# Improving catheter-related blood stream infection in haemodialysis patients using a practice development framework

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## Abstract

Catheter-related blood stream infection (CRBSI) contributes to hospitalisation and death in the haemodialysis population. Increasing numbers of catheter infections prompted a unit practice development program to reduce infection episodes.

**Objective/hypothesis** Improvement in clinical practice in dialysis catheter care would decrease dialysis CRBSI in the haemodialysis population.

**Context** Five dialysis units and one nephrology ward in regional Australia.

**Participants** Nephrology nurses working with haemodialysis patients who have central venous dialysis catheters (CVDC) in situ.

**Method** Use of a practice development framework to engage clinicians in reviewing their clinical practice and developing strategies to decrease dialysis CRBSI. Clinical practice was measured by undertaking clinical audits of CVDC care. The CRBSI rate was monitored and reported by the infection control department annually.

**Results** Rates of dialysis CRBSI have decreased from 4.39 per 100 patient-months to 3.42 per 100 patient-months ($p<0.001$) 12 months after the implementation of the project. There was a statistically significant association between improved staff practice and infection outcome measures.

**Conclusion** Dialysis CRBSI is a common, yet preventable complication in the dialysis unit. The results show that dialysis nurses play a significant role in preventing dialysis CRBSIs. Basic infection control standards are paramount and should be strictly followed for effective CVDC care.

**Keywords** Central venous dialysis catheter, bacteraemia, haemodialysis, catheters, sepsis, nursing.

## Introduction

The central venous dialysis catheter (CVDC) is a commonly used device in haemodialysis. Patients who are not suitable for creation of arterial-venous (A-V) fistula or graft require catheters to receive haemodialysis. Catheter-related blood stream infection (CRBSI) is a major complication in patients with CVDC (Johnson *et al.*, 2005; Rosenbaum *et al.,* 2006) and therefore CVDCs should be considered as a last choice for dialysis access (Ramanathan *et al.*, 2007). Despite the high incidence of infections with CVDCs, there are still more than 64% of patients in New South Wales who start dialysis with catheters, and infection remains one of the leading causes of death in the haemodialysis population (ANZDATA, 2011).

CRBSIs can result from extraluminal or intraluminal contamination (Lok & Mokrzycki, 2011). Extraluminal contamination often happens at the time of insertion, while intraluminal contamination involves transfer of organisms by contact from the hands of health care workers accessing the catheter for dialysis (Lok & Mokrzycki, 2011 p. 590). Poor hand hygiene, clinical environment such as dirty equipment, and inadequate sterilisation procedures, are factors that could potentially cause intraluminal contamination and result in dialysis CRBSI.

## Definition of dialysis CRBSI

CRBSI in the haemodialysis population has been defined by Ramanathan *et al.*, 2007 as "positive blood culture results from a haemodialysis patient with a tunnelled catheter in whom no other obvious source of infection was evident" (Ramanathan *et al.*, 2007, p. 606). A more recent definition was discussed in the North American Vascular Access Consortium (NAVAC) as:

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> *A) The same organism grown from at least one percutaneous blood culture and from a culture of the catheter tip/or B) A blood culture drawn from a catheter that has a ≥3 fold greater colony count of microbiologic isolates than those drawn from a peripheral vein* (Lee *et al.*, 2011, p. 521).

Despite the existence of guidelines and definitions, the episode of CRBSI is known to be hard to quantify and report (Dinwiddie & Bhola, 2010). This is due to the lack of a standardised method with which to quantify infection episodes related to dialysis catheters when compared to other infection sources.

Recent studies have suggested that comparing the time to the growth of colony count between a catheter sample and a sample from a peripheral vein could be a valuable tool to diagnose CRBSI (Nakazawa, 2010). However, due to the high associated cost this method is not commonly used for the purpose of clinical diagnosis in hospital settings. Moreover, many renal patients have poor peripheral vessels resulting in difficulties in obtaining blood samples from the peripheral line. Therefore, a CVDC is inserted instead of fistulae or grafts, making the above method impractical in many clinical situations.

Reporting systems have also been a major issue for the surveillance of dialysis CRBSI. Currently, there is no unified reporting mechanism for dialysis CRBSI established across Australia. Some units report infection episodes per "patient-months" while others report as per "1000 catheter days". This has made it difficult for dialysis units to benchmark and monitor their infection rate with other units or the Australian Council on Healthcare Standards (ACHS, 2011).

In this project, a CRBSI was identified from a positive blood culture. Each episode of positive blood culture was then reviewed by a microbiologist and the infection control team to ensure the number accurately reflected a dialysis access related infection. The reporting system used was episodes per 100 patient-months as suggested by the Australian Council on Healthcare Standards (ACHS, 2011).

