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# Central venous access care practices in hemodialysis centers across India: A cross-sectional analysis

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**Abstract**
End-stage kidney disease (ESKD) poses a significant and growing health burden in India, where late presentation and limited vascular access planning often necessitate the use of central venous catheters (CVCs) for haemodialysis initiation. Although the Kidney Disease Outcomes Quality Initiative (KDOQI) guidelines recommend arteriovenous (AV) fistulas as the preferred vascular access, up to 80% of Indian patients begin dialysis with CVCs, which substantially increases the risk of catheter-related bloodstream infections (CRBSI) and mortality. This study assessed central venous access care (CVAC) practices across dialysis facilities in India, focusing on adherence to international guidelines and identifying variations in protocols.

A descriptive cross-sectional design was employed in seven dialysis centres representing different regions of India. Data were collected through direct observation of CVC procedures, facility record reviews, and interviews with nephrologists, nurses, and dialysis technicians. A 12-item checklist based on KDOQI 2019 guidelines was used to evaluate adherence during CVC access and exit-site care.

Findings revealed considerable variability in vascular access practices and infection prevention protocols across facilities. Only 55.7% of patients had AV fistulas, with reliance on temporary or permanent CVCs ranging from 10% to 95% between Centres. Antiseptic use for CVC care differed, with only 2 of 7 facilities using 2% chlorhexidine as recommended; povidone-iodine and spirit were more commonly used. Exit-site dressing frequency, type of occlusive dressing, and use of antibiotic barriers also varied. Overall adherence to guidelines averaged 67% (range: 53.8-83.9%), with strong compliance in mask use and sterile dressing but poor documentation of CVC assessments and CRI rates.

These findings underscore the urgent need for standardized operating procedures, competency-based training, and improved resource utilization to optimize CVAC practices. Strengthening adherence to evidence-based guidelines could significantly reduce infection-related morbidity and mortality among patients receiving haemodialysis in India.

**Keywords:** Central venous catheter (CVC), haemodialysis, central venous access care (CVAC) practices, adherence to evidence-based guidelines

## Introduction
End-stage kidney disease (ESKD) represents a rapidly increasing global healthcare burden. India has one of the largest populations on chronic dialysis, with thousands of new cases added annually. By 2030, the global need for kidney replacement therapy (KRT) is projected to more than double to 5.4 million people, with the highest growth expected in Asia [1].

A population-based study from a large urban cohort in India estimated an age-adjusted incidence of ESKD at 232 per million population [2]. In 2010, among 52,273 adult patients with chronic kidney disease (CKD), 61% were not receiving KRT, 32% were on hemodialysis (HD), 5% on peritoneal dialysis (PD), and 2% were being evaluated for kidney transplantation [3].

The Kidney Disease Outcomes Quality Initiative (KDOQI) recommends initiation of permanent vascular access, preferably an arteriovenous (AV) fistula at Stage IV CKD when glomerular filtration rate falls below 30 mL/min/1.73m [2, 4] In India, many patients present late, at Stage V, with severe uremia or fluid overload, necessitating urgent initiation of HD using a temporary double-lumen central venous catheter (CVC) inserted into the jugular, femoral, or subclavian vein.

At initiation, approximately 60-80% of patients depend on CVCs as a bridge to AV fistula creation [5]. The relative risk of bacteremia is nearly seven-fold higher with CVCs compared with AV fistulas, with a 50% increase in mortality [5].

In a study of 134 maintenance HD patients, 81% were initiated on dialysis via temporary vascular access on an emergency basis. The mean survival on HD was 40.31±26.99 months, with infections accounting for 26.5% of deaths [6]. Another Indian study reported catheter-related bloodstream infection (CRBSI) incidence rates as high as 8.75 per 1,000 catheter-days [7]. A retrospective cohort study from South India reported a CRBSI rate of 7.34 episodes per 1,000 catheter-days among 169 patients with non-tunnelled jugular catheters [8].

Given this high risk of infection and mortality, adherence to strict aseptic protocols during CVC use and exit-site care is essential. While KDOQI and National Kidney Foundation guidelines provide evidence-based recommendations for CVC care, practices vary widely across dialysis centers in India.

This study aimed to examine central venous access care (CVAC) practices across dialysis facilities in different regions of India to identify variations in protocols and adherence to guidelines.

