An Innovative and Time-Efficient Dialysis Catheter and Exit-site Electronic Surveillance (DCES) Tool in the Paediatric Dialysis Unit

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The purpose of this paper is to share with the health care professionals (HCPs) an overview of the development and implementation of a user-friendly, time-efficient, electronic catheter screening tool to be utilized by the dialysis nurses at each dialysis session to assess for catheter function, patency and signs of infection.

The objectives of the study are:

- To analyse the variables of assessment of the Dialysis Catheter and Exit-Site Surveillance Tool (DCES)
- To state acceptance and efficiency of the tool among nursing staff

The aim is to help the HCPs to monitor chronic dialysis catheters for signs of thrombosis and infection, provide a research tool to study the effect of different practice approaches, and generate tracking and quality improvement data for the dialysis unit.

Introduction and background

The United States Renal Data System (USRDS) reported a decrease in the number of children and adolescents beginning end-stage renal disease (ESRD) care, from a high rate of 17.5 per million in 2004 to 13.8 per million population in 2016, representing a decrease of 21.1%. Children initiate ESRD therapy with Haemodialysis (HD) more frequently than Peritoneal Dialysis (PD) or transplantation. In 2016, 702 (51.2%) initiated therapy with HD, 353 (25.7%) with PD, and 275 (20.0%) with transplant (1).

The aetiology of ESRD in children varies by age of development; in the younger age group, structural and inherited causes of ESRD predominate, while glomerulonephritis and other acquired causes are more common in the older children (2).

Dialysis for children with ESRD continues to pose unique challenges to parents, providers, and the healthcare system; not only due to the unique and specific dialysis-treatment prescriptions and challenges related to size and anatomy, but also because children tend to be more active and more likely to manipulate their catheters; that puts their dialysis access at an increased risk of malfunction and or infection.

There are three principle forms of vascular access available for the treatment of children with ESRD by HD: tunnelled catheters placed in a central vein, Central Venous Lines (CVLs), arteriovenous fistulas (AVF), and arteriovenous grafts (AVG) using prosthetic or biological material. CVLs remain the most widely used access type in the paediatric HD population and accounts for 72%-81% of all HD access types.

Children older than 10 years with the following issues are more likely to receive their HD treatments via CVLs (3,4):

- candidates not suitable for peritoneal dialysis
- short wait time on transplant lists
- urgent need to start HD
- perceived fear of needles to access AVFs and AVGs.

The dialysis catheter is considered the life-line for children with ESRD on HD. Dialysis unit's staff provide extensive education to the patients and their caregivers on how to care for the catheter and keep the exit-site infection-free among other maintenance care. Moreover, accessing the (CVLs) is limited to the dialysis staff and well-trained medical personnel. Different techniques and barriers are used to disinfect and clean the catheter exit-site and lock the dialysis catheters (5), all aiming at lowering the rates of central line related blood stream infections and prolonging the lifetime of the dialysis catheter while minimizing its complications and co-morbidities (3).

Despite recent improvements in dialysis mortality, a difference in mortality by modality remains; with HD- and PD-associated one-year all-cause mortality rates 5.4 and 2.2 times higher than for transplant patients, respectively. Sepsis remains among the top five causes of mortality in the paediatric ESRD population (1). The most common reason for cuffed CVL removal is infections, which can range from exit-site infections to tunnel infections to bacteraemia (4).

There are advantages to a CVL, including the ability for it to be used immediately and the absence of needle cannulation. Comparatively however, CVL have more disadvantages, such as its short life span, thrombosis, infection, malfunction and possible fibrin sheath formation (4).

Screening for early signs of exit-site and dialysis catheter infection, thrombosis and dysfunction is not only critical in reducing patient morbidity, but also in salvaging the dialysis catheters, lowering the cost to the health-care system, and tracking of infection risk factors and causative organisms.

Dialysis units rely on a wide array of screening tools; in many instances those tools are paper forms or excel sheets, such tools pose a challenge in maintaining and tracking the data in a real-time and readily accessible format. In this paper, we present our new, innovative and time-efficient dialysis catheter and exit-site electronic surveillance (DCES) tool with an aim to help health care professionals monitor chronic dialysis catheters for signs of thrombosis and infection, provide a research tool to study the effect of different practice approaches, and generate tracking and quality improvement data for the dialysis units.

Methods

The tool (DCES) was developed using Visual Basic programming language, uploaded to the work stations in the dialysis unit at Sidra Medicine in Doha, Qatar, and was integrated as part of the dialysis nurses work flow. Recorded data track the different variables of study such as:

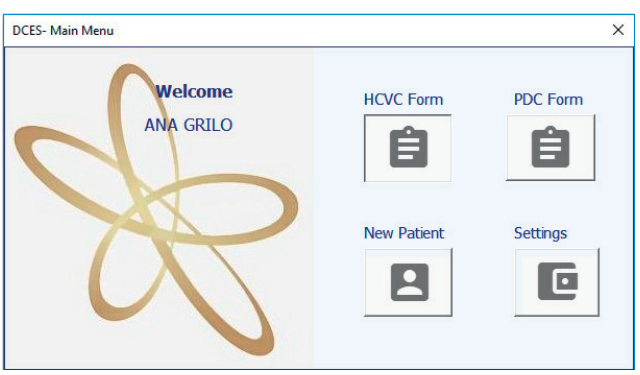
- the catheter locking solution type
- five measures of patency: difficulty in withdrawing locking solution/blood or presence of clots in catheter, ease to flush catheter lumens, need to swap/reverse lines, need to use thrombolytic agents
- two measures to assess for signs of catheter infection (positive blood cultures, need for antibiotics),
- two measures of exit-site assessment (dressing integrity and signs of infection, such as redness, tenderness, inflammation, exudate, pain).