## Project aims

The project aims to use a practice development framework (Manley, McCormack & Wilson, 2008) to develop an action plan to reduce numbers of CRBSI by:

- identifying the causes of rising dialysis CRBSIs in the department
- identifying strategies to reduce dialysis CRBSIs
- engaging all staff in developing and implementing practice change initiatives
- monitoring ongoing compliance and evaluating results.

## Methodology

A practice development framework was used in this project by adapting the methodology from the New South Wales Nursing and Midwifery Models of Care project and the Essentials of Care program (New South Wales Health: Nursing and Midwifery, 2009) to ensure both the engagement of the clinicians and sustainability of change. The working party was established, consisting of a nurse manager, a clinical nurse consultant, infection control unit representatives, and a dialysis nurse from each dialysis unit including: a major tertiary referral hospital and four satellite dialysis units in the surrounding region. The project was also registered on the nephrology department's quality agenda.

To gain a better understanding of what was causing the CRBSI rate to rise, the working party agreed to conduct clinical observations and a documentation audit of CVDC care performed in all dialysis units.

## Audit tool

There are many contributors to dialysis CRBSI. The major contributors include patients, caregivers, equipment and environmental factors. These factors are summarised in a CVC infection cause-effect fishbone diagram which was used to guide the development of clinical observation tools in this project.

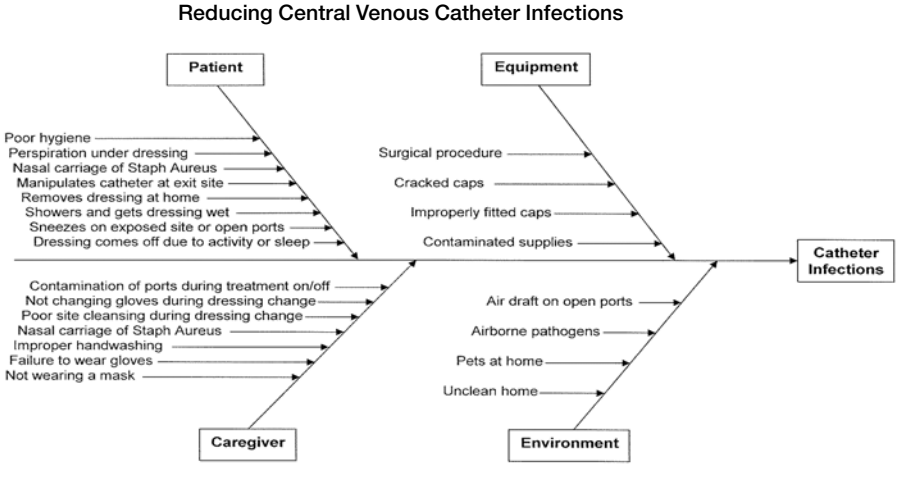


*Figure 1. CVC infection cause–effect fishbone diagram. Source: FistulaFirst from http://www.fistulafirst.org*

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Two audit tools were developed by the working party by adapting the fishbone diagram and the New South Wales policy directive for "central venous access device insertion and post insertion care" (NSW Health PD 2011-060) to ensure each element of CVDC care was properly reviewed. These audits focused on observing clinical practice and nursing documentation (Tables 1 & 2) and were conducted in all dialysis units over a four-week period during September 2010.

*Table 1. Clinical observation audit tool (HNELHD, 2010).*

| Performance indicator | MRN | Yes | No | NA | Comments |
|---|---|---|---|---|---|
| **Environment** | | | | | |
| 1. Is equipment wiped down before use, including no items left on the table? | | | | | |
| 2. Is procedure applied in a stable environment (e.g. minimise air-flow)? | | | | | |
| 3. Is PPE available to staff? | | | | | |
| **Aseptic technique** | | | | | |
| 4. Is dressing pack set up with aseptic technique? | | | | | |
| 5. Is dressing applied with aseptic technique? | | | | | |
| 7. Is a three-minute scrub performed? | | | | | |
| 8. Compliant with five moments of hand hygiene? | | | | | |
| 9. Are staff and/or patient talking while attending procedure? | | | | | |
| 10. Is aseptic technique used when reverse lines? | | | | | |
| 11. Are staff and/or patient talking/coughing over open lumens? | | | | | |
| 12. Is aseptic technique performed to connect patient to the machine? | | | | | |
| **Dressing** | | | | | |
| 13. Is dressing moist prior to change? | | | | | |
| 14. Is dressing intact prior to change? | | | | | |
| 15. Does dressing cover the exit site post-dressing change? | | | | | |
| 16. Are staff and/or patient talking over open exit site? | | | | | |