## Materials and Methods

### Research Design

A descriptive cross-sectional study was conducted to assess CVAC practices in selected dialysis facilities across India. The investigator observed and documented CVAC protocols and procedures in seven dialysis centers, ensuring regional representation.

### Sampling Technique and Inclusion Criteria

Haemodialysis facilities that provided consent for direct observation were included. A consecutive sampling method was used in each facility to observe CVC use, access procedures during dialysis, and exit-site care.

### Data Collection

Vascular access-related practices were assessed using investigator-developed proformas (Appendices 1-3). Facility records were reviewed with permission, and nephrologists, nurses, and dialysis therapists were interviewed to clarify procedures.

- **CVC Access Practices:** Protocols followed during initiation and termination of dialysis were documented (Appendix 2).
- **Exit-Site Dressing Practices:** Procedures followed by nurses and dialysis therapists were assessed (Appendix 3).

Adherence to KDOQI 2019 guidelines [5] was assessed using a 12-item observational checklist (Appendix 4). Each item was scored as complete adherence (2), partial adherence (1), or non-adherence (0), with total scores ranging from 0 to 24. In each facility, five independent observations of CVAC procedures were conducted. Variations in practice were recorded, and the average time required for CVC access and exit-site care was documented.

## Results

### Facility Profile

Seven dialysis facilities were observed, comprising three government and four private centers, distributed across South (n=3), Central (n=2), North (n=1), and Northeast India (n=1). On average, each facility conducted 58 haemodialysis (HD) sessions daily, catering to 138 patients with end-stage kidney disease (ESKD). Patient numbers varied widely (53-240 per facility), with daily sessions ranging from 24 to 145.

Overall, 55.73% of patients were dialyzing via arteriovenous fistula (AVF), although facility-level rates ranged from 5.95% to 90%. Among those with central venous catheters (CVCs), only 58.26% had permanent devices. Two facilities exclusively used permanent catheters for CVC-dependent patients.

### Vascular Access Practices

Marked heterogeneity was observed in the choice of vascular access for HD initiation. One facility relied almost entirely on temporary catheters (95.05%), later transitioning to permanent CVCs. In contrast, two facilities routinely initiated long-term HD with permanent catheters when AVF was not feasible, reserving temporary catheters for acute or emergency use. Facility 3 reported the lowest AVF prevalence (5.95%) and the highest reliance on permanent CVCs (69.62%). These findings highlight significant deviations from KDOQI recommendations, which advise limiting temporary catheter use to short-term or emergency HD.

**Table 1:** Facility Profile & Vascular access choice for Hemodialysis

| Facility Profile and Vascular Access choice | Mean | Median | Range | Maximum | Minimum |
|---|---|---|---|---|---|
| No: of HD/day | 58.43 | 42 | 121 | 145 | 24 |
| Number of patients with ESKD enrolled for MHD | 137.86 | 110 | 187 | 240 | 43 |
| Percentage of patients with AVF as vascular access | 55.63 | 64.15 | 84.05 | 90 | 5.95 |
| Percentage of patients on CVC | 44.37 | 35.85 | 84.05 | 94.05 | 10 |
| Percentage of CVC with PCVC | 58.26 | 65.5 | 100 | 100 (3) | 0 |
| Percentage of CVC with TCVC | 35.02 | 20 | 100 | 100 | 0 |

