over the pilot period.

The proportion of steps completed correctly for each CVC observation for all pilot facilities combined is provided in Figures 6-8. Most steps were performed correctly. Steps in which there were lapses in technique, requiring the observer to remind staff of the recommended antiseptic protocol, were: 1) allowing for appropriate antiseptic dry time during catheter connection (10%) and disconnection (4%), 2) avoiding contact after antisepsis during exit site care (28%), and 3) applying antibiotic ointment to the catheter exit site (27%).

Products used for catheter care varied across facilities. All four facilities in Atlanta used TEGO connectors which are changed weekly. In the two New York facilities the hemodialysis the CVC hub caps were changed with each treatment and replaced with ClearGuard® HD (Pursuit vascular, Maple Grove, MN) antimicrobial caps. In the Grand Forks facility, the hub cap was replaced by a 3M Curos™ cap weekly. The antiseptic product most commonly used for skin antisepsis was chlorhexidine gluconate with 70 % alcohol, followed by sodium hypochlorite,
and isopropyl alcohol 70%. One facility reported using normal saline for exit site care in a patient who had refused “chemicals” and antiseptic agents. Use of antibiotic ointment at the catheter exit site was part of the routine care at 6/7 hemodialysis facilities and adherence was 100%. One of the two facilities in New York did not include antimicrobial ointment as part of the routine catheter care and reserved its use for exit site infections (observed in only 3% of procedures).

The checklist results were reviewed on 19 occasions. The majority of these occurred at the 3 facilities which were performing weekly audits, (Facility E=12 views, Facility F=3 views, Facility G=3 views), and in 1 facility performing monthly observations (Facility A=1 view). The procedures videos were viewed by staff twice.

**Post-Pilot Feedback**

Due to the COVID-19 pandemic the post-pilot surveys were not completed. Team leaders provided feedback during a virtual town hall meeting in October 2020. The electronic format was preferred over the paper forms, as data analysis was automatic and viewing the data in aggregate format was “convenient.” Paper audit tools had the risk of being misplaced and required separate calculations to perform an analysis for use at the monthly facility meeting. In addition, the ECC tool could be modified more easily by individual facilities to reflect facility-specific practices.

The additional staffing time required to perform frequent observations was challenging. Each observation required an average of an additional 10-15 minutes per patient. One team leader, assigned to conduct weekly observations, stated that the pilot effort accounted for as much as
40% of her time on days conducting the observations. Another leader stated that weekly scheduling of observations “was an extremely time-consuming process”. To protect their time, the team leaders enlisted other hemodialysis staff to perform observations, however motivation quickly waned because it added to their heavy workload, without additional compensation.

Additional challenges included the timing of observations: 1) missing catheter connection steps for patients with early morning start times, 2) nursing staff having to notify the observer when catheter care will occur, and 3) multiple patients undergoing care simultaneously limiting the ability to observe all.

Staff reported improved patient engagement. At one facility, the staff found the ECC observations to be a learning opportunity for assessing gaps in patient knowledge about catheter care. The tool also facilitated communication from the nursing staff to the patients on the challenges of adherence to optimal antiseptic technique. Team leaders offered to assist the patients in selecting the educational videos available on the tool, however in some instances patients were disinterested and declined.

Participating facilities provided the following suggestions for optimizing future use of the ECC: 1) limit observations to a monthly or quarterly schedule, 2) recruit multiple staff members to share responsibility for performing audits, and 3) provide additional staff compensation for time required to perform observations.

Discussion
The CDC core interventions, which include the use of catheter care observations, have been proven to be effective in reducing rates of hemodialysis catheter-associated BSI (3-5, 12) and checklists have been used for the prevention of BSI other settings (13,14). We explored whether converting catheter care checklists to an electronic format facilitated performance of observations in busy outpatient hemodialysis facilities.