In Figure 1, there is a snapshot of the A) Front page, B) Main Menu, C) Haemodialysis Catheters Assessment, D) PD catheter assessment user-friendly tool.

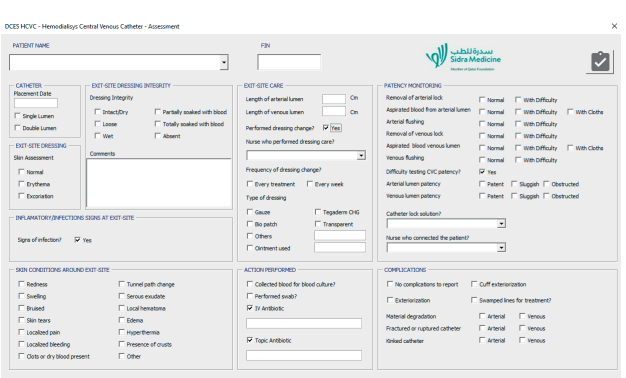
Fig. 1 - DCES – Dialysis Catheter and Exit-Site Surveillance

A) Front page of the program

B) DCES main menu



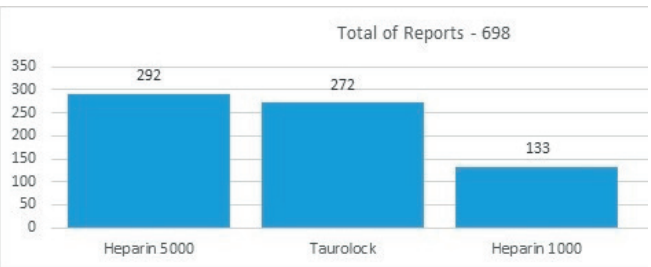
C) Haemodialysis Catheters Assessment page



Discussion

The need to have dialysis-catheter and exit-site events data in a real-time and readily accessible format to screen, track and generate quality reports prompted us to develop this new, innovative and time-efficient dialysis catheter and exit-site electronic surveillance (DCES) tool. Since 2018, our dialysis unit staff have used it exclusively to track, assess, and evaluate access patency, complications and generate outcome and quality reports (example. Figure 2).

Fig 2 – Total of reports since November 2018 to September 2019 by Locking Solution

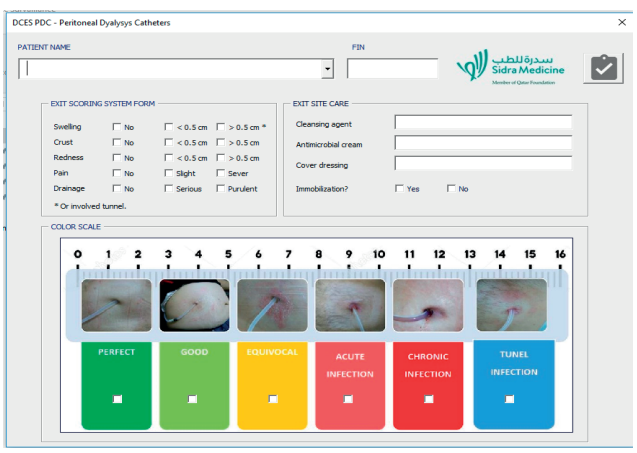


The tool was well-received by the dialysis team; it was both time-efficient (< 2 min to complete), and allowed for easy tracking of catheter related events, and made data utilization for quality improvement and research projects readily available.

While the tool was intended for dialysis unit use, it has the potential for a far-reaching utilization and can be implemented in other medical fields that care for patients with CVLs; such as those in the ICUs and oncology setting.

The use of the tool was also expanded to assess peritoneal dialysis catheter and exit-site for signs of infection and malfunction (figure 1 –D).

D) PD catheter assessment page



Other investigators have suggested using venous pressure, Kt/V or urea reduction ratios to track patency and efficiency of the dialysis access. Chand et al. (2002) reported that dynamic venous pressure monitoring does not adequately predict access failure in paediatric HD patients (6). In another study, a nursing team addressed the potential effect of skin color on identifying signs of exit-site infection, they created a surveillance tool that enabled staff to identify infections in patients of any skin color (7). While our tool was designed to track locking solutions and nine measures of the dialysis catheter patency and infection, it does not track venous pressure changes, Kt/V or urea reduction ratios. Also, because most of our dialysis patients receive their treatments via CVLs, our tool is not suited for tracking AVFs and AVGs outcomes. Finally, our tool needs to be validated in a large dialysis cohort group to establish its cost saving and clinical benefits.

Conclusion

With minimal nursing time and input, using our (DCES) tool will allow for real time tracking of dialysis catheter events, early identification of patency and infectious complications, generate clinical and quality outcome reports and serve as a research tool to examine different preventive catheter and exit-site intervention. This could translate into cost savings for the dialysis units, fewer episodes of bacteraemia and septicaemia, lower catheter-related morbidity and mortality, better antibiotic stewardship, fewer thrombolytic medication usage and interventions, fewer hospital admissions, and longer dialysis catheter life, as well as improvement in patient and caregivers' quality of life.

Implications for Clinical Practice

Key messages for Clinical Practice can be seen in Table 2

Table 2

Key Messages for Clinical Practice
It is fundamental to adopt a standardized tool for documentation in dialysis units in order to assess, compare and improve quality of care for patients.
Our access documentation electronic tool (DCES) is user-friendly and time efficient in recording events in the dialysis unit

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