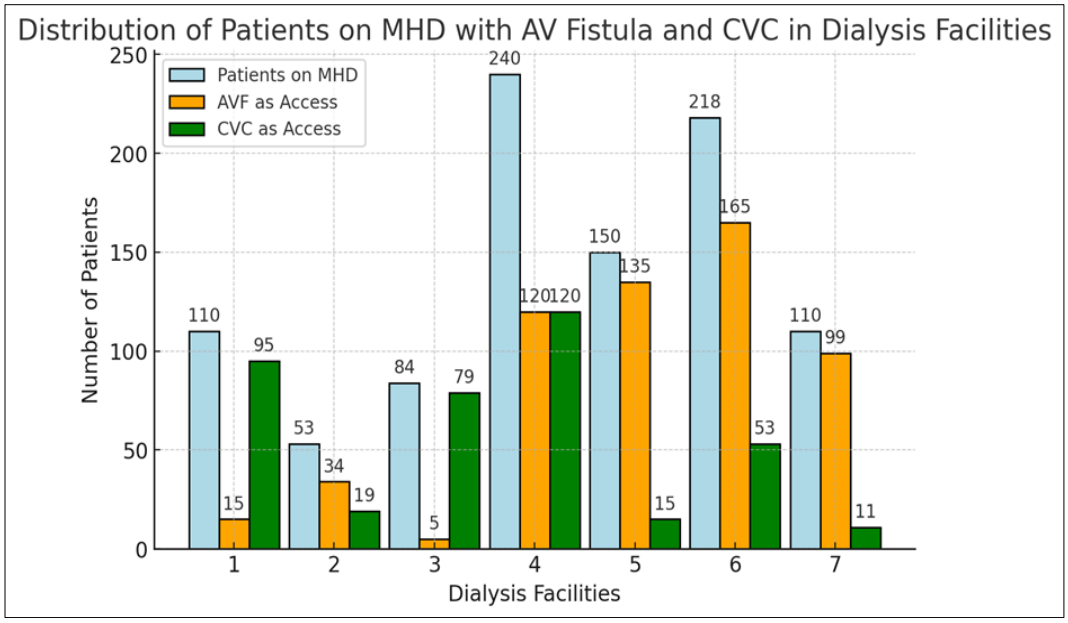


**Fig 1:** Distribution of patients on MHD with AV Fistula and Central Venous catheter.

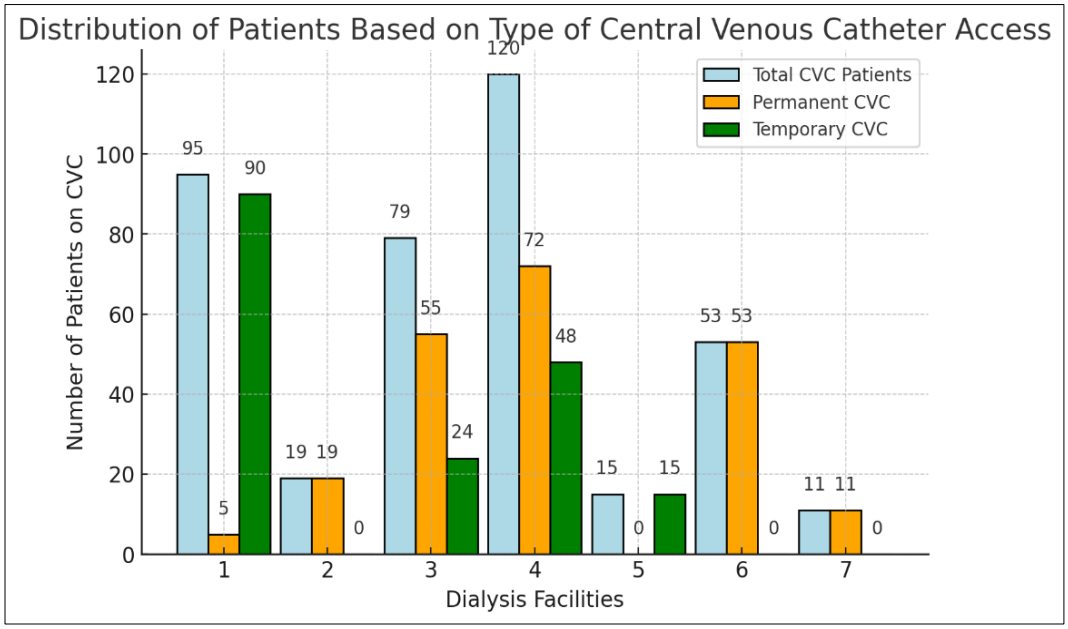


**Fig 2:** Distribution of sample based on the type of CVC.

**Personnel Performing Dialysis**

Dialysis was performed by the dialysis technicians or therapists in most centres, with only one to two nurses per shift for nursing care. Three facilities had nurses independently performing HD, while only one had a structured competency-based training and certification program for nurses, including specialized role of Haemodialysis Specialist Nurse for vascular access surveillance.

**Protocols and Procedures practiced for Central Venous Catheter Access and Exit-Site Care**

Protocols for catheter access and site care observed varied substantially between facilities.

- **Antiseptic use:** Only two facilities employed 2% chlorhexidine, while most used povidone-iodine, with or without surgical spirit.
- **Catheter Hub cleaning:** Just three facilities practiced the recommended "scrub-the-hub" technique.
- **Lock solutions:** Heparin was universally used, though concentration used varied widely (1000-10,000 units/mL). One facility used heparin-gentamicin combination.