*Table 2. Documentation audit tool (HNELHD, 2010).*

| CVC documentation audit | Unit | | | | Date | | | | |
|---|---|---|---|---|---|---|---|---|---|
| MRN | Ongoing documentation | | | | Catheter flow issues | | | Infection | |
| | Entry on CVC care form for each session (cross-check with transnet) Y/N | Appearance of exit site documented each entry? Y/N | If documented red/moist/signs of infection and so on – was it followed up? | Redressed at least weekly? Y/N | Are there flow issues documented Y/N | If yes, what was the reason and was the reason documented? | >3 times Has a referral to vascular access nurse been made? Y/N | Has the patient had episodes of CVC-related infection? Y/N | If yes, have they been decolonised/ treated or have they reinfected? |
| 1 | | | | | | | | | |
| 2 | | | | | | | | | |
| 3 | | | | | | | | | |
| 4 | | | | | | | | | |
| 5 | | | | | | | | | |

## Ethics consideration

This was a quality improvement project and did not require human research ethics approval. Approval to conduct the project was provided by department and organisational heads.

## Audit results

Forty episodes of clinical practice of CVDC care were observed and recorded on the clinical observation audit tool. Results from the clinical practice audits indicated significant practice variation in: cleaning of work surfaces prior to set up; sterility of the dressing pack; and whether or not a three-minute scrub was completed prior to attending to the catheter. Also documented were episodes of the patient or staff member talking/coughing over open lumens and exposed exit sites (see Table 3 for pre- and post-observation results).

Fifty-five patients with a CVDC had their medical record charts audited. Both the patients' bedside medical record and the electronic database utilised within the nephrology department were audited. While results showed excellent compliance with recording insertions and removals on the electronic database, the bedside records showed poor compliance with documentation including only 10% of catheters had the exit site (the site at which the dialysis catheter exits the skin) appearance documented for each treatment session and only 55% included an entry for each dialysis session about the accessing of the CVDC.

## Action plan

An action plan was developed by the working party as a result of the audits. This included:

- Standardised practice for accessing CVDC to ensure evidence-based practice and to minimise practice variation. A standardised Hunter area guideline and procedure (HNELHD GrandP 11_28) was developed by working together with the infection control unit as well as using national renal guidelines such as Caring for Australians with Renal Impairment (CARI, 2000) and Kidney Disease Outcomes Quality Initiative (KDOQI, 2006) to ensure CVDC practices in our facility are evidence-based.
- A standardised haemodialysis treatment form was modified by adding a section referring to the CVDC exit site and dressing, to ensure the patient's CVDC is assessed, reviewed and documented for every dialysis treatment. By using the same form across 11 dialysis units within the local health district, patients can also be provided with a continuity of care between dialysis units.
- "Top 10 tips for CVDC care" – results from the clinical observations showed many CVDC procedures could potentially have been contaminated by patient/staff coughing and chatting during the procedure. It is recommended by the KDOQI guideline that coughing and chatting during the procedure should be avoided to prevent airborne contamination (KDOQI, 2006). The top 10 tips for CVDC care such as wearing masks and no chatting during the procedure were summarised into a poster by the working party and displayed in every dialysis unit as a reminder for all staff and patients of best practice.

## Implementation

All staff were introduced to the new guideline and procedure to minimise practice variation, and to ensure that the care delivered was evidence-based. Staff were also provided with education from the infection control unit regarding catheter infection management and prevention. The implementation of a standardised treatment form has enabled staff to promptly identify and manage infections through assessing and evaluating a patient's dialysis catheter and the exit site appearance every treatment.

## Results

The evaluation focused on staff practice and the overall dialysis CRBSI rates. A clinical observation tool (Table 1) used to record pre-observation data was also used to evaluate the post-observation results 10 months after all action had been implemented. Both pre- and post-observations were conducted randomly in all dialysis units in various time frames by the same observers. Data were analysed by comparing the improvement of percentage of each practice observed (Table 3). For example, staff practice of disinfecting work surfaces as part of CVDC preparation has increased from 58% to 80%, and the percentage of dressing packs being set up with aseptic technique increased from 80% to 90%.

In order to determine whether the increasing percentage is statistically significant to show the overall improvement in CVDC care, a chi-square test was performed to calculate the *p*-value. A logistic regression model was used to test for a difference in positive responses to evaluate between pre- and post-observation periods. The model was fitted within a generalised estimating equation framework to adjust for the repeated questions on individuals, for example, the improvement of 16 indicators (Table 3) on individual patients.