Staff noted some benefits to the electronic format. The reduction in paperwork and improved ease of collating data for use during facility QAPI meetings was widely noted to be a benefit. The staff also noted that the electronic format allowed easier transfer of data into the national database for reporting purposes. The data collected during the pilot was reviewed more frequently in the three facilities assigned to a schedule of weekly observations, whereas only one facility assigned to perform monthly observations reviewed their facility’s results. This may have been due to limited data available in the monthly assigned facilities and early termination of the pilot. Another advantage to the electronic tool is that individual steps could be easily modified by the individual facility, such as type of antiseptic agent used, type of catheter hub device, and type of antibiotic ointment or dressing applied at the exit site.

While the CDC educational videos provide “best practice” instructions for staff, they were infrequently used. This may be because the staff completing the audits were already familiar with the steps and did not feel that they needed the additional instruction. Furthermore, viewing the videos in real time is likely impractical given how quickly the steps occur during catheter care. Ideally, staff would view the videos prior to performing observations.
The pre-pilot survey revealed that the extent of patients’ knowledge about catheter care steps was wide-ranging, from “no idea” to “proficient in self-care.” Educating patients about the correct methods for performing each step and the importance of performing meticulous catheter care is central to improving patient safety. Use of the ECC tool in general provided opportunities to engage patients in discussions. However, experiences varied by facility regarding patient interest in watching the videos. Utilization of the ECC tool for patient education will require that the staff have time to illustrate its content to patients. In the future, allowing patients to use the tool independently may increase video viewings and opportunities for patient engagement and education. The educational content available in the tool may be easily modified or developed by individual facilities to better meet their specific patient needs.

The drawbacks cited by staff regarding use of the ECC tool primarily reflected the challenges of performing observations in general and not directly related to the electronic format. Staff had to complete their other duties as well as perform observations and the time required was considerable. All team leaders agreed that weekly observations demanded too much time away from patient care responsibilities, and that performing monthly, or every 3-month observations, as is currently recommended by CDC, is preferable. Recruiting and training more frontline staff members to perform observations may increase the likelihood that performing the observations monthly becomes standard practice in the future and may provide additional education and training. Once staff feel more familiar with the ECC there may be more interest to further explore additional educational features (e.g., videos).

During the pilot project period, we found a high degree (>95%) of adherence to most catheter care steps. This may be attributable to the Hawthorne effect, where the observer’s presence
improves adherence to antiseptic practice and improves patient safety. However, some areas for improvement were identified. One is the need to educate staff on appropriate antiseptic drying time, performed correctly in only 90% of cases, which required a reminder by the observer in the remaining 10%. One way to address this deficiency is to make best practice information for each product in use at the facility more readily available to staff. This information can be reviewed regularly in facility staff meetings or posted in the dialysis station on a laminated card that can be disinfected. In addition, the electronic tool can be customized and facility-specific information on such practices added.

Limitations of the project included the relatively short duration, which was further decreased when the COVID-19 pandemic started to consume staff time. The pilot was implemented in only seven facilities and there was common ownership across some of the facilities so variations in facility policies or practices that might increase or decrease acceptability of tool may not have been identified. This was an observational feasibility project and was not powered to determine efficacy. The post-pilot surveys were not completed, and feedback was obtained in a town hall format limiting the ability to assess some components of the implementation such as how patients rated their catheter care knowledge post implementation.

In summary, the utilization of an ECC to perform chairside audits in hemodialysis facilities was preferred over existing paper audit tools. Furthermore, the ECC provided aggregated real-time data which could be shared during the facility QAPI meetings. An additional unique aspect of the ECC tool is the incorporation of educational videos available to patients and staff. Unfortunately, the electronic format did not alleviate required staff time, one of the primary
barriers to performing observations. Adequate support for hemodialysis staff and protection of their time to perform ECC observations are necessary to prevent task stacking and to improve catheter care.