**Exit-site dressing:** All facilities changed dressings at every HD session. However, only one inspected the site before HD initiation as per guidelines. Tegaderm with gauze was the most common dressing (3/7), while others used gauze with Elastoplast. A quasi-experimental study that compared the effectiveness of different cutaneous antiseptics in reducing risk of catheter-related infection in intensive care unit (ICU) patients showed that the incidence of catheter-related infection was lower with 2% Chlorhexidine as compared to povidone iodine [HR, 0.35; 95% CI (0.15, 0.84), p = 0.02].

However, 2011 CDC/Healthcare Infection Control Practices Advisory Committee (HICPAC) Guidelines for the Prevention of Intravascular Catheter-Related Infections,

recommend disinfection with an appropriate antiseptic (greater than 0.5% chlorhexidine with alcohol, 70% alcohol, or 10% povidone-iodine) prior to accessing the dialysis catheter hub. There is not enough evidence to recommend one antiseptic over the others.

**Antibiotic barriers** were used for exit site in only three facilities.

**Adherence to CVAC Practice Guidelines**

Overall adherence to KDOQI recommendations for catheter access care (CVAC) was 67% (SD 11.41), with facility scores ranging from 53.85% to 83.85%. Universal compliance was observed for mask use during CVAC and application of sterile occlusive dressings. In contrast, adherence was lowest for documentation: only 32.86% routinely recorded catheter site assessments, and just two facilities-maintained infection rate records.