The dialysis CRBSI rate has also decreased to 3.42 per 100 patient-months from 4.39 per 100 patient-months, which is a decrease of almost 22% in the infection rate (Figure 2).

*Figure 2. Dialysis CRBSI 2009–2011.*

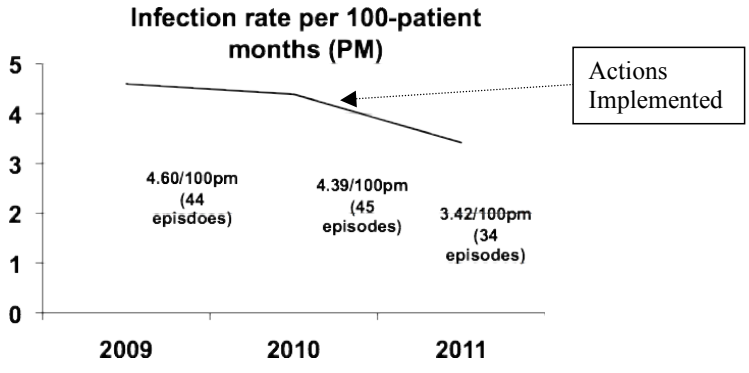

*Table 3. Comparison of pre- and post-result of clinical observations.*

| Performance indicator | Pre (n=40) | | Post (n=40) | |
|---|---|---|---|---|
| **Environment** | Yes | No | Yes | No |
| 1. Is equipment wiped down before use, including no items left on the table? | 58% | 42% | 80% | 20% |
| 2. Is procedure applied in a stable environment (e.g., minimise air flow) | 78% | 22% | 98% | 2% |
| 3. Is PPE available to staff? | 100% | 0% | 98% | 2% |
| **Aseptic technique** | | | | |
| 4. Is dressing pack set up with aseptic technique? | 80% | 20% | 95% | 5% |
| 5. Is dressing applied with aseptic technique? | 78% | 22% | 85% | 15% |
| 7. Is a three-minute scrub performed? | 70% | 30% | 82% | 18% |
| 8. Compliant with five moments of hand hygiene? | 62% | 38% | 95% | 5% |
| 9. Are staff and/or patient talking while attending procedure? | 42% | 58% | 22% | 78% |
| 10. Is aseptic technique used when reverse lines? | 98% | 2% | 99% | 1% |
| 11. Are staff and/or patient talking/coughing over open lumens? | 15% | 85% | 5% | 95% |
| 12. Is aseptic technique performed to connect patient to the machine? | 5% | 95% | 50% | 50% |
| **Dressing** | | | | |
| 13. Is dressing moist prior to change? | 2% | 98% | 3% | 97% |
| 14. Is dressing intact prior to change? | 80% | 20% | 85% | 15% |
| 15. Does dressing cover the exit site post-dressing change? | 58% | 42% | 100% | 0% |
| 16. Are staff and/or patient talking over open exit site? | 10% | 90% | 7% | 93% |

($p<0.001$)

## Discussion

The results of this project show that the infection rate for CVDCs may be reduced by improving clinical practice. Literature suggests that each element of nursing practice listed in Table 3 is a significant contributor to CRBSIs (Betjes, 2011). This project was able to improve these elements to reduce overall CRBSI rate in our service. The outcome of this project has indicated that the staff practice may have a significant impact on CRBSI, especially in haemodialysis units where nurses have the most contact with the patient's CVDC.

A study conducted by Bennett, Janko & Whittington (2005) indicated that there was a significant practice variation in CVDC care in all dialysis units in Australia. There are many practices still based on general opinions rather than evidence. The lesson learnt from this project was the importance of introducing a standardised procedure for CVDC care throughout all the haemodialysis units within the local health district. Use of a simple and unified protocol has encouraged staff to adhere to best practice and national/international guidelines.

A limitation of this project was that the team focused only on nurses' practice in CVDC care once the catheter was inserted. The period of care prior to insertion and the actual insertion method and care were not investigated in this project. This was because this project focused on what the dialysis nurse could change in their practice to reduce infection rates. Phase Two of this project would need to focus on the pre-insertion and insertion method to ensure best practice is being followed in an effort to further reduce CVDC infections.

## Conclusion

CRBSI is a major cause of morbidity and mortality in haemodialysis patients (Rosenbaum *et al.*, 2006). Staff should never underestimate the importance of infection control standards, such as hand hygiene and keeping the environment clean. The strategies used in this project can be transferred and adapted to any settings for the care of dialysis patients. Despite the limitation of this project, the results have demonstrated the importance of clinical practice which is the key element to patient outcomes.

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