**Disclosures:** M. Mokrzycki reports Consultancy Agreements: Member of the Clinical Events Committee, Medtronic Global Simplicity Registry, Medtronic Spyral HTN On/Off Meds, RECOR MEDICAL/RADIANCE II, Medtronic Spyral Dystal trial, BOA GARNET trial; Honoraria: spherix global insights. L. Golestaneh reports Honoraria: Horizon Pharmaceuticals; Other Interests/Relationships: compensation from the Cardiovascular Research Foundation for fulfillment of duties as a member of the Clinical Events Committee for the the Spyral Hypertension trials, sponsored by Medtronic. A. Kliger reports Consultancy Agreements: ASN, National Institutes of Diabetes, Digestive Diseases and the Kidney; Honoraria: several universities and medical schools, professional organizations - honoraria for lectures, seminars, webinars; Scientific Advisor or Membership: Qualidigm (Quality Improvement Organization); Other Interests/Relationships: Renal Physicians Association, American Society of Nephrology. V. Niyyar reports Consultancy Agreements: Ironwood Pharmaceuticals (finished Dec 2018) - and in the past, agreements with Lesinurad and Ardea Biosciences; Honoraria: American Society of Nephrology - Invited speaker, American Society of Nephrology Highlights - Invited speaker, American Society of Diagnostic and Interventional Nephrology - Invited speaker, National Kidney Foundation - Invited speaker, KidneyCon - Invited Faculty, Albert-Einstein Montefiore - Invited Faculty, Ironwood Pharmaceuticals – REAC, Lesinurad - Advisory Board Member, Ardea Biosciences, Random surveys and questionnaires; Scientific Advisor or Membership: American Society of Diagnostic and Interventional Nephrology – PresidentElect, Previously ASDIN Secretary-Treasurer and Councilor, ASDIN Chair, US Certification Committee, ASDIN - Chair, HVA Certification Committee, KHI - ASN/FDA (graft committee), American Society of Nephrology
Consulting. All remaining authors have nothing to disclose.

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**Author Contributions:** M Mokrzycki: Conceptualization; Data curation; Formal analysis; Investigation; Project administration; Visualization; Writing - original draft; Writing - review and editing

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A Kliger: Conceptualization; Methodology; Supervision; Writing - review and editing

V Niyyar: Conceptualization; Data curation; Methodology; Project administration; Supervision; Writing - review and editing

V Bren Asp: Project administration; Writing - review and editing

L Golestaneh: Formal analysis; Writing - review and editing

Q Taylor: Conceptualization; Methodology

S Novosad: Conceptualization; Funding acquisition; Project administration; Writing - review and editing
References


6. Safe Care Campaign video on importance of proper hand hygiene
https://www.youtube.com/watch?v=tZnKlFtAUDw&feature=youtu.be

https://www.youtube.com/watch?v=_CUoht_RmF4&feature=youtu.be
8. Safe Care Campaign video on Preventing CRBSIs
   https://www.youtube.com/watch?v=sFROH5rvWOY&feature=youtu.be

9. FAQs about Catheter-Associated Bloodstream Infections (for patients)
   https://www.safecarecampaign.org/assets/sheab-1.pdf

10. What is proper technique? CDC Video: Preventing Bloodstream Infections in Outpatient Hemodialysis Patients. https://www.youtube.com/watch?v=_0zhY0JMGCA


   Available at: https://www.cdc.gov/dialysis/prevention-tools/audit-tools.html


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<th>B</th>
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<th>D</th>
<th>E</th>
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<td>Total Patient Audits per month Months 1-3 Pre-Pilot CVC Connection</td>
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<td>Total Patient Audits per month Months 1-3 Pre-Pilot CVC Disconnection</td>
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<td>6-10</td>
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<td>&gt;20</td>
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<tr>
<td>Total Patient Audits per month Months 1-3 Pre-Pilot CVC Exit Site Care</td>
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<td>6-10</td>
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<td>&gt;20</td>
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Table 2. Results of pre-pilot patient surveys

Likert scale: 1=“I have no idea what they are doing”; 5=“I could do it myself”

Reported as the Mean (± SD)