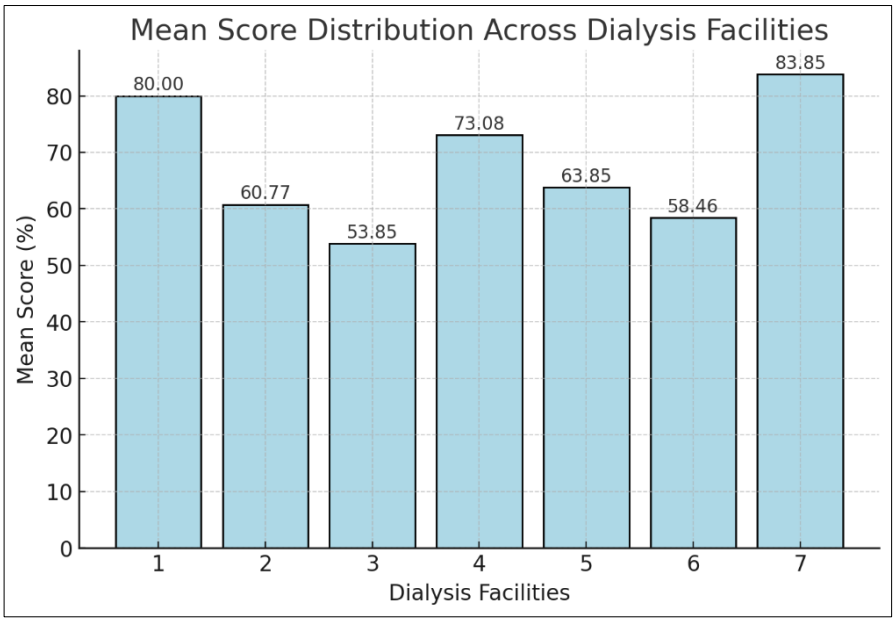


**Fig 3:** Mean Score on Adherence to CVAC Guidelines (n=35)

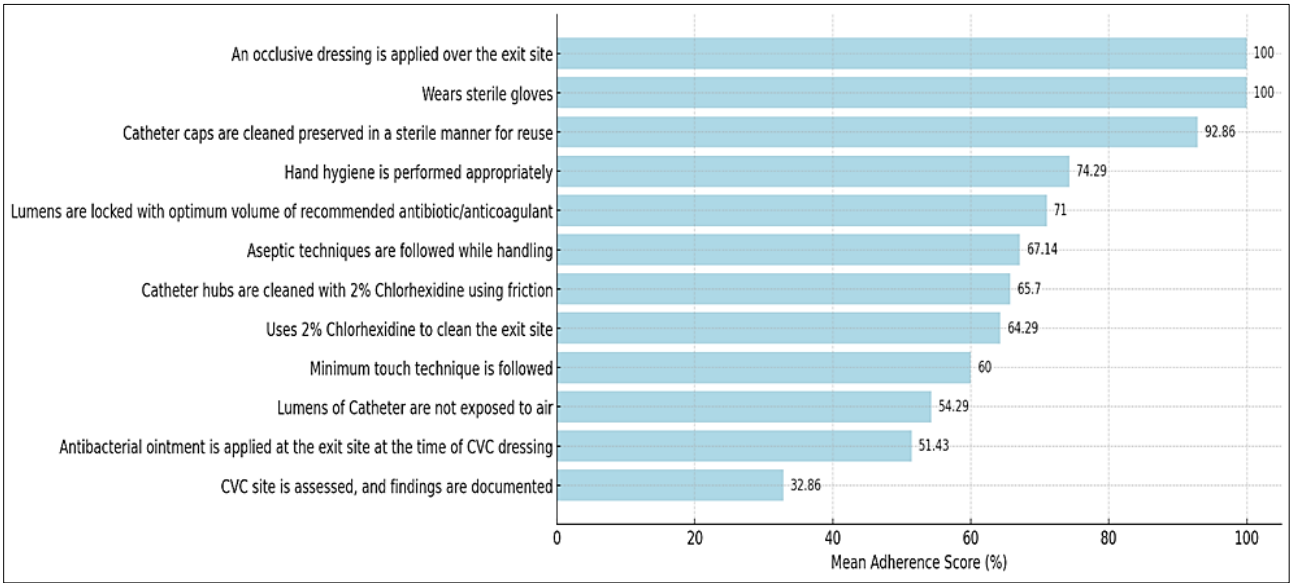


**Fig 4:** Distribution of Sample based on Adherence to CVC care Guidelines (n=35)

**Time and Material Utilization**

The mean catheter handling time was 17.7 minutes (range: 12.5-25.5). Exit-site dressing accounted for the largest proportion (mean 8 minutes). Time variability was attributed to inefficient organization of materials and procedural interruptions.

Most centres used reusable autoclaved stainless-steel sets, though the number and type of items varied. Disposable kits were rare. Antiseptic solutions were often used excessively, leading to wastage. Gloves and masks were consistently employed, but cost analysis of resource use could not be undertaken due to lack of facility-level data.

**Discussion**

The investigator conducted direct observations in seven dialysis facilities across different regions of the country, comprising three government and four private centers, to evaluate protocols and practices related to central venous access care (CVAC).

**Facility Profile and Vascular Access Choice**

The facilities performed 24-145 haemodialysis (HD) sessions daily (median 42), serving 53-218 patients on maintenance haemodialysis (MHD). Only 55.6% of patients had arteriovenous fistulas (AVF), while 44.4% relied on central venous catheters (CVC), of which 35% were temporary non-tunnelled catheters. Notably, three facilities maintained 100% of CVC patients on permanent tunnelled catheters (PCVC), while one reported only 6% PCVC use.

These findings are concerning, given KDOQI guidelines that recommend AVF as the preferred access for incident HD patients and restrict non-tunneled catheters to <2-3 weeks [5]. Evidence consistently shows that CVC use is associated with significantly higher bloodstream infection (BSI) rates compared to AVF. The observed practice of initiating most patients with temporary jugular catheters, followed by conversion to tunneled catheters and later AVF, mirrors patterns reported in North America, where CVCs remain the most common initial access [9]. A nationwide online questionnaire was distributed to nurses, renal trainees, and consultants involved in dialysis line insertions and removals in 72 renal units in the UK, showing that 49% of patients commence hemodialysis (HD) using either a temporary or tunneled central venous catheters [10].

**CVAC Protocols During HD Connection and Disconnection**

Marked variations were noted in antiseptic choice for hub and exit site care. While KDOQI recommends 2% chlorhexidine, most facilities used povidone-iodine, surgical spirit, or saline. Only two centres followed the recommended chlorhexidine-based protocol. A quasi-experimental study that compared the effectiveness of different cutaneous antiseptics in reducing risk of catheter-related infection in intensive care unit (ICU) patients showed that the incidence of catheter-related infection was lower with 2% Chlorhexidine as compared to povidone iodine [HR, 0.35; 95% CI (0.15, 0.84), p = 0.02] [11].

However, 2011 CDC/Healthcare Infection Control Practices Advisory Committee (HICPAC) Guidelines for the Prevention of Intravascular Catheter-Related Infections, recommend disinfection with an appropriate antiseptic (greater than 0.5% chlorhexidine with alcohol, 70% alcohol, or 10% povidone-iodine) prior to accessing the dialysis catheter hub [12].

Additionally, adherence to “scrub the hub” technique recommended by CDC to remove any blood residue from the threads of the hub [12] and contact times for antiseptic application was inconsistent. Uniform practices included aspirating and discarding lock solution before dialysis and reusing catheter caps preserved in antiseptic. However, lumen exposure was avoided in only ~54% of procedures.

Lock solutions also varied, with most centres using heparin but at different concentrations (1,000-10,000 U/mL). Only one facility used a heparin-gentamicin combination.

Three European RCTs compared citrate to heparin CVC lock (total N = 542) and showed no statistically significant difference between groups (RR, 1.25; 95% CI, 0.53-1.96] [13-15].

Evidence from 5 RCTs and meta-analyses suggests that low-dose heparin (<5,000 U/mL) is equally effective in maintaining catheter patency while reducing bleeding complications and infection risk [16]. None of the facilities employed prophylactic thrombolytics or antibiotic-impregnated devices, reflecting limited adoption of advanced practices.

**Exit Site Care and Dressing Practices**

Exit site dressing was typically performed after HD, though one facility did so prior to HD, allowing early infection detection and aligning with KDOQI recommendations [4]. Frequency of dressing changes was uniformly high (every session), despite CDC guidelines permitting dressing change once in 7 days for tunnelled catheters [17]. Antiseptic use again showed reliance on povidone-iodine rather than chlorhexidine.

Topical antibiotic barriers were applied in fewer than half the facilities, despite robust evidence showing that use of mupirocin reduces catheter-related bloodstream infections (CRBSI) by 75%-93% [18].

A randomized controlled trial (n=50) performed to compare the effect of thrice-weekly exit site application of mupirocin (mupirocin group) vs no ointment (control group) on infection rates and catheter survival in patients receiving hemodialysis showed significantly fewer catheter-related bacteremia (7 vs 35%, $P$<0.01) and a longer time to first bacteremia (log rank score 8.68, P<0.01) [19].

**Occlusive Dressing:** Except for two facilities that used gauze and Elastoplast as an occlusive dressing for exit site, all other facilities used transparent dressing over a gauze that covered the exit site.

Recent data indicate that there is no significant difference between transparent, semipermeable dressings and standard gauze dressings with respect to CVC exit-site colonization or CRBSI [20, 21].

Documentation practices were weak, with infection-related records retrievable in only half the centres.

**Adherence to CVAC Guidelines and protocols**

Overall adherence to CVAC protocols was suboptimal, with a mean compliance of 67.6% (range 53.9-83.9%). High adherence was observed for mask use and occlusive dressing, but documentation of catheter site assessment was poor (32.7%). Hand hygiene was universally performed, but correct technique was followed in only 74.3% of observations.

These findings align with the findings of international surveys done on health care personnel in Italy and UK showing widespread variability and incomplete adherence to evidence-based guidelines on antiseptic selection, dressing frequency, and antibiotic use at exit sites [22, 23].

**Implications for Practice**

The study highlights considerable heterogeneity in CVAC practices across Indian dialysis facilities, with frequent departures from established guidelines. Over-reliance on temporary catheters, inconsistent antiseptic protocols, variable lock solution concentrations, and poor documentation collectively contribute to elevated infection risk and suboptimal outcomes.

Given that dialysis in India is predominantly technician-driven, there is an urgent need to strengthen training and empowering nursing staff to develop, implement, and audit standardized evidence-based protocols. Adoption of best practices such as prioritizing AVF creation, consistent use of chlorhexidine antisepsis, application of topical antibiotic barriers, optimal lock solutions, and systematic

documentation could significantly reduce CRBSI rates and improve patient safety.

## Conclusion

The variation in practices between facilities in the country in accessing central venous catheters and performing exit site care during hemodialysis points to the need for standardization of protocols and procedures related to Central Venous Access care. Nurses need to be trained and empowered to lead and manage care in hemodialysis settings. Improvement in Central Venous Access care practices would eventually translate to reduction in catheter-related infections and improved patient care outcomes.

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## Conflict of Interest

Not available

## Financial Support

Not available

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