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<td>N=4</td>
<td>N=29</td>
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<td>3.08 (1.44)</td>
<td>3.38 (1.02)</td>
<td>4.25 (0.96)</td>
<td>3.34 (1.14)</td>
<td>2.41 (1.12)</td>
<td>3.46 (1.45)</td>
<td>2.38 (1.12)</td>
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<tr>
<td>How would you rate your knowledge about the steps the staff take to disconnect your CVC at the end of treatment?</td>
<td>3.08 (1.44)</td>
<td>3.06 (1.06)</td>
<td>4.25 (0.96)</td>
<td>3.28 (1.22)</td>
<td>2.41 (1.06)</td>
<td>3.54 (1.45)</td>
<td>2.31 (1.14)</td>
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<td>How would you rate your knowledge about the protocol for CVC exit site care?</td>
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<td>3.43 (1.15)</td>
<td>4.00 (1.41)</td>
<td>3.41 (1.3)</td>
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Table 3. Results of electronic catheter checklist pilot project

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<td>N</td>
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<td>9</td>
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<td><strong>CVC connection</strong></td>
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<td>(32.5%)</td>
<td>(42.9%)</td>
<td>(33.9%)</td>
<td>(36.2%)</td>
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<td>31</td>
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<td>(37.4%)</td>
<td>(38.1%)</td>
<td>(35.5%)</td>
<td>(26.8%)</td>
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<td>N (%)</td>
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<td>38</td>
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<td>70</td>
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<tr>
<td><strong>CVC exit site care</strong></td>
<td>(37.9%)</td>
<td>(30.1%)</td>
<td>(19.1%)</td>
<td>(30.7%)</td>
<td>(31.7%)</td>
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<td>(32.1%)</td>
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<td>N (%)</td>
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<td><strong>View Checklist results N (%)</strong></td>
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<td><strong>Watch Proper Procedure Videos</strong></td>
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Figure Legends

Figure 1. Dialysis care checklist (initial screen)

Figure 2. Dialysis care checklist (second screen)

Figure 3. Educational videos for patients

Figure 4. Pre-pilot survey of patient knowledge about catheter care procedures. Question: “How would you rate your knowledge about the steps the staff take to connect and disconnect your catheter, and about the protocol for exit site care?”

Figure 5. Type of observer using the electronic catheter checklist for each pilot facility

Figure 6. Catheter connection observation results (n=361)

Figure 7. Catheter disconnection procedures (N=305)

Figure 8. Catheter exit site procedures (n=288). * One facility did not use antibiotic ointment.
Dialysis Care Checklist

* Required

Who is observing the procedure? *

- Technician
- Nurse
- Social Worker
- Dietician
- Physician
- PA/APRN

Procedure *

- Catheter Connection
- Catheter Disconnection
- Catheter Exit Site Care
- Watch Proper Procedure videos
- View Checklist Results

NTDS  Making Dialysis Safer Coalition

Transforming Dialysis Safety
Dialysis Care Checklist

* Required

**Catheter Connection**

1. Mask worn properly (if required) *
   
   Covering both the nose and mouth

   - Yes
   - No
   - Yes, after being reminded
   - No, not required by facility policy
Educational Resources for Patients

Topics

- Importance of Hand Hygiene
- Catheter-Associated Bloodstream Infections
- Proper Technique to Prevent Infection
- Clean Hands Count Campaign for Dialysis

NEXT
Figure 6

- Mask worn: 100%
- Hand hygiene before: 100%
- New clean gloves: 100%
- Scrub Hub: 100%
- Antiseptic dry time appropriate: 90%
- Catheter connected Aseptically to blood line: 100%
- Gloves removed: 100%
- Hand hygiene after: 100%

Procedure Correctly Performed
Figure 7

- Mask Worn
- Hand hygiene before
- New clean Gloves
- Catheter disconnected aseptically
- Scrub Hub
- Antiseptic dry time appropriate
- Gloves removed
- Hand hygiene after

Procedure Correctly